**FIRST JOINT SUMMER SCHOOL**

Organized by Finnish Russian Cross Border Universities

27.–31.8.2012

**University of Lapland**

Rovaniemi, Finland

# Multidisciplinary Dialogue

## – Wellbeing, Technology and Environment

**EXTENDED ABSTRACT BOOK**

BARENTS Cross Border University

Kolarctic ENPI CBC | CROSS-BORDER COOPERATION

CBU CROSS-BORDER UNIVERSITY

UNIVERSITY OF LAPLAND LAPIN YLIOPISTO

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**Cover**
Irma Varrio

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# PREFACE

The world around us is changing rapidly. Both local and global economic, social, technological and environmental changes have impact on future of societies. We are facing more and more complex challenges such as, for example, fast population growth, increasing life expectancy and global warming. In general, emerging development in different spheres of life has raised the need for multidisciplinary approach and collaboration in discussion and solving of current and future challenges.

With establishment of the event "Multidisciplinary Dialogue - The First Joint Summer School" the organizers hope for their part to contribute to the discussion and offer a possibility for multidisciplinary communication between researchers, teachers and students representing different fields of study and research.

The First Joint Summer School was organized in co-operation with the Barents Cross-Border University (BCBU) and the Finnish-Russian Cross-Border University (CBU) and was co-funded by the Aleksanteri Institute, Barents Cross-Border University development project 2011 - 2013 (BCBU+) and the program of Finland´s cooperation with neighbouring areas coordinated by the Ministry for Foreign Affairs of Finland.

The Summer School was divided into five sessions where in addition of the research methodology and ethics the three main disciplines; technology, wellbeing and environment were discussed with a multidisciplinary approach. The program was composed of keynote lectures, students´ oral and poster presentations based on pre-sent abstracts, workshops and discussions. Part of the pre-sent abstracts was selected to be included in this Extended Abstract Book.

On the basis of collected feedback the participants considered this kind of event very interesting and useful and it has encouraged the organizers to continue the joint work. Planning of the next Joint Summer School has already been started and it will be held in 2014 in Kuopio, Finland.

The organizers would like to thank all lecturers, students and other participants for contributing to organization and success of the First Joint Summer School. We also acknowledge the financial contribution of the networks, individual partner universities and the external co-sponsors. Thank you and see you in Kuopio!

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# PROGRAMME

**August 27 - 31, 2012 Rovaniemi, Finland**

**WELLBEING AND TECHNOLOGY**

Monday 27.8.2012
Lecture Hall 2 (LS2 Main lobby)

The first day is reviewing the question of how information technology can support living of senior citizens. The keynotes will enlighten how senior citizens living environment at home can be developed more intelligent and how their quality of life could be improved. The workshop session covers student´s oral and poster presentations about the different kind of models.

9:00 - 10:00 **Registration**
10:00 - 10:30 **Opening**
**Opening:** *Professor Tarja Orjasniemi, University of Lapland*
**Welcoming address:** *Rector Mauri Ylä-Kotola, University of Lapland*
**Chairs:** *Petri Pulli & Kari Pankkonen, University of Oulu*

10:30 - 12:00 **Keynotes**
10:30 - 11:15 "Smart Living Environment for Senior Citizens"
*Professor Petri Pulli, University of Oulu*

11:15- 12:00 "PiTaSU - Universal touch interface"
*Professor Goshiro Yamamoto,*
*Nara Institute of Science and Technology (NAIST)*

12:00 - 13:00 **Lunch break**
13:00 - 14:15 **Keynotes**
13:00 - 13:30 "Evolving Welfare by using IT"
*Lecturer Arja Kilpeläinen, University of Lapland*

13:30 - 14:15 "Politics of Development in the Barents Region"
*Research Professor Monica Tennberg, Arctic Center*

14:15 - 14:35 **Break**
14:35 - 15:55 **Oral Presentations**
14:35 - 14:55 "Ethical and Legal Consequence of these Medical Discoveries"
*Denard Veshi, Università Carlo Cattaneo*

14:55 - 15:15 "Context Aware Recommendation of Location-based Data"
*Karol Waga, University of Eastern Finland*

15:15 - 15:35 "Smart Kitchen Architecture"
*Zeeshan Asghar, University of Oulu*

15:35 - 15:55 "Computational Approaches to Visual attention for Usability and User Experience"
*Hana Vrzakova, University of Eastern Finland*

15:55 - 17:00 **Poster Presentations**

"Use of Workflow Technology in Smart Kitchen Environment"
*Tomi Sarni, University of Oulu*

"Context-aware adaptation process for Smart Kitchen Environment"
*Yahui Li, University of Oulu*

"Safety Navigation System"
*Kang Wang, University of Oulu*

"Remote-Guidance for Elderly Demented People"
*Xiao Bin, University of Oulu*

**TECHNOLOGY AND ENVIRONMENT**

Tuesday 28.8.2012
Lecture Hall 2 (LS2 Main lobby)

Technology is becoming more and more important in environmental issues. Monitoring of environment requires special measurements and the analysis of measured data requires computational methods. The keynote presentations are selected from Finnish and Russian Universities (University of Eastern Finland and from St Petersburg State University) and from the Technical Research center of Finland (VTT). Keynote presentations cover both academic and technology oriented research results.

9:00 - 09:15 **Opening**
**Chair:** *Mika Huuhtanen, University of Oulu*

9:15 - 11:50 **Keynotes**
9:15 - 10:00 "Environmental Informatics"
*Professor Mikko Kolehmainen, University of Eastern Finland*

10:00 - 10:20 **Break**
10:20 - 11:05 "Digital Systems and Environment"
*Professor Evgeny I. Veremey, St. Petersburg University*

11:05 - 11:50 "Wireless environmental measurements"
*Senior Scientist Klaus Känsälä, VTT Technical Research Centre of Finland*

11:50 - 13:00 **Lunch break**
13:00 - 13:50 **Keynote**
13:00 - 13:50 "Introduction to Digital Processing World" (demonstration)
*Evgeny I. Veremey & Margarita Sotnikova, St. Petersburg University*

13:50 - 14:30 **Oral Presentations**

13:50 - 14:10 "Water Supply Systems in Petrozavodsk, Russia and Oulu, Finland"
*Anastasia Dupatova, University of Oulu*

14:10 - 14:30 "Utilization of Remotely Sensed Hyperspectral Information for Forest Analysis"
*Paras Pant, University of Eastern Finland*

14:30 - 14:50 **Break**
14:50 - 15:50 **Poster Presentations**

"Perception of Forest Industry Companies towards Forest Certification in Russia"
*Maxim Trishkin, University of Eastern Finland*

"Spectral Images Compression Using PCA and Wavelet Transformations with Information Losses Control"
*Artur Khromov, Saint-Petersburg State University*

“Content Popularity"
*Liliya Rudko, University of Helsinki*

"Forest Stand Segmentation from Lidar Data Based on Mean Shift and Spectral Clustering"
*Zhengshe Wu, University of Eastern Finland*

**RESEARCH METHODOLOGY**

Wednesday 29.8.2012
Lecture Hall 2 (LS2 Main lobby)

Research methodology is a very important issue when something is studied systematically and scientifically. There are several ways to perform a research study properly depending on the branch of science and methods used. These methods may vary a lot and some of them have also specific features. The lecturers will present an overview (keynote) and field specific methodologies as case studies covering interviews, field tests and modeling/experimental work. The output of the day will be beneficial for all the participating students as they get information on methods used in the different fields. Also, the multidisciplinary presentations

may give the students new ideas to be adapted in their own researches and studies.

9:00 - 9:15 **Opening**
**Chair:** *Tarja Orjasniemi, University of Lapland*

9:15 - 11:50 **Keynotes**
9:15 - 10:00 "Towards post-disciplinarily? Mixing methods and multi-disciplinary dialogue"
*Professor Suvi Ronkainen, University of Lapland*

10:00 - 10:20 **Break**
10:20 - 11:05 "Methodologies in Modeling and Experimental Studies"
*Professor Kauko Leiviskä, University of Oulu*

11:05 - 11:50 "Quantitative Research Design. The reason for Choice"
*Docent Marina Kubyshkina, Northern (Arctic) Federal University*

11:50 - 13:00 **Lunch break**
13:00 - → **Cultural Programme in Rovaniemi**
The programme is designed to be free and open. Students will make their own program for the afternoon.

18:00 - 20:00 **Meeting for BCBU and CBU Finnish working group members**
*Separate invitations, Venue: Sokos hotel, Fransmann, Donna-kabinet*

**WELLBEING AND ENVIRONMENT**
Thursday 30.8.2012
Lecture Hall 2 (LS2 Main lobby)

The effect of place and environment are important for the health and wellbeing. However during the global processes in economics and livelihoods, many changes take place, e.g. the global comes to local especially seen in mining. What are these effects to the local people when environment and living conditions are in change?

9:00 - 9:15 **Opening**
**Chairs**: *Juhani Miettola & Annika Männikkö*
*University of Eastern Finland*

9:15 - 11:50 **Keynotes**
9:15 - 10:00 "Socio-cultural Environment and Well-being"
*Professor Jussi Kauhanen, University of Eastern Finland*

10:00 - 10:20 **Break**
10:20 - 11:05 "Old Age Alcoholism as a Social Phenomenon"
*Professor Andrey Soloviev, Northern State Medical University*

11:05 - 11:50 "Cross-Border Prostitution in the North"
*Lecturer Pia Skaffari, University of Lapland*

11:50 - 13:00 **Lunch break**
13:00 - 13:40 **Oral Presentations**
13:00 - 13:20 "Co-design as a Method of Inclusion for Older Adults in Public Social and Health Care Services"
Hanna-Riina Vuontisjärvi & *Marjo Outila, University of Lapland*

13:20- 13:40 "Social Determinants of Health in Well-Being"
*Paul Pavitra, University of Eastern Finland*

13:40 - 14:00 **Break**
14:00 - 14:40 **Poster Presentations**
"Health Care Quality in Sparsely Populated Area: Health Care in Murmansk Region"
*Maria Semenova, University of Eastern Finland*

"Social Adaption of Orphans and Children without Paternal Support"
*Irina Petuchova, Petrozavodsk State University*

18:00 - 20:00 **Get Together Evening**
Venue: University of Lapland LS20 and LS21, A-Wing, Ground Floor

**MULTIDISCIPLINARY RESEARCH ETHICS**

Friday 31.8.2012
Lecture Hall 2 (LS2 Main lobby)

The ethical questions are even more important in the multidisciplinary research - they cover the whole field of research from the research questions to communication. During the day we will first about the research ethics in general/national level (Professor Riitta Keiski from University of Oulu and lecturer Lidia Kriulya from NArFU), and continue with two focused talks about the special questions in multidisciplinary health research (Professor Anna-Maija Pietilä, University of Eastern Finland) and social sciences (Professor Merja Laitinen, University of Lapland). In the afternoon we have workshop about the ethical aspects which have been noticed or discussed in participants own research work or master´s theses.

9:00 - 9:15 **Opening**
**Chairs**: *Professors Arja Rautio, University of Oulu &*
*Mirva Lohiniva-Kerkelä, University of Lapland*

9:15 - 11:50 **Keynotes**
9:15 - 10:00 "Research Ethics in Finland"
*Professor Riitta Keiski, University of Oulu*

| | |
|---|---|
| 10:00 - 10:20 | **Break** |
| 10:20 - 11:05 | "Research Ethics in Russia"<br>*Lecturer Lidia Kriulya, Northern (Artic) Federal University* |
| 11:05 -11:50 | "Challenges in Multidisciplinary Health Research"<br>*Professor Anna-Maija Pietilä, University of Eastern Finland* |
| 11:50 - 13:00 | **Lunch break** |
| 13:00 - 14:00 | **Group work (LS20, LS21, SS22, SS23)** |
| 14:00 - 14:20 | **Lunch break** |
| 14:25 - 15:00 | **Result of the group work (LS2)** |
| 15:00 - 15:30 | **Closing the summer school** |

# BOOK OF EXTENDED ABSTRACTS

# ETHICAL AND LEGAL CONSEQUENCE OF THESE MEDICAL DISCOVERIES

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**Abstract:** During the 19th century there was an impressionable increase in medical discoveries that led to the invasion of medicine in our life. At the same time, and precisely in the '60s, was born the science of Bioethics. Philosophers and jurists started to discuss about the possibility if humans have or not the availability of their life. Today, the majority of them believe that when the legislator has to discipline the making of the end-of-life decision, he has to find the balance between the right of the single individual to decide about his own destiny and the general interest of the State to save the human's life. It seems that the term "euthanasia" has not the meaning of "easy death", as identified by the Greek term *"eu thanatos"* , but it appears like an instrument to transform the death in a procedure. For this reason the law has to be clear and easily compressible. Therefore, the State has the maximum freedom to regulate the *proceduralisation* of the life-ending decision, but it *can't* deny that decision. Additionally, the State has to take into account the *slippery slope* which is the fear that legalizing euthanasia would lead to an analogous application to cases which do not fit under this category.

***Keywords:*** *bioethics, new technologies, euthanasia, law, philosophy*

## INTRODUCTION

With the birth of bioethics, began a great debate about the ethical and legal consequences of medical decisions, which involved both philosophers and jurists. They started by distinguishing between the cases of euthanasia and assisted suicide. Both concepts can be explained with the same definition, i.e., the acts or omissions which have the intention to end the life of a human being. In the cases of assisted suicide, the person that does these acts is also the proprietor of the life while, in the cases of Euthanasia, the act is made by a third person who is not the owner of that life. It must be noted that there are different forms of Euthanasia. In case of *Active Euthanasia*, the act that stop the life is done directly by the third person while in case of *Passive Euthanasia*, the result of an omission of the third person conducts to the patient's death. Instead, in the case of *Indirect Euthanasia*, which happens when the behavior of a doctor has the purpose to relieve the patient's pain, the patient's death is considered an indirect and foreseeable consequence. All philosopher and jurists agree not to punish this kind of Euthanasia because there is no intention to kill the patient.

## METHODS AND MATERIALS

In the first step of this paper the author analyzes the medical discoveries that have prolong our life, such as anesthesia, antibiotics, vaccination, the DNA structure etc. After that, the study was concentrated to the ethical and legal consequence of these medical discoveries. In the project the various trends of the philosophy related to the availability (or not) of the life was explore in details. In concrete, there were examined the neo-Kantianism, the neo-Classicism, the Liberal Bioethics, the Utilitarianism and the Virtue Ethics. At the end of this work there were assessed the legal consequences of end-of-life decision making.

In addition to the theoretical analysis of the philosophy and law, some real life examples were included in order to support the conclusions of this project. After a small

introduction to the Case of Quinlan of 1976, one of the first verdict from the Supreme Court of USA, the project paid attention to the European legislations and cases, especially the legislation of the Netherlands. Moreover, in this work were analyzed some juridical cases in Germany, Italy and Spain, countries which do not have a specific law about Euthanasia, but is the Supreme Court which takes the decisions in singular cases based on the "European Convention on Human Rights and Biomedicine," also called the "Oviedo Convention" of April 4, 1997.

## RESULTS

Philosophers and jurists are divided about the fact if humans have or not the availability of their life. In the first group we find the Catholic doctrine, the neo-Kantianism and the neo-Classicism. According to the Declaration on Euthanasia of the Sacred Congregation of June 1980, there is unavailability of life because life is one of the sacraments; as a result euthanasia is considered homicide. For other philosophers, that considered themselves prosecutors of Kant, euthanasia is thought as an act against human dignity. The prosecutors of the neo-Classicism believe that euthanasia is illegal because the practical sense prescribes the forms of our moral action.

On the other hand, today, the majority of the philosophers recognize the availability of life. According to the prosecutors of Liberal Bioethics there is the *'availability of life'* because everyone has the freedom and self-determination which are fundamental rights. Other philosophers agree with the availability of life because it is based on the conception of compassion, which is a virtue ethics. They claim that every action must bring benefit to the recipient of it. A third group of the doctrine, which acknowledges the availability of life, attacks the Catholic doctrine by highlighting the concepts of the Utilitarianism. According to them, life is a relative good that depends on the circumstances of the situation. Euthanasia is a good action if derives a benefit for the patient. In this case there is a maximization of the utility.

One of the first legislatures that disciplined the end-of-life decision making was the legislature of the Netherlands. This state continues to punish homicide and assisted suicide, but, in the other side it has predicted an exception for the doctors who help the patient to commit suicide only if they observe the criteria predicted by the law. First of all, the medical situation has to be hopeless. So, it is not necessary that the patient has to be in a terminal phase, but just into intolerable pain. Additionally, it is needed the consent of the patient. However, before taking the decision, the doctor should request the opinion of another independent doctor. After the act the doctor has to redact a report that must be sent to one of five Regional Commissions which will do the examination of the documents. If the Regional Commission has any doubts of an irregular step taken during this procedure, they must report that the Procurator. In other states where there is no provision of law on the availability of life, it is the Supreme Court the one who solves the problems on this matter (Germany or U.S.A.), usually by taking into consideration the "European Convention on Human Rights and Biomedicine" of 1997, the constitutional right of health and by trying to do a balance between the personal right of health and the State's general interest to preserve human's life.

## CONCLUSIONS

Now we are in the third millennium and we have a high level of welfare because there have been lots of new discoveries which have influenced our way of living. It seems that we depend so much from the technology that we do not have the possibility of taking a choice for ourselves in order not to use the technology. Philosophers and jurist have to discuss about this new situation which is always in evolution. It is for me very difficult to imagine that humans cannot have the freedom and the self-determination to decide for their own destiny; therefore everyone should have the availability of his/her own life.

On the other hand life is a precious good that can't be interrupted with a rapid decision; so the legislator has to discipline end-of-life decision making through a long administrative procedure which will avoid decisions made under stress, violation, pressure, based on misinformation or when this decisions are irrational. Moreover, the legislator has to take into account the fact that, by legalizing the euthanasia, patients who are not in a terminal phase or do not have a hopeless medical situation would also ask to "die" because they have a disadvantaged social situation. I definitely think that people have to invest in technology and also philosophers and jurists have to adjourn their knowledge and discussions about the ethical and legal consequences that come from the new medical discoveries.

## REFERENCES

Rachels J, (1986) The End of Life: Euthanasia and Morality, Oxford University Press, 187-236 pp.

Singer P (1995), Rethinking life and death. The collapse of our traditional ethics, Oxford University Press, 95-122 pp.

Canestrari S (2003), Eutanasia e diritto, Giappicchelli, 52-123 pp.

Kuhse H. and Singer P (2006) Bioethics. An Anthology, Blackwell, 24-63 pp.

# CONTEXT AWARE RECOMMENDATION OF LOCATION-BASED DATA

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**Abstract:** There is much information available, but the problem is how to find which is relevant. We present a context aware recommendation system, which recommends relevant location-based data. We study its performance within MOPSI service that includes fixed form maintained database and free form user collection.

***Keywords:*** *Recommendation, relevance, context-aware, location, content, network, time, location-based applications*

## INTRODUCTION

Recommendation systems are important research and are in scope of interest of both universities and companies (Adomavicius and Tuzhilin 2005). Recommendation systems produce personalized search results by performing analysis of user actions (Birukov et al 2005). Such systems can be used, for example, for recommending similar products in online stores, music or videos which may be of interest of particular user, and advertisements targeted to specific audience. Recommendation system takes into account additional information about user, which is called context. Examples of contexts we identified are user's location (distance to the service), identity (age, gender, hobbies and language), social network, history of activities, time, technical resources (network accessibility, bandwidth), and the purpose of use (work, leisure time).

Location is very important attribute of our data. Mobile technology is increasing its popularity and availability and it allows collecting location data (Ge et al. 2010). Furthermore, mobile phones are one of the main devices for information access (Ricci 2011). Because of technical limitation, such as bandwidth and screen size, recommendation system can be used to reduce amount of information presented to user. Recommendation system can consider user's location for recommending the nearest service (ATM, restaurants, pubs, tourist sights and social events). However, the nearest service may not be the most interesting for user and other factors should also be considered.

Our goal is to design a context-aware recommendation system based on the four aspects of relevance (content, time, location and social network) discussed in (Fränti et al. 2011). For recommendation we use the MOPSI services geo-tagged database, which contains user-generated photo collection and service database. Our solution is designed and implemented as a prototype solution within MOPSI, as a case study. The MOPSI project implements various location-based services and applications such as mobile search engines, data collection, user tracking and route recording. It has applications integrated both on web and in mobile phones.

## SYSTEM DESCRIPTION

In this section, we provide description of what our system actually recommends and

how it uses the four main aspects of relevance as the context.

Our aim in MOPSI is to recommend interesting places in user's surrounding. In the service, we have two databases that are used for the recommendation. First database contains trusted services verified by administrators. These services represent variety of categories from restaurants, bars, and cafeterias, through grocery stores, pharmacies, and ATM machines, to car repairs, and museums. Service data include location, contact information, and relevant keywords.

Second database contains photos users have taken using mobile phones and uploaded real-time with several related information, such as location, time, and description. Both photos and services (referred as items from now onwards) are rated by users. Moreover, photos can picture any place, which is found interesting by the user.

In our recommendation system, we give personalized recommendations by combining various paradigms of recommendation systems. We combine collaborative filtering with information about user profile and context.

Having these two sources for recommendation, the challenge is how to select the most relevant items to users. First we define context for each recommendation request. In our previous work we identified four aspects of relevance: location, content, time, and network (Fränti et al. 2011). Location is physical place of the user represented by geographical coordinates (latitude and longitude). Content in MOPSI is determined currently based on the description of the photos and keywords attached with the services. Time is considered only for photos and measures age of photo and the season (of the year) when photo was taken. Network is utilized via ratings given by other users to items and it constitutes an integral part of the system based on collaborative filtering. Considering these context in mind, we create profile for each user of MOPSI.

User profile contains user behavioral data, such as location and previous usage of data, i.e. how user interacted with the system. Currently this is measured by the keywords user has performed earlier searches and visited locations.

In this section, we describe in details how we implement the system. Summary of the algorithm is followed by description of the scoring function used by the algorithm.

Recommendation algorithm consists of three major steps. Its input is the username and location of the user. First step is to select potential items that are to be considered. We use location as the criterion for this pre-selection. Items that are far from user are considered irrelevant and are skipped already at this stage. The selected items are then scored in the second step.

Third step is to prepare final list of the recommended items ordered according to the scores received in the second step. The system outputs the final recommendation list, which consists of 20 items of the highest scores.

User interface is provided both for the MOPSI mobile application and the website. In web, the recommendation function is embedded on the MOPSI main page where user can request recommendation by pressing a single button. The results are visualized on screen in two ways. On the left, there is scroll list of the recommended items including

title, street address and distance. Photo results include the description user has entered (if available), street address, date, distance, photo thumbnail and author. All the results are marked on the map visible on right side of the screen. Services are marked with green bubbles and photos with yellow bubbles. User location is marked by blue bubble with "*Mopsi dog*" icon.

In mobile application, the recommendation function is embedded in MOPSI Services screen where user can request recommendation by pressing a single button. Application will show list of results including name, distance and type (service or photo) of each item. It is possible to see details of every result by selecting it on the list. Details of service results include title, street address, distance and list of keywords. Photo results include description user has entered (if available), photo thumbnail, street address, distance, author and date. By clicking on the address field, user can see map with item and its location marked.

## SCORING FUNCTION

Services are scored using contextual information about search history, location, and explicit rating. Photos are scored based on the same three factors and also on time. These factors are discussed next. We explicitly use two of the four aspects of relevance (location and time), whilst the other two factors (search history and rating) combine content, social network and time.

We define two search histories that are based on previous user behavior: *general* and *user-specific*. For services we take into consideration both the service name and the associated keywords, and for photos, we use the description which is assigned by the user.

The *general* history records keywords used for searches by all MOPSI users. It is used in three ways. Firstly, to check if any of the keywords associated to the service in question has been searched in nearby locations ($S_N$). Secondly, to check if any of the keywords has been searched recently ($S_S$). Thirdly, to check if the keyword has high frequency within all search requests ($S_F$).

*User specific* history records keywords that a given user has been used before for searches ($S_U$). Keywords of services and photos that are found in the history list are given 3 points each. For example, let us consider a service with keywords *café* and *restaurant*, and a user who has searched for *restaurant*, *bar*, *café* and *sauna* in the past. In total, this service gets 6 points for user specific history since two matched keywords were found.
Total score of search history consists of the following components:

$$S_H = S_N + S_S + S_F + S_U \quad (1)$$

where $S_N$, $S_S$, $S_F$, and $S_U$ are the raw counts for keyword matches in nearby locations, within recent time, frequency of keywords in search history, and searches done by current user, respectively.

We calculate the distances between each recommendation item and the user's location and define it as location score. By use of distance, we introduce location relevance aspect to the system.

Users can rate photo and services through the web or mobile interface. Services in MOPSI database have been rated by users in scale of 0 to 5 and the rating for photos is cumulative, using a thumbs up/thumbs down system (e.g. a photo liked by 5 users and disliked by 2 has a score of 3). The average score, in the case of services and the total score, in the case of photos, represents the rating score.

Time is also a very important aspect of relevance. Photo relevance decreases with time, as the places or views capture by user may suffer changes over the years. Also, the season when the photo is taken is very important for the relevance, as winter activities, for example, cannot be recommended during summer.

More recent photos in user collection are considered more relevant than old ones and the newer the photo is, the higher score it receives. Additional difference is that the score is also influenced by time of the year when photo was taken.

We define following time thresholds (points given in brackets): 1 week (10), 1 month (7), and 1 year (4). Secondly, photos are classified into one of the four seasons of the year (winter, spring, summer, autumn). If the recommendation request is performed during the same season as the photo was taken, it is given additional 10 points. Thus, total score based on time is for each photo calculated as follows:

$$S_T = S_A + S_Y \tag{2}$$

For example, photos that were taken 4 days ago, and in the same day are scored $S_A$=10. The photo was also taken in the same time of year thus $S_Y$=10. By use of time for scoring photos, we introduce time relevance aspect to our system.

All the above scores are normalized to the scale [0..1] using the following formula:

$$N = \frac{S - MIN(S)}{MAX(S) - MIN(S)} \tag{3}$$

where $S$ is the raw score, $N$ is the normalized score, , and MIN(S) and MAX(S) are the minimum and maximum scores for each of the criterion respectively.

Final score of each service is then calculated using the following formula:

$$S_{SERVICE} = w_H N_H + w_L N_L + w_R N_R + 1 \tag{4}$$

where $N_H$ stands for the normalized score for search history, $N_L$ for location, and $N_R$ for rating; $w_H$, $w_L$ and $w_R$ are weights for the corresponding scores. A constant of one point is added in order to promote services for recommendation, because they are assumed to originate from a trusted source and therefore more relevant than older photos from user collection. The location score is multiplied by two emphasize nearby locations.

Final score of each photo item is calculated in the same way as services, having an additional time score:

$$S_{PHOTO} = w_H N_H + w_L N_L + w_R N_R + w_T N_T \tag{5}$$

where $N_T$ stands for time score and $w_T$ is the weight for the time score.

## CONCLUSIONS

In conclusion, our system gives useful recommendation and selects relevant items. There some exceptions where behavior of the system is not satisfactory. However, the system fails to give useful recommendation in specific, untypical cases, for example when user generated photo collection is very dense and limited to test photos with useless content or when there is no information about particular area in our data collection.

## REFERENCES


Adomavicius, G. & Tuzhilin, A. (2005) Toward the next generation of recommender systems: A survey of the state-of-the-art and possible extensions. IEEE Transaction on Knowledge and Data Engineering 17(6), 734-749

Birukov, E. Blanzieri, E.& Giorgini, P. (2005) Implicit: An agent-based recommendation system for web search. International Conference on Autonomous Agents and Multi-Agent Systems.

Fränti, P., Chen, J., Tabarcea, A. (2011) Four Aspects of Relevance in Sharing Location-based Media: Content, Time, Location and Network. International Conference on Web Information Systems and Technologies.

Ge, Y., Xiong, H., Tuzhilin, A., Xiao, K., Gruteser, M. & Pazzani, M. J. (2010) An Energy-Efficient Mobile Recommender System. ACM SIGKDD Conference on Knowledge Discovery and Data Mining.

Ricci, F. (2011) Mobile recommender systems, Information Technology & Tourism, Volume 12, No. 3, 205-231

# COMPUTATIONAL APPROACHES TO VISUAL ATTENTION FOR USABILITY AND USER EXPERIENCE

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**Abstract**: Usability and user experience, as important parts of any product life cycle, are difficult to observe, measure and evaluate. On the other hand, actual state-of-art in eye-tracking allows us to observe human gaze under various conditions and hence, provides us powerful tool for visual attention analysis. Our research focuses on human cognitive states, as parts of usability and user experience, their reflection in eye movements, and finally methods how to extract and predict them from a single gaze.

***Keywords:*** *eye-tracking, usability, user experience, prediction*

## INTRODUCTION

Usability engineering with accent on user experience has become a central part of any software, hardware, product and service development. Using the advances in methods such as screen, voice and facial expressions recording and analysis, researchers try to evaluate the strengths and weaknesses of the product at hand by observing user behavior during casual interaction. Generally, such observations are time-consuming and difficult to interpret, since every user comes from different background, has a unique prior experience, mood and motivation. Usability researchers thus have hard times to measure user experience using objective units. Thus, multiple measurements and methods need to be performed and applied to reduce the bias.

Among available solutions to the aforementioned challenges, eye-tracking offers opportunity to gain objective information about the distribution and dynamics of user visual attention during interaction with the product. This includes information about how long and where the user was looking during interaction and how his visual attention varied in time. In this manner, eye-tracking and related analysis can provide an objective and unobtrusive tool to measure user's visual attention, as it was shown in prior research (Papakostopoulos et al. 2010, Palinko et al. 2010, Klingner 2010, Jacob 1991, Jacob and Karn 2003). Similarly to screen or voice recording, eye tracking at present itself cannot provide an answer to the question of how good the actual user experience was. To build a reliable bridge between low level eye-tracking data and high-level aspects of user experience, the visual attention analysis methods need to be able to provide a correspondence to observers' findings.

Present state-of-art eye-tracking technology offers fast and accurate eye movement recognition; we have an opportunity to obtain information about the finer nuances in user's visual attention. Such possibilities, on the other hand, bring about high volumes of data, computational demands and in particular, the lack of accurate interpretations. As it was mentioned before, technical solutions and improvements alone cannot provide a binary answer to questions concerning such complex phenomena as user experience. Therefore, the proposed work investigates how effectively, and in the best case automatically, we can align user experience, observers' findings and users' gaze patterns during testing. Such links, in forms of computational models, would provide a breakthrough possibility for measurement, classification and prediction of aspects of user experience from gaze data.

Using objective alignment, we can discover weaknesses of the tested product according to every user visual attention. Moreover, we can capture interaction mistakes that even the user would not mention. Furthermore, the obtained knowledge base in forms of user and application models can automatize the usability engineering pipeline, for example allowing automatic annotation of datasets of user recordings, or based on the tested interface to automatically generate a match against usability heuristics.

## METHODS AND MATERIALS

One of the underlying assumptions of this research is that human interaction activity during is presumably involuntarily reflected in eye movements (Eivazi 2010, Bednarik et al. 2012), thus, I am about to study in depth how particular eye movements reflect specific activities, experience and users' states of mind.

Prior research has focused on pupillary responses, and more recently on fixation, saccades, and smooth pursuit, as indicators of underlying human activities. Since processing of raw incoming data is computationally time consuming, eye movements data are filtered and transformed into features. However, the employed extraction techniques and chosen features differ across research and experiments. The background knowledge about the feasible features and their sensitivity to human cognition and other aspects of interactive behavior is relevant aspects of user experience.

Another challenges in the gaze data analysis lie in time domain of eye movements and their sensitivity to inner and outer stimuli, for example pupillary responses due to ambient illumination or emotional changes. These side effects bring noise into classification. Hence, analyses of unstable eye-tracking data call for methods and features corresponding to source specificity: several approaches for data normalization, sample rate and window size, or outlier detection need to be investigated. Using extracted input data, machine learning and prediction modelling offer promising techniques to classify even short glimpse in eye movements.

I investigate the possibilities of connecting human activities with eye movements and evaluate feasibility of such a relation in commonly used applications. Thus, I am aiming to answer the following questions:

- What features and computational methods deliver the best in human activity recognition?
- How accurately features correspond to specific activities?
- How well task independent and task specific features describe human activities?
- How uniquely eye movement patterns specify their users?
- Has one general mathematical model ability to describe all kind of users, or a bank of prediction models is needed?
- How the implemented real-time classification can affect the user interaction?

My work is experimental-driven and blends field of eye-tracking, human-computer interaction, machine learning, pattern recognition and usability into the novelty approach. To gain deeper understanding of user experience and its relation to eye-tracking, my research concerns following phases:

<u>Phase1: Data mining of user experience from usability observations</u>

In the initial phase of the project, user experience and usability measurements will be summarized and encoded into machine-readable representation. In this phase, another feedback will be obtained from the third party observers, for example researchers from Faculty of psychology. The results will serve as labels for gaze data and input for supervised learning methods.

Phase2 : Supervised established correlation between gaze patterns and user experience

Methods of feature extraction, detection of outlier, effects of normalization and environment influence results of any classification thus, several experiments will show sensitivity due to varying settings. Furthermore, feature filtering and subsets present stand-alone chapter of research, not systematically studied before. Carefully extracted feature subsets of user eye movements will be classified by present machine learning standards (e. g., Support Vector Machines, Neural Networks, Hidden Markov Models) to compare how well specific features correspond to observed user experience. Finally, computational demands and time complexity will be discussed for future feasibility in real-time applications.

Phase3 : Unsupervised prediction of user experience without gaze patterns

Aforementioned knowledge about the distribution of user gaze patterns and its links to user experience will enhance the ground truth about usability, and hence, allow us to lead usability testing without need of time-consuming observations. Later on, user experience can be evaluated even without gaze input and truly relied on user's input through other modalities (e.g., mouse and keyboard typing). This phase will compare results of traditional user experience observations, supervised gaze-based prediction and newly, unsupervised gaze-off user experience prediction. Evaluations will show us possibilities and limitations of machine learning algorithms when estimating user experience.

Phase4: Creating automatic annotation advisor in usability engineering

Eventually, feature subsets and the classifier with the best performance will be compiled into a universal classification module, which will run at background of applications and provide immediate feedback of user interaction. The implementation will be tested through the annotation tool (e.g., ELAN) as a notification system, which will offer user experience predictions to the observer. The observer will have opportunity to accept or declined the suggestions, and according to try-and-hit rate, we will evaluate feasibility and enhancements of the implemented solution.

## RESULTS

So far, my prior research has concentrated on analysis of eye movements as a description of human intentions. During problem solving (8Puzzles), I have extracted features from fixations, saccades and pupillary dilation and employed them as markers of user's intentions to move a selected puzzle tile. The machine learning task consisted of binary classification based on Support Vector Machines with RBF kernel. I have proved human intentions were classified with accuracy of 75\% with AUC~0.8 and thus, provided positive motivation for future research.

## CONCLUSION

As overall results of my work, I will establish a connection between eye movements and user experience, supported by supervised and unsupervised learning methodology and evaluated on working prototype of the improved annotation tool. The proposed visual attention driven computational framework will be feasible in various domains (e.g. neurosurgeries, airplane cockpit, and educational technologies) and offer user experience as available feedback in common applications.

Additional results of my research include well-annotated and in detail marked eye movement datasets, describing various user experience at different cognitive level, as well as analytical guidelines for their processing and finally, a database of features, their sensitivity and performance under observed human activities serving as a baseline for future experiments.

## REFERENCES


Vassilis Papakostopoulos, Dimitris Nathanael, and Nicolas Marmaras. (2010) An explorative study of visual scanning strategies of motorcyclists in urban environment. In Proceedings of the 28th Annual European Conference on Cognitive Ergonomics, ECCE ’10, pages 157–160, New York, NY, USA, ACM.

Oskar Palinko, Andrew L. Kun, Alexander Shyrokov, and Peter Heeman. (2010) Estimating cognitive load using remote eye tracking in a driving simulator. In Proceedings of the 2010 Symposium on Eye-Tracking Research Applications, ETRA ’10, pages 141–144, New York, NY, USA. ACM.

Jeff Klingner. Fixation-aligned pupillary response averaging. In Proceedings of the 2010 Symposium on Eye-Tracking Research Applications , ETRA’10, pages 2 75–282, New York, NY, USA, 2010. ACM.

R. J. K. Jacob. (1991) The Use of Eye Movements in Interaction Techniques: What You Look At is What You Get. Human-Computer Interaction , 9:152–169,.

R. J. K. Jacob and K. S. Karn. (2003) Commentary on section 4. eye tracking in human-computer interaction and usability research: Ready to deliver the promises. In The Mind’s Eye: Cognitive and Applied Aspects of Eye Movement Research, pages 573–605. Elsevier Science.

Shahram Eivazi and Roman Bednarik. (2010) Inferring problem solving strategies using eye-tracking: system description and evaluation. In Proceedings of the 10th Koli Calling International Conference on Computing Education Research, Koli Calling ’10, pages 55–61, New York, NY, USA. ACM.

Roman Bednarik, Hana Vrzakova, and Michal Hradis. (2012) What you want to do next: A novel approach for intent prediction in gaze-based interaction. In Proceedings of the 2012 Symposium on Eye-Tracking Research & Applications, ETRA ’12, New York, NY, USA. ACM.

# CONTEXT-AWARE ADAPTATION PROCESS FOR SMART KITCHEN ENVIRONMENT FOR ELDERLY DEMENTED PEOPLE

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**Abstract:** This thesis is part of project smart living environment for senior citizen, which aims to research and develop a smart way to aid elderly people and help them live independently. This thesis focuses on a scenario process of making coffee, by detailing user cases, finding all possible paths and exploring ways to cater to the elderly individually. Video with content of old people cooking coffee will be shot for experiment, a data processing system is developed to extract key frames and time range of steps from them. Symbols and voice reminders are collected which can aid guidance. This research builds a data library which could be taken as reference for further smart kitchen applications, It aims to collect data for the design of workflow engine. As this smart kitchen environment will be applied to the individuals, different old people's activities and living condition are detected and recorded by this data processing system too. Idea of logical grid is applied to this research, process of extracting key frame is accomplished based on that.

*Keyword: smart kitchen, senior citizen, key frame extraction, healthcare, personalization*

## 1 INTRODUCTION

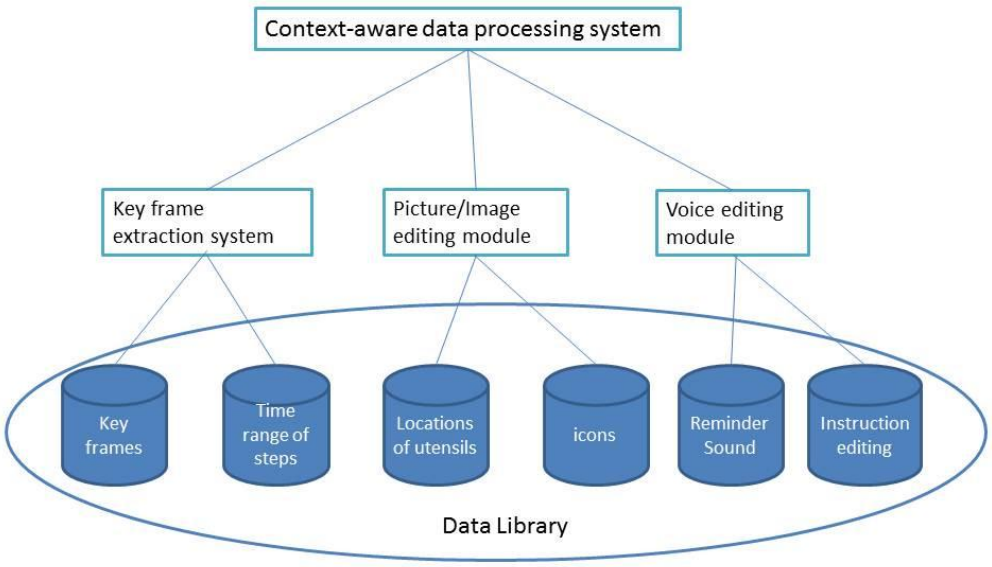
As medical technology and social healthcare are developing, average age of population is increasing. By the time people become old, their mobility and memory ability decrease, it is helpful to have friends or family members to take care of them constantly. But in reality family member and friends can't be with senior citizens all the time, it is not realistic to put all responsibility of taking care of the elderly to them. It is necessary to find ways to help old people live independently. Eating and drinking are indispensable activities every day, kitchen is an important place to operate these cooking processes. To help older people live independently, it is necessary to help them behave independently in kitchen first.

When people grow old, they gradually lose ability of learning new knowledge and technology, they constantly live in the way they are already familiar with. Hence we try to extract key information of their activities to build a tailored guidance system which does not interrupt senior citizens' normal life. Old people with Alzheimer's problem not only can't learn new knowledge but also appear symptoms. For example, they forget what they are doing, repeat doing same step of an operation, leave things what they are currently doing and move to do some other things. Symbols and voice reminder will help attract their attention, instruct them back to the normal process what they are doing and finish the process smoothly.

## 2 SYSTEM DESIGN

Structure of data processing system will be as below described:

**Figure1**: Structure of context-aware data processing system



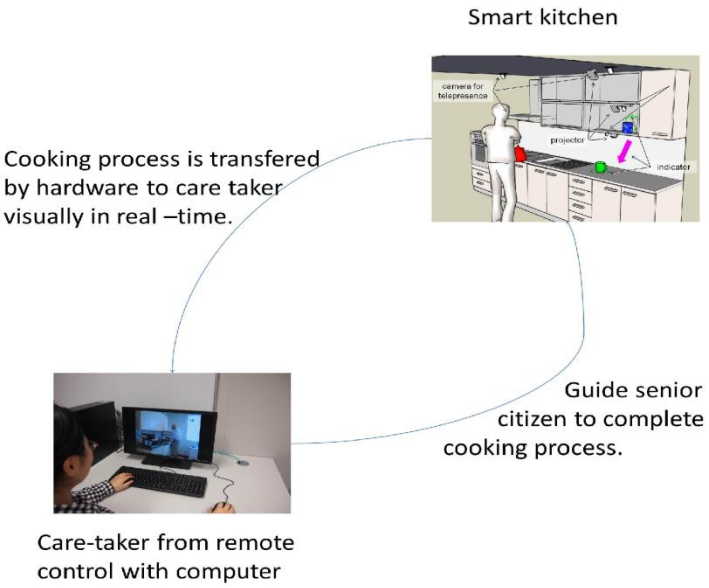

## 2.1 Key frame extraction module

In this module, movement of objects (which are utensils)'s location is key element to determine steps, the initial location of one utensil is the starting point of a step, its destination is the end point of that step. By knowing a start point and end point of an object, a dynamic image can be drawn. Utensils' path of movement has various possibility, but it does not influence the fact that its starting point and end point is settled. Sensor is system's eye to detect changes of utensils' location, it helps determine key frames very easily according to predefined key frames characteristics.

## 2.2 Image editing module and voice editing module

Image editing module creates symbols that are used for instructing old people's activity. Voice editing module is a text to speech system. By typing message, system could transfer message into speech, deliver speech to the old person. There won't be language problem between remote caretaker and old person, due to the reason that this system can translate text into old person's mother language.

**Figure2**: Smart kitchen environment, remote guidance to senior citizen [1-2]




## 3 FUTURE WORK

Optimize this system so that an old person's personal habit can be recorded by this system, this data will be collected to build personal database, which will be used to adjust workflow engines to old person's need. Cooking in the kitchen is an activity of daily lives, data stored from old people's cooking activity will also be further used as reference for old person's health care.

## REFERENCES

1, Ikeda, S., Asghar, Z., Hyry, J., Pulli, P., Pitkanen, A., Kato, H., Remote Assistance Using Visual Prompts for Demented Elderly in Cooking, (2011), 4th International Symposium on Applied Sciences in Biomedical and Communication Technologies

2, Pictorial representation by Master thesis student Saima Batool

# SAFETY NAVIGATION SYSTEM

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**Abstract**: Senior citizen is becoming a large group in the structure of the society. People cannot ignore them. ICT technology is a good way to help senior citizen in the future. Safety Navigation System is one of the systems which design for elder people. The purpose of the system is to navigate senior citizen when they are outside. .

***Keywords:*** *Navigation, senior citizen, wellbeing technology and environment.*

## 1 INTRODUCTION

It is known that we are going into the 'aging society '. The age problem was becoming a more and more important issue for the society. Especially governments have put increasing quality of serving senior citizens into the schedule. And also it was a popular topic for researchers and companies. So does University of Oulu. As a student who are studying in information processing technology in university of Oulu. Somehow I had been connected to the research field of senior citizen. Actually, I do had intentions of using what I have learnt to server elder people before. Because it was not only benefits my own parents but also it will benefits all the parents.

Safety Navigation System is a kind of intelligent real-time services. It was designed especially for elderly people who have the memory problem. Such as the people who often lost in their way home. The purpose of the system is to help elderly people in their daily life. As its named showed, the system is designed for navigating senior people with ICT technology. For example a user can be helped to navigate to a safe location or to an intended destination if she is lost. In addition to elder people or senior citizens also his or her trusted persons e.g. a close relative or personal nurse, are users of the system.

In this document, chapter 2 is going to give you a brief description of Safety Navigation System including requirements and user needs, subsystems diagram, and use cases. The outlook of Safety Navigation System is in the next chapter.

## 2 SYSTEM DESCRIPTIONS

### 2.1 Requirements and user needs

From the storyboard (Attachment 1, taken from Lehtonen et al. (2011)) we can see the multiple situations that the Safety Navigation System must take in account. (For simplicity we will assume the senior citizen (SC) is female in this document following the storyboarding in Lehtonen et al. (2011).) When the senior citizen is leaving from home the system must check that she has all relevant devices with her. These include mobile phone (smart phone), camera button (smart button) and a key ring - laser pointer combination device. Before leaving the senior citizen has to declare what is her destination so that safety boundaries can be set. Most usual destinations and their safety boundaries e.g. the grocery store, are programmed beforehand to the system. If an alarm for a situation when a senior citizen crosses the safety limit is sent, the camera button starts taking photos and safety actions e.g. phone call from a trusted person (family member etc.) or a safety person follows.

Consider the system is designed for elder people, it has to be so simple and implemented for everyday tasks and it must be simple to use and it should not require high technological understanding or skills.

### 2.2 Subsystem diagram

The Safety Navigation System is a combination system with Mobile Unit System, Home Guard System, Navigate System, and Remote User Interface (Fig. 1). All the subsystems are connecting each other and supporting each other.

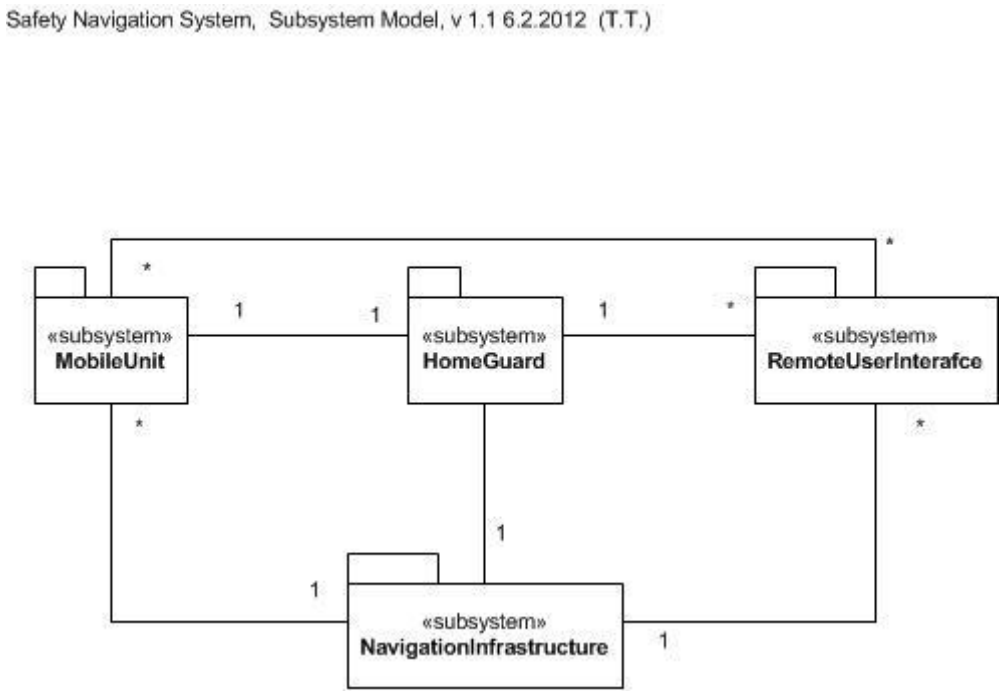



**Figure 1.** Subsystem model

### 2.3 User case

System should include several use cases (Fig. 2). There are five main use cases used by four different groups of users. The following table (Table 1) shows which users are needed to perform the actions that are presented as use cases.

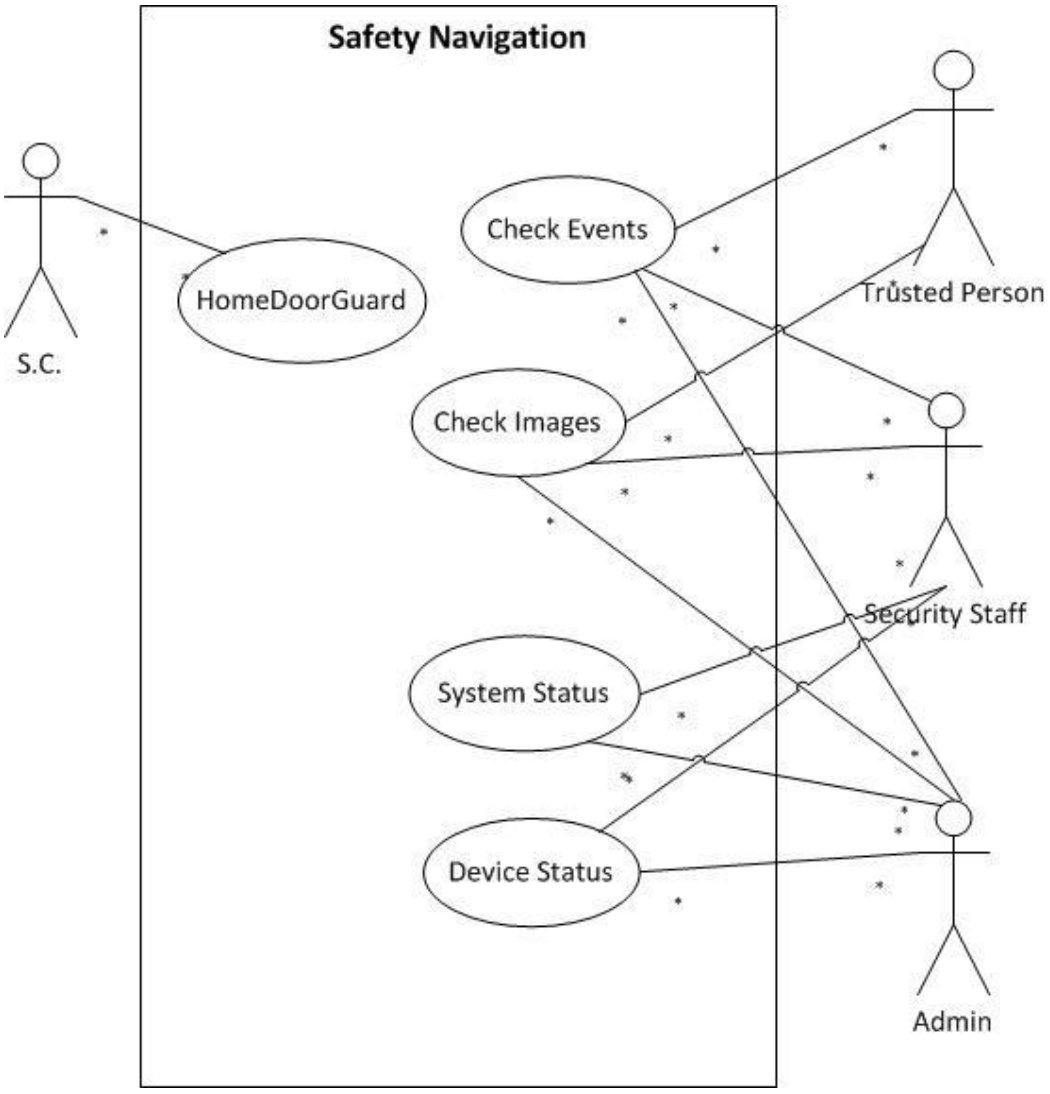



**Figure 2.** Use cases.

**Table 1.** The new use cases of Fig. 1 in table format

| | **Senior Citizen (S.C.)** | **Administrator** | **Security Staff** | **Trusted Person** |
|---|---|---|---|---|
| **HomeDoorGuard** | X | | | |
| **Check Events** | | X | X | X |
| **Check Images** | | X | X | X |
| **System Status** | | X | X | |

| | | | | |
|---|---|---|---|---|
| **Device Status** | | X | X | |

**Check Events:** Check Events activity records the events that are stored in the system database. Specific users, if the access isn't limited, i.e. Administrator, Security Staff member and Trusted Person are enabled to check those events when needed and in case of emergency.

**Check Images:** The system is taking photos in certain specific situation (i.e. the senior citizen is gets lost on her way to the shop). These photos are available for the users that might need them, possibly Administrator, Security Staff and Trusted Person. Image database would also store images taken by the Home Guard System (see below).

**System Status:** Certain users need to be able to check the system's status, whether it is on or off, working properly or is there some kind of error in the system. Also in addition to this the system need to check its status automatically and inform the users if there is error in the system. This action is usually for the Administrator or Security Staff.

**Device Status:** Like the main system itself, the status of the various devices needs to be controlled, followed by the system, informed in the case of error and enabled to be checked by specific users. This action is usually for the Administrator or Security Staff. (This is also included in the more detailed description of the use cases for the administrator in the subsection below.)

## CONCLUSIONS

Safety Navigation System was a very interesting topic which not only useful for the old people but also is the meaning of caring them from the society. As time goes on, more and more people become old. The duty of society, obligation of government should not ignore them. Safety Navigation System is a good idea of using ICT technology to help to solve the senior people's problem. When they want to go out, it will give them safer and make their children's mind at rest. Anyway, the Safety Navigation System just at its beginning stage, more and more issues should be researched in the future. I hope it can be adopted into practice quickly.

***Acknowledgements:***

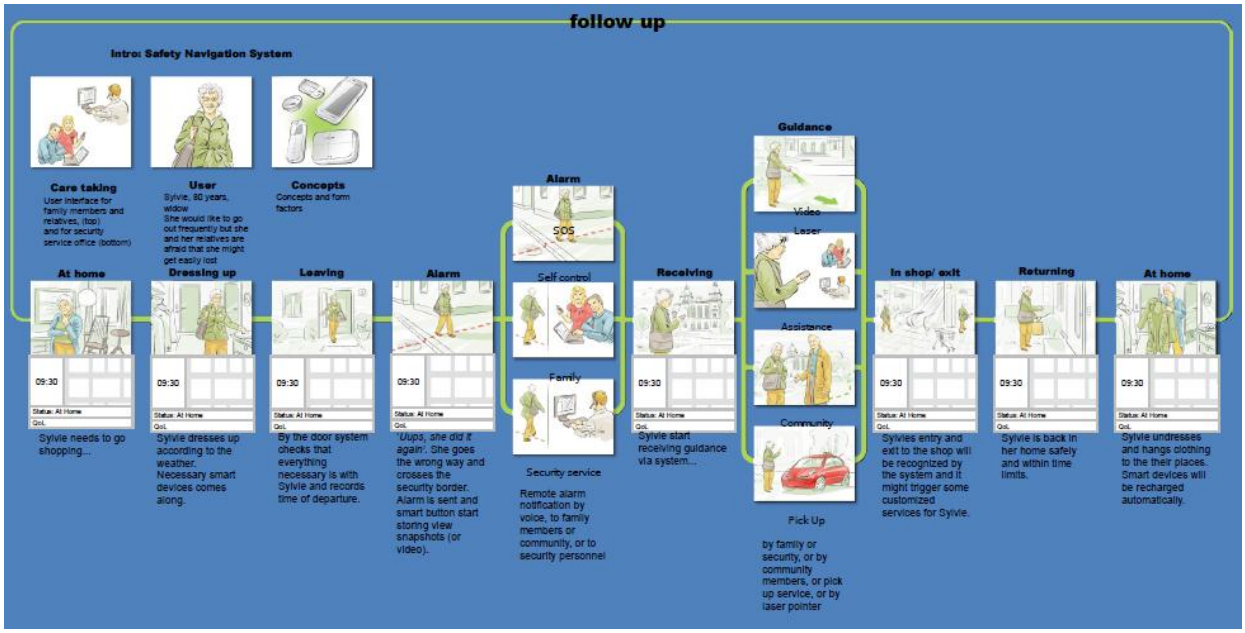
*I would like to thank University of Oulu and Professor Petri Pulli for his cooperation and help.*

## REFERENCES

Douglass, B.P. (2003). Real-Time Desing Patterns. Robust Scalabl Architecture for Real-Time Systems, Addison-Wesley, Pearson Education, pp. 500.

Lehtonen, J., Kaikkonen, L., Pulli, P., Siitonen, M., Pitkänen, A., Winblad, I. & Leinonen, E. (2011). Safe Navigation Concept Scenario, Scope Associates Oy and Univ. of Oulu, document.

## APPENDIX A.




Fingure 3. Storyboard from Lehtonen et al. (2011).

# REMOTE-GUIDANCE FOR ELDERLY DEMENTED PEOPLE USING SMARTPHONE SENSOR

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**Abstract**: This research paper suggested a novel approach to deliver data describing the state of the elderly to the caretaker synchronously, which enables the caretaker to provide real time guidance to the elderly in out-door environment. In this design, smart phone (Android system) will be used as a portable device to capture the real time situation of senior citizens. Camera sensor, compass sensor and GPS sensor on the mobile phone platform will provide snapshot, head direction and location of the elderly person respectively. Sensor data are processed on the platform of caretakers, presented by map, street view and photos. The information reflects the safety state of the elderly person. It is easy and effective for the caretaker to make guidance decision using the information from mobile phone sensors. The design has many novel features as: (1) System is designed to be useful and helpful in outdoor environment. (2) Multi-sensors embedded in smart phone are used to make the platform easy and convenient for elderly person. (3) Multi-media approach is used to provide vision and logical cognition for caretaker to make sure the accuracy of decision.

***Keywords:*** *elderly, remote guidance, multi-sensor, smart phone*

## 1 INTRODUCTION

Nowadays, more and more citizens are stepping into old age. As an obvious problem, a lot of senior citizens live alone, while many of them are facing with bad memory problems and some potential dangerous situations in living environment. For example, the senior citizen is easy to get lost on the way of shopping or forget about the home keys usually. What's more, the elder people may be even confused to follow the traffic rules.

To these cases, if the remote relatives or families can help them, it could be a quite efficient and welcomed approach. Thus, we can promote the living environment of senior citizens by providing safety and assistance. Real time systems are supposed to used, giving a simultaneous feedback to the trusted person. By this way, the senior citizen can get guidance and help form the trusted persons.

It is a quite meaningful topic, with developing population aging. Because this system allows the governments devote less labor and cost to face this social problem.

## 2 TABLES AND FIGURES

The figure1 below describes the utilize environment for system. State of the elderly can be transformed to caretaker by mobile phone, as the system is designed, which enables the caretaker to make a decision and provide remote guidance by laser point.

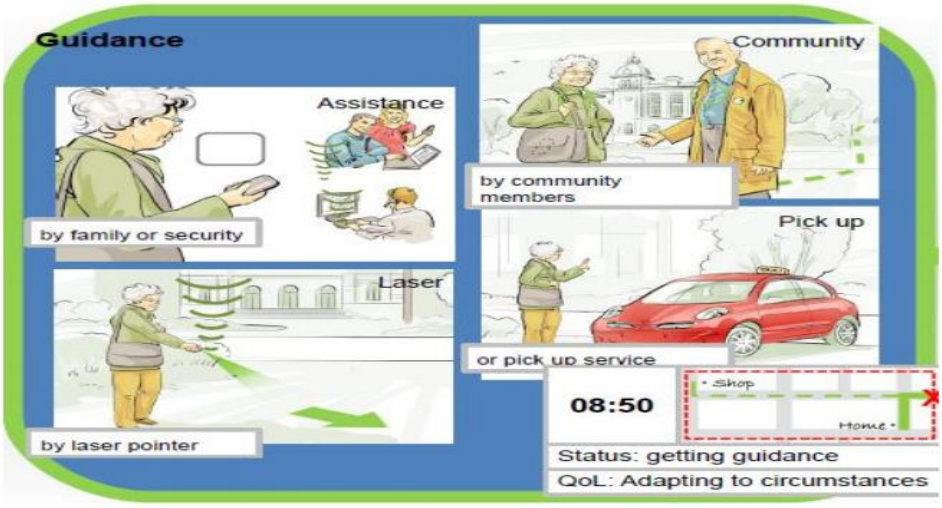


**Figure 1.** System Utilize Environment (Office Jarmo Lehtonen Scope Associates, 2011)

The figure 2 explains the participants and functionality structure of the system. There are four roles for the system participants. The trusted person acts as caretaker, providing guidance under assistant of security staff.

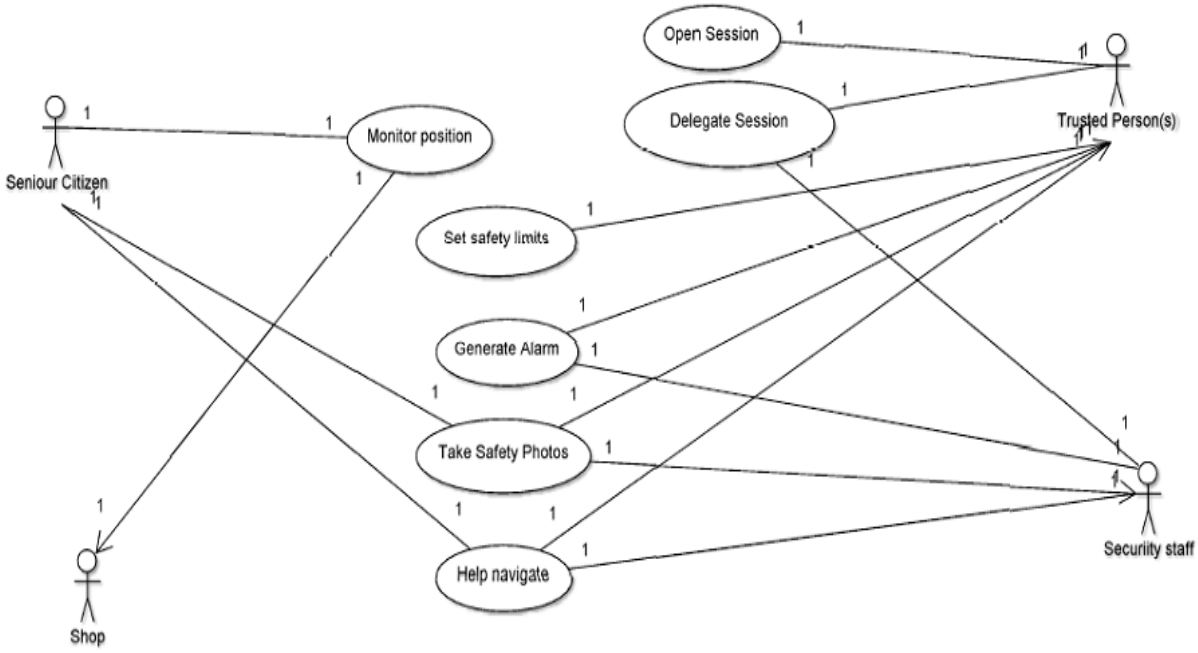


**Figure 2.** Use case model of the system

The following figure describes the system sequence, which coordinating with each other among APP modules.

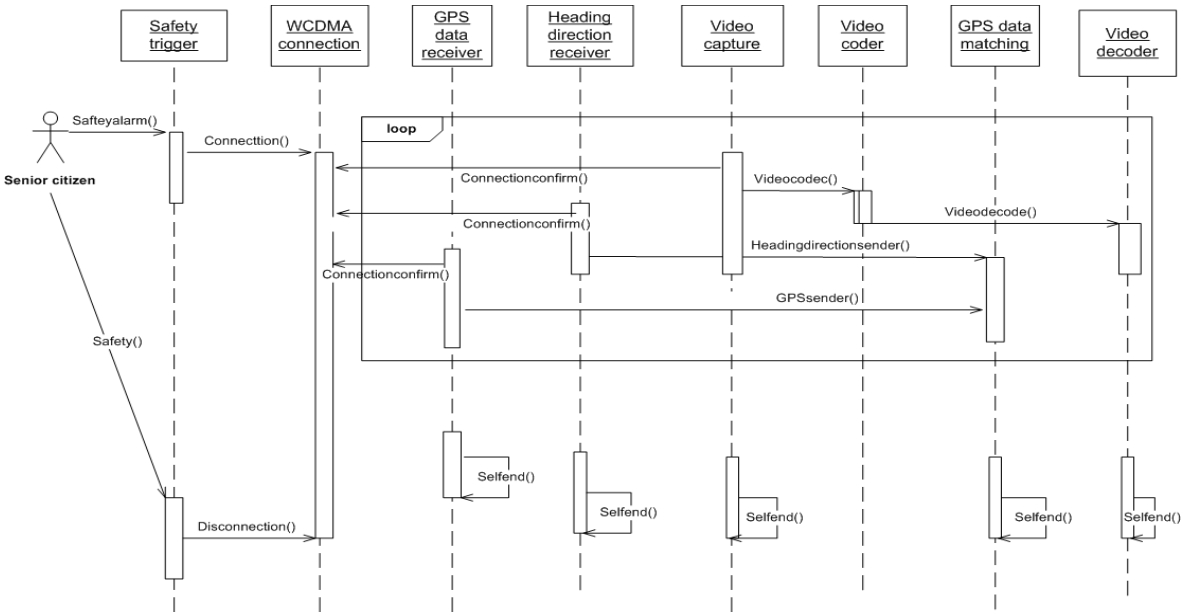


**Figure 3.** Sequence Diagram of the system

Google street view is quite helpful to show the location and synchronous situations of the elderly. GPS, camera and compass are used. Figure 4 explains the architecture of the system.

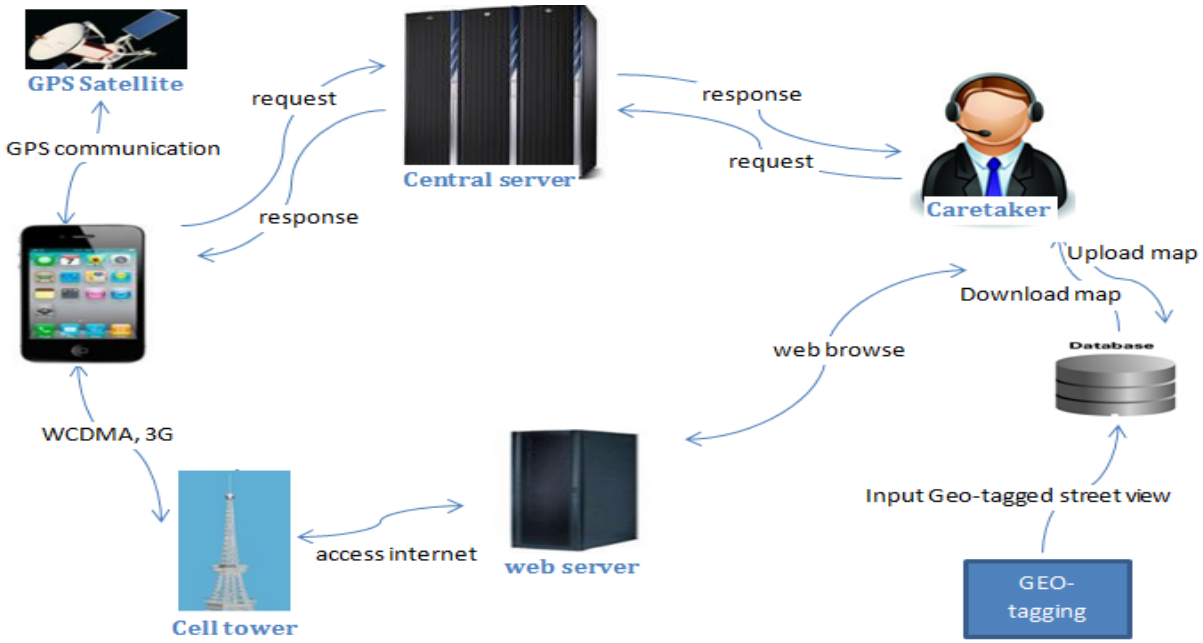


**Figure 4.** Architecture of the system

# WATER SUPPLY SYSTEMS IN PETROZAVODSK, RUSSIA AND OULU, FINLAND

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**Abstract**: This paper aims to find the differences and similarities of water supply in Petrozavodsk and Oulu. It is based on the literature, and at first it gives an overview of the quality of raw resources in Petrozavodsk and Oulu. The paper introduces water supply and distribution systems of both of the cities as well as the treatment stations and their processes. The biggest challenge was to take into account the different approaches in Finland and Russia. It became clear that exchanging of knowledge helps to identify the good practices as well as the problems and their solutions.

***Keywords:*** *water supply, treating, quality, potable water, distribution system*

## 1 INTRODUCTION

Water which meets the quality requirements is needed for steady social and economic development. Nowadays, water is an economic product that is both sold and bought. Health of population depends on the presence and quality of water resources and their sustainable use and protection. In more densely populated areas health of people also depends on good operation of water supply systems. These issues show how well the country is developed.

This work examines the water supply systems of Finland and Russia using the cities Oulu, Finland and Petrozavodsk, Russia as examples. The comparison helps to identify the differences and similarities on the process to produce drinking water, and to find out the good practices in water supply management.

## 2 RAW WATER RESOURCES AND WATER QUALITY

The cities of Oulu and Petrozavodsk were taken as examples due to their similarities: both are regional capitals and they both use mainly surface water as their raw water source. The population in Petrozavodsk is 270 000 (Lugacheva 2012), and in Oulu 142 000 inhabitants (Intelligent 2012). The raw water quality norms are set by the governments in both countries.

Raw water for water supply of Petrozavodsk is taken from the lake Onega. Water quality in the Petrozavodsk Bay of Lake Onega is influenced by the River Shuja, as well as by drainage and storm water runoff from the city territory, and by wastewater from Petrozavodsk industries. Main problems of water quality are high colour of water and permanganate consumption. The colour of water can increase up to 180 degrees in the end of winter and beginning of spring, during snow melting period. The high permanganate consumption reflects the high content of humus in water. The temperature of water in the Lake Onega at winter time varies from 0, 1° to 3°C (Zaytseva 2009)

Raw water for water supply of Oulu is taken from the Oulu River, which begins in Central Finland and flows westward into the Gulf of Bothnia. The quality of raw water from the Oulu River varies during the season. The highest values of the quality parameters are measured in spring during April and May, when the river is flooding, and the lowest during winter time. Moreover, the catchment area of the Oulu River is

rich with peatlands and agriculture, thus increasing the amount of natural organic matter. In water treatment processes the increase of organic matter and turbidity may be controlled by adjusting the coagulant dose. (Department of Energy 2003)

The raw water from the Oulu River has met all the requirements and recommendations set for household raw water source. The amount of chemicals used in the purification process has nevertheless increased significantly due to the deteriorating condition of the water quality in the Oulu River (H2O 2009).

## 3 WATER TREATMENT PROCESSES

The cities of Petrozavodsk and Oulu use mainly surface water for water supply, but they both also exploit groundwater to a small extent. In Petrozavodsk there is a small system of water supply from groundwater sources for the housing estate Solomenoe. It is situated approximately 12 km from the Petrozavodsk centre. Oulu has an additional groundwater intake in Hangaskangas groundwater deposit. The treatment plants are situated in the city centre both in Oulu and Petrozavodsk.

### Water treatment plant in Petrozavodsk

The drain pipe from waste water treatment plant and the intake of water treatment plant are situated close to each other and near the place where river Shuja runs into the lake. The lake freezes in winter time, which hinders the lake water to mix from top to bottom. This causes substantial growth of pathogenic bacteria in raw water and increases of colour of water. Nowadays, increasing of bacterial pollution of water is frequently monitored and prevented by additional disinfection at the treatment plant.

The capacity of the Petrozavodsk treatment plant is 114 553 $m^3$ per day. Water treatment process is introduced in figure 1. Raw water from the lake Onega is pumped through the revolving screen. After that the water is discharged into the contact tanks for mixing with reagents. The reagent used is a coagulant: (sulfate of aluminium, PIX-18); flocculant (Fennopol); soda ($Na_2CO_3$). (Zaytseva 2012)

After coagulation the water is conducted in the contact pre-filters and through two blocks of filtration. Water purification process also includesof primary and secondary chlorination. Each filter is flushed regularly and the rinsing water is returned in the sewerage system.

### Water treatment plant in Oulu

There are two purification plants in Oulu: Hintta and Kurkelaranta. They are situated on the opposite banks of the river. Chemical processing is applied only to the first block of filtration with settling velocity. The capacities of the treatment plants are 9000 and 1200 $m^3$ per h for Kurkelanranta and Hintta, respectively. The treatment processes consists of coagulation with ferric sulphate, flocculation and flotation, sand filtration, ozonation, activated carbon filtration and disinfection. In addition, the treatment process in Kurkelanranta plant includes UV disinfection (figure 2). (H2O 2009)

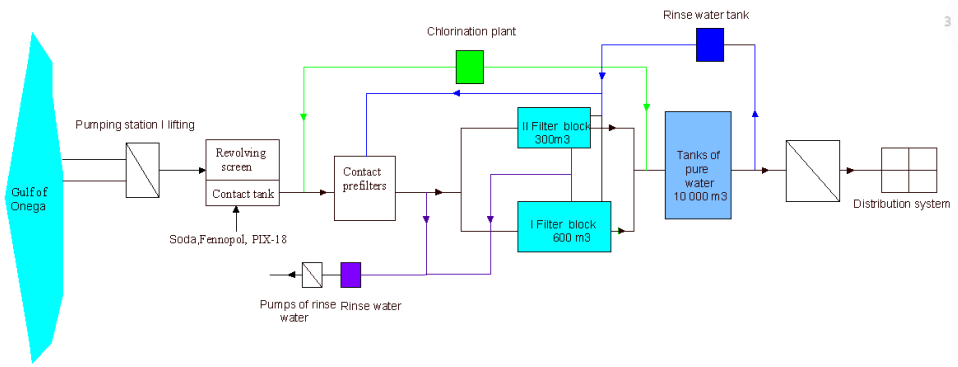


**Figure 1.** Scheme of water treatment plant in Petrozavodsk [AutoCad 2012].

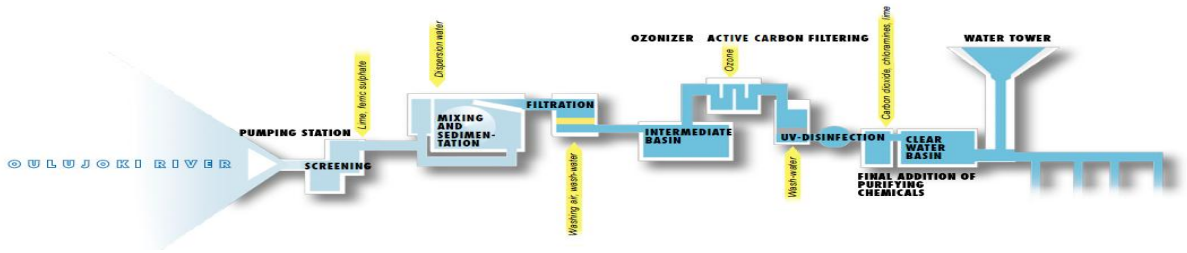


**Figure 2.** The scheme of water treating plants of Oulu [Oulu Water Works Bulletin 2009].

Both Petrozavodsk and Oulu have some problems with the quality of pipelines. Because of this the systems have problems such as corrosion, clog and leakage. In Petrozavodsk, a lot of pipes have been in use for over 20 years. Lot of pipes are in a bad condition. In the past, the network systems were built from cast iron or other metals.

## CONLUSIONS

The main problem in the water supply of Petrozavodsk is connected with the quality of potable water. This is mainly due to poor raw water quality, which is partly caused by the fact that rinsing water from water treatment plant is dumped into the sewerage system. There is evident need to build a sludge treatment system. The system should consist of a retaining tank, precipitation, condensation and dehydration of sludge. The dehydrated sludge should be taken out to be used e.g. in landfills. Water after dehydrating should be conducted back into the treatment station. Dumping the rinsing water into the sewerage should be stopped. In addition, water treatment processes should be controlled automatically, and the placement of water intake has to be changed.

In Oulu a good opportunity to improve quality and security of water supply is to use groundwater. There are several benefits in using groundwater compared with the purified river water. The groundwater is a sustainable way of water supply. The environmental permit for the Viinivaara groundwater project was grnated in 2008 (H2O 2009). However, Viinivaara is 100 kilometres from Oulu, and the distance and effects of water intake on the environment and building of pipelines cause problems in using groundwater from Viinivaara.

The pipes are being repaired each year in Russia and Finland. Despite of that the average age of pipes is still growing, because quantity of repair work is not enough.

Investments in distribution systems should be in the first place after administrative and structural questions. To prevent increasing the average age of pipes, the governments need to triple their investments.

Examination of different approaches helps to find good ways for improving the operational quality of water supply systems. It is essential also to harmonize Russian and EU approaches in drinking water quality. Unfortunately, the quality of potable water in the Republic of Karelia is not good. One reason is the lack of funding from authorities and ministries. Available facts and knowledge could help to study groundwater and surface water experiences, so that local people would receive good quality drinking water.

***Acknowledgements:***

*The authors return their thanks to the instructor of the Faculty of Industrial and Civil Engineering of Petrozavodsk State University Ph.D. Zaitseva Maria Igorevna for her cooperation and help, and to the University of Oulu for financial support.*

## REFERENCES

Bobkov Y. (2012) From the first stage to the second. http://www.roscomsys.ru/data/content/content_files/publication/vodamag_petrozavodsk.pdf.

Department of Energy, (2003) http://www.geni.org/globalenergy/library/national_energy_grid/finland/EnergyOverviewofFinland.shtml.

Filatov N, Litvinenko A, Särkioja A, Porttikivi R, Regerand T 2006 (edit.). Water Resources of Republic of Karelia and Their Use for Drinking Water Supply. Petrozavodsk – Kuopio: PAH, Suomen ympäristökeskus.

H2O, Oulu Water Works Bulletin (2009). Oulun Vesi. Oulu: Tornion Kirjapaino.

Intelligent Community Forum. 2012 Community Oulu, Finland 2012. http://www.intelligentcommunity.org/index.php?src=news&refno=687&prid=687

Lozovik P, Ryzhakov A, Zobcov M, Belkina N, Martynova N 2008. Surface Water Monitoring in Republic of Karelia (Russian federation): Northern water problems institute of Karelian research center RAS.

Lugacheva M. 2012 Petrozavodsk. http://federacia.ru/encyclopaedia/city/petrozavodsk/

Matilainen A 2007. Removal of the Natural Organic Matter in the Different Stages of the Drinking Water Treatment Process. Tampere: Tampere University of Technology.

Oulu Waterworks 2008. Annual report 2008. Oulun Vesi. Oulu: Viestintäkeskus.

# UTILIZATION OF REMOTELY SENSED HYPERSPECTRAL INFORMATION FOR FOREST ANALYSIS

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**Abstract**: Different remote sensing devices have been used to study forest from ecological and economical point of view. In our study SPECIM, AISA Eagle II the pushbroom hyperspectral imaging camera was used to measure forest canopy in the visible to the near infrared region (400 nm to 1000 nm wavelength). These images were used to study the classification of tree species plots of pine, spruce and birch. The tree plots were extracted from the hyperspectral images. All together 255 plots (117 pines, 70 spruces and 68 birches) were extracted. Linear discriminant analysis was used as the classifier. The spectral information and simulated Leica ASD40 data were used as the feature for the classification. The leave-one-out classification rate and the kappa value were calculated to evaluate the classification performance. The result shows that the hyperspectral improves classification rate when compared to simulated Leica ADS40 data.

***Keywords:*** *Tree classification, Remote Sensing, Multispectral, Hyperspectral, Leica ADS40*

## INTRODUCTION

With the advancement in the remote sensing sensor technology, several approaches have been used to analyze forest for tree species classification. Tree type and its information have both ecological and economical importance. Generally, tree information is collected from forest and combined with the remote sensing data for decision making (Korpela et al., 2010). Two remote sensing approaches, the active remote sensing and the passive remote sensing are widely used. An example of an active remote sensing technique is LiDAR. In LiDAR system reflected laser pulses are detected. LiDAR images have been used to study trees in forest (Korpela et al. 2010). For passive remote sensing, different multispectral imaging solutions are available and hyperspectral imaging solutions are becoming popular. In passive remote sensing the natural light (sun) is used as light source and the reflected light is detected. The distinction between hyperspectral and multispectral is nuanced. Multispectral device usually detects fewer discrete wavelength bands than hyperspectral device. A widely known example is RGB camera where three bands are used. Hyperspectral devices can have hundreds of bands that provide dense sampling of spectral signal.

Different task can be performed in forest analysis using accurate hyperspectral information. For example, mapping of land uses and vegetation, identify living or dead trees, classify different tree species and other plants in forest etc. (-Schowengerdt R A., 2006). Several works have been done to study the tree species classification using multispectral data. Tree classification using the simulated Leica ADS sensor properties from spectral reflectance of tree species was studied (Heikkinen et al., 2010). Variation and anisotropy of reflectance in trees, using radiometrically calibrated multispectral ADS40 data was analysed and tree classification were studied (Korpela et al., 2011). Furthermore, classification study was conducted using the data from multispectral Leica ADS40 system (Heikkinen et al., 2011).

In our study, SPECIM, AISA Eagle II, hyperspectral pushbroom camera (www.specim.com) was used to measure the forest canopy in Hyytiälä forest area. Hyperspectral images were measured from 400 nm to 1000 nm wavelength at the sampling rate of around 9.4 nm, providing 64 band images. From the measured image we study tree species plot classification. Plot is an area of 21×21 pixel having same tree species. The hyperspectral information and simulated Leica ADS40 data were used as features and linear discriminant analysis as the classifier. To evaluate the classification performance of different features classification rate and the kappa value were calculated.

## METHODS AND MATERIALS

A flight campaign over Hyytiälä forest area Fig. 1, southern Finland (61.50’ N, 24.20’ E) was executed between 20.07.2011 and 22.07.2011. The forest area was divided into different imaging strips B1b, B2, B3, B4, B5, B6a, B6b, B7 and B8 as shown in Fig. 1. The strips were measured using SPECIM, AISA Eagle II hypserspectral camera and the camera raw images were processed.

The flight direction, atmospheric condition, sun position at the time of flight affects the measurement results. In our study flight direction were towards and away from the sun and the atmospheric corrections were not taken into consideration.

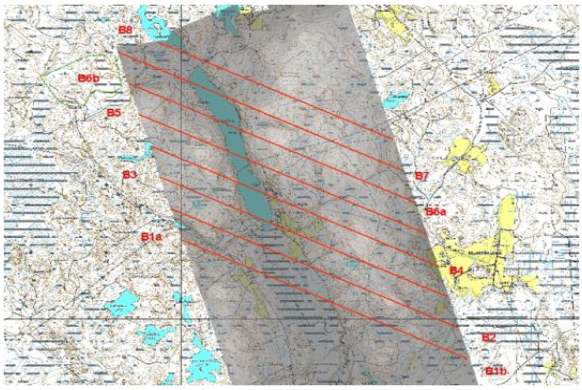


**Figure 1:** Hyytiälä forest area and the imaging strips.

From the corrected raw imaged strips the centre of pure tree species plot was marked by an expert using visual inspection and additional ground information. The pure plots were those plots where all the trees in the plot belong to one species class. From the centre of the pure plot, a 21×21 pixel window was drawn around and all the pixels inside the window were extracted. Each pixel gives approximately 0.5m spatial resolution. All together there were 255 pure plots and spectra (117 pines, 70 spruces and 68 birches) collected from the strips. The mean tree species spectra from the plots are shown in Fig 2. Two different approaches were used while making the datasets for classification study. In the first approach, dataset D1 was constructed where mean of each plot was calculated. In the second approach dataset D2 was constructed, before calculating the mean of the plot, outlier pixels (ground shadow and other) were removed. To remove the outliers, the Normalized Difference Vegetation Index (NDVI) (Crippen, 1990) was calculated for each pixel in the plot by using The NIR (near infrared) 814 nm and RED 691 nm wavelength band. Thresholding was done and the pixels having NDVI value less than 0.6 in the plot were considered as outliers and were removed from the plot. After removing the outlier pixel, the remaining pixels in the plot

were used to calculate the mean of the plot. An example of the single plot image, the NDVI represented image and the remaining pixels after thresholding are shown in Fig. 4. In summary two hyperspectral datasets D1 and D2 of 255 spectra from 255 plots were created. Furthermore, from these two hyperspectral datasets we simulated four bands Leica ADS40 dataset. In simulation the hyperspectral data were integrated over Leica ADS40 sensitivity function to obtain the four band simulated Leica ADS40 responses. Leica ADS40 sensitivity functions are shown in fig 3. Simulated Leica ADS40 dataset was also used for the classification. In the classification problem, any unknown test objects are assigned to the known class. Likewise, in our case the plot is assigned to one of the three tree species (pine, spruce and birch). Linear discriminant analysis was used (Bishop 2007) as the classifier. To evaluate the classification performance, classification rate and kappa value (Cohen 1960) were calculated for both hyperspectral datasets and for the simulated Leica ADS40. Kappa value is a widely used statistic for measuring the degree of accuracy. The Kappa value lies between -1 and +1. In many cases, the kappa values greater than 0.6 are considered to considerable accuracy and 0.80 are considered as very good accuracy

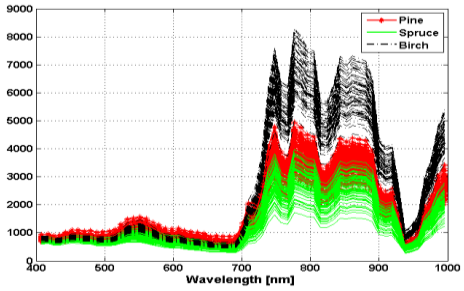


**Figure 2:** The spectra of tree species from D1, dataset.

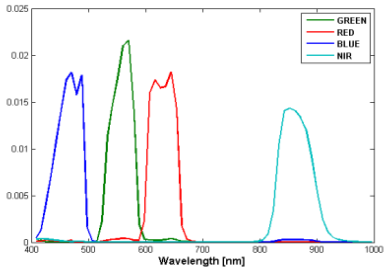


**Figure 3:** Leica ADS40 sensor sensitivity function.

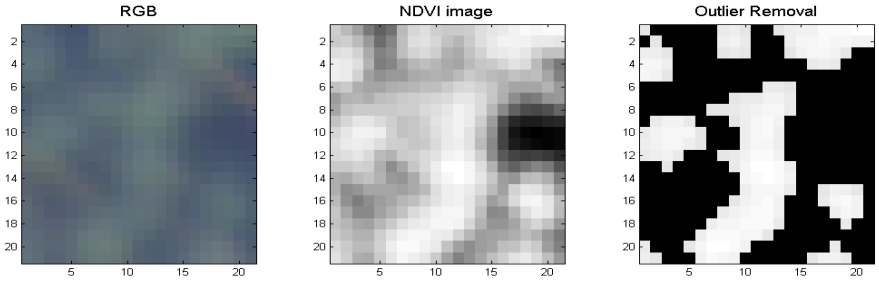


**Figure 4:** A single plot RGB image, NDVI representation of each pixel and the remaining pixel image after thresholding and removing NDVI values less than 0.6 image.

## RESULTS

The two hyperspectral datasets D1, D2 and the corresponding simulated Leica ADS40 data was used for the classification. The classification rate and the kappa value for both the datasets D1 and D2 have been shown in Tab. 1. The dataset D2 is represented by extra suffix '*' (see Tab. 1 row three and four). With the use of hyperspectral information we get 100% classification result for dataset D2 and 99.61% for dataset D1, but classification result are lower for the case of simulated Leica ADS40 dataset. This is partly due to the fewer number of bands in simulated Leica ADS40 dataset. It can be also expected that real ADS40 data will improve the classification accuracy of

simulated ADS40 data. Overall, all the classification results for hyperspectral are excellent, which is partly due to small number of plots used in classification. Furthermore the plots were marked by the subjective evaluation of an expert and further work is needed in order to validate the ground truth information. In practice, the plot area may contain several tree types, which decreases the classification accuracy.

However, although these are preliminary results, they are promising by taking into account that atmospheric corrections were not done for the data. Furthermore, the plots were from different strips and the measurement and sun geometric direction variations between the plots were not taken into consideration.

Currently multispectral sensors are widely used in forest analysis due to cost effectiveness (operational and data processing) when compared to hyperspectral sensors. When taking account high information content of hyperspectral data and evolving sensor technology and processing methods, it is expected that the utilization of hyperspectral imaging is viable choice in future forest analysis.

**Table 1:** The leave-one-out classification result for the two datasets D1, D2 and for the hyperspectral and simulated Leica ADS 40 features. Dataset D2 is represented with an extra suffix '*'. Cr is the classification rate and Ka is the kappa value.

| Features | Cr (%) | Ka |
|---|---|---|
| Leica_4 | 94.12 | 0.91 |
| Spectral | 99.61 | 0.99 |
| Leica_4* | 93.33 | 0.90 |
| Spectral* | 100.00 | 1.00 |

## CONCLUSIONS

The adequate information of trees in forest is crucial forest from ecological and economical point of view. Here we presented classification results for tree species plots using hyperspectral and simulated multispectral data. Classification result shows that hyperspectral data from SPECIM, AISA Eagle II sensor lead to significantly higher classification accuracy when compared to the simulated Leica ADS40 multispectral data.

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## REFERENCES

Bishop C. M. (2007) Pattern Recognition and Machine Learning (Information Science and Statistics), Springer.

Cohen, J (1960). "A coefficient of agreement for nominal scales". Educational and Psychological Measurement 20 (1): 37–46.

Crippen, R.E. (1990), Calculating the vegetation index faster, Remote Sensing of Environment, 34, 71-73.

Heikkinen V., Korpela I., Tokola T., Honkavaara E., Parkkinen J. (2011), An SVM Classification of Tree Species Radiometric Signatures Based on the Leica ADS40 Sensor. IEEE T. Geoscience and Remote Sensing vol. 49, no. 11 4539-4551.

Heikkinen V., Tokola T., Parkkinen J., Korpela I., Jääskelainen T. (2010), Simulated Multispectral Imagery for Tree Species Classification Using Support Vector Machines. IEEE T. Geoscience and Remote Sensing 48(3-2) 1355-1364.

Korpela, I., Heikkinen, V., Honkavaara, E., Rohrbach F., Tokola, T. (2011). Variation and anisotropy of reflectance of forest trees in radiometrically calibrated airborne line sensor images – implications for species classification in digital aerial images. Remote Sensing of Environment.

Korpela I. and Ørka H.O. and Maltamo M. and Tokola T. and Hyyppä J. (2010), Tree species classification using airborne LiDAR-Effects of stand and tree parameters, downsizing of training set, intensity normalization, and sensor type, Journal Silva, Fennica,vol. 44, 319-339.

Schowengerdt R A., (2006) Remote Sensing: Models and Methods for Image Processing, Third edition, Academic Press.

# PERCEPTION OF FOREST INDUSTRY COMPANIES TOWARDS FOREST CERTIFICATION IN RUSSIA

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**Abstract:** This study explores the perception of forest industry companies associated with forest certification. The interviews were carried out in form of structured questionnaire from September to December 2011, with 35 forest industry companies operating in North-Western Russia that supply primary and value-added wood products, where 40% represented non-certified companies and 60% had a valid certificate. The interviewed companies represented 70% of market share in terms of wood consumption in North-Western part of Russia. Thus, development of certification in individual companies was initiated by general market demand; however representatives of certified companies also emphasized the importance of internal corporate policy. Both groups of respondents identified market demand as a main driving force influencing on development of forest certification. Insuring the legality of wood origin, company's image and competitiveness of wood products were recognized as the most important benefits associated with forest certification. Absence of mandatory requirements from authorities and customers appeared to be the largest obstacle among both groups of respondents, in addition to that the representative of non-certified companies pointed out economic inaccessibility and low level of preparedness of management as of high importance, which is mainly associated with absence of quality management system. The results of the study indicated a general positive attitude; however it was noticed that respondents have gaps in understanding the principles and limited awareness with regards to forest certification, especially among non-certified forest industry companies.

***Keywords:*** *attitude, forest certification, Russia*

## 1 INTRODUCTION

Illegal logging is considered as one of the main challenges. According to official governmental statistics the illegal wood removals are estimated as 15-25 million $m^3$ annually, when non-governmental organizations (NGO) estimate as 40-50 million $m^3$. The difference in the estimates of the uncertainty associated with the legal status of "illegal logging" as well as the lack of an effective system to control the forest management practices in most parts of the country (Yaroshenko, 2012).
The facilitation of certification process in Russia was initiated by environmental non-governmental organizations in late 1990s mainly to promote FSC certification scheme (Tysiachniouk 2003). The Kosihinsky leshoz in the Altay region was the first company in year 2000 to receive FSC certificate of forest management covering 30 thousand ha of forest land (All about Russian forests 2000). As of December 2011, 28 million ha of forest had been certified by FSC scheme, with 171 CoC certificates holders (FSC, 2011).

## 2 METHODS

The perception of forest industry companies operating in North-Western (N-W) part of Russia was analyzed via survey. It was conducted from September to December 2011; when selected 35 companies' representatives were interviewed, with respond rate of 35% from overall number of contacted companies. The sampling included both certified and non-certified forest industry companies.
Surveyed companies included primary wood product (roundwood, trading) and value-added products (sawnwood, wood-based panels, furniture, packaging, pulp and paper).

While the total number of forest industry companies operating in North-Western Russia exceeding 3000 (Industrial business handbook of Russia, 2012), only limited number of forest industry companies were interviewed in the study. Whereas those companies represent 70% of wood consumption in the N-W region mapped on the atlas (Gerasimov et al., 2009) or equivalent to about 20 million $m^3$ of primary and value-added wood products, including large-, medium and small-sized companies.
Collected data were analyzed by the Statistical Package for Social Science (SPSS). Although the sampling was not purely random the indicative significance testing was used. Additionally, the data used to estimate the benefits and barriers for both groups of respondents was recoding in SPSS from 5 scale into 3 scale system, where 1=very low and 2=low importance joint into 1=low importance; 3=moderate into 2= moderate; and 4=high and 5 very high importance joint into 3=high importance.

## 3 RESULTS

The interviewed companies were covering most of the regions of North-Western Russia, except Kaliningrad and Murmansk regions.
The significant difference among two groups of respondents has been found for “better access to leasing contracts” and “additional sales of wood products” (Table 1) regarding the potential benefits associated with forest certification.

**Table 1.** Benefits associated with forest certification.

| Factors | Comp. type | Mean value | S.D. | Importance of benefits | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | low | | moderate | | high | |
| | | | | n | % | n | % | n | % |
| Better access to demanding markets | Cert. | 3.7 | 1.384 | 3 | 14 | 6 | 29 | 12 | 57 |
| | N-cert. | 3.4 | 1.697 | 5 | 36 | 1 | 7 | 8 | 57 |
| Increased export share of wood products | Cert. | 3.3 | 1.155 | 3 | 14 | 8 | 38 | 10 | 48 |
| | N-cert. | 3.2 | 1.369 | 5 | 36 | 1 | 7 | 8 | 57 |
| Improved competitiveness of wood products on the market | Cert. | 3.9 | 0.964 | 1 | 5 | 9 | 43 | 11 | 52 |
| | N-cert. | 4.0 | 0.961 | 0 | 0 | 6 | 43 | 8 | 57 |
| Improved image of the enterprise for stakeholders | Cert. | 4.0 | 0.775 | 0 | 0 | 7 | 33 | 14 | 67 |
| | N-cert. | 4.2 | 0.802 | 0 | 0 | 3 | 21 | 11 | 79 |
| Insuring the legality of wood material | Cert. | 4.4 | 0.590 | 0 | 0 | 2 | 10 | 19 | 90 |
| | N-cert. | 4.4 | 1.151 | 1 | 7 | 1 | 7 | 12 | 86 |
| Improved trade with foreign forest industry companies | Cert. | 3.5 | 1.078 | 2 | 10 | 8 | 38 | 11 | 52 |
| | N-cert. | 4.1 | 1.269 | 2 | 14 | 1 | 7 | 11 | 79 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Improved occupation health and safety issues | Cert. | 3.2 | 1.167 | 7 | 33 | 5 | 24 | 9 | 43 |
| | N-cert. | 3.6 | 0.842 | 2 | 14 | 2 | 14 | 10 | 71 |
| Increased efficiency of forestry operations | Cert. | 2.4 | 1.076 | 9 | 43 | 9 | 43 | 3 | 14 |
| | N-cert. | 3.1 | 0.663 | 2 | 14 | 8 | 57 | 4 | 29 |
| Additional sales of wood products* | Cert. | 3.5 | 1.078 | 2 | 10 | 9 | 43 | 10 | 48 |
| | N-cert. | 4.4 | 0.745 | 0 | 0 | 2 | 14 | 12 | 86 |
| Secured demand for the products | Cert. | 3.7 | 1.065 | 3 | 14 | 8 | 38 | 10 | 48 |
| | N-cert. | 3.9 | 0.864 | 0 | 0 | 6 | 43 | 8 | 57 |
| Long-term sustainability on domestic market | Cert. | 3.3 | 1.111 | 3 | 14 | 10 | 48 | 8 | 38 |
| | N-cert. | 3.4 | 0.633 | 0 | 0 | 10 | 71 | 4 | 29 |
| Higher interest to certified products from the customers | Cert. | 3.9 | 1.062 | 3 | 14 | 5 | 24 | 13 | 62 |
| | N-cert. | 4.0 | 0.784 | 0 | 0 | 4 | 29 | 10 | 71 |
| Better access to leasing contracts* | Cert. | 2.3 | 1.189 | 15 | 71 | 2 | 10 | 4 | 19 |
| | N-cert. | 3.0 | 0.877 | 5 | 36 | 4 | 29 | 5 | 36 |
| Advantages in bank loans | Cert. | 1.8 | 0.889 | 17 | 80 | 3 | 15 | 1 | 5 |
| | N-cert. | 2.4 | 1.158 | 5 | 36 | 7 | 50 | 2 | 14 |
| Easier functioning with the authorities | Cert. | 2.0 | 1.140 | 17 | 80 | 2 | 10 | 2 | 10 |
| | N-cert. | 2.6 | 1.336 | 5 | 36 | 4 | 29 | 5 | 36 |

* $p<0.05$

Primary barriers associated with forest certification are shown on Table 2. The significant difference among two groups of respondents has been found for “low level of preparedness of management system” and “economic inaccessibility”.

**Table 2**. Primary barriers associated with forest certification.

| Factors | Comp. type | Mean value | S.D. | Importance of barriers | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | low | | moderate | | high | |
| | | | | n | % | n | % | n | % |
| Absence of competitive advantages | Cert. | 2.7 | 1.028 | 8 | 38 | 9 | 43 | 4 | 19 |
| | N-cert. | 3.3 | 0.611 | 1 | 7 | 8 | 57 | 5 | 36 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Absence of legal requirements from consumers | Cert. | 2.7 | 1.236 | 8 | 38 | 8 | 38 | 5 | 24 |
| | N-cert. | 3.5 | 0.941 | 2 | 14 | 5 | 36 | 7 | 50 |
| Continuous amendments of the standards | Cert. | 2.9 | 1.195 | 8 | 38 | 7 | 33 | 26 | 29 |
| | N-cert. | 3.1 | 0.730 | 2 | 14 | 10 | 71 | 2 | 14 |
| Voluntariness of certification | Cert. | 3.6 | 1.167 | 3 | 14 | 6 | 29 | 12 | 57 |
| | N-cert. | 3.6 | 0.852 | 2 | 14 | 3 | 21 | 9 | 64 |
| Unawareness of top management | Cert. | 2.6 | 1.434 | 12 | 57 | 3 | 14 | 6 | 29 |
| | N-cert. | 2.9 | 0.917 | 6 | 43 | 3 | 21 | 5 | 36 |
| Economic inaccessibility* | Cert. | 2.5 | 1.207 | 11 | 52 | 6 | 29 | 4 | 19 |
| | N-cert. | 3.9 | 0.829 | 1 | 7 | 2 | 14 | 11 | 79 |
| Low level of preparedness of management system * | Cert. | 2.1 | 1.231 | 15 | 71 | 3 | 14 | 3 | 14 |
| | N-cert. | 3.3 | 0.726 | 2 | 14 | 6 | 43 | 6 | 43 |
| Subjectivity of assessment by auditing companies | Cert. | 2.6 | 1.165 | 9 | 43 | 7 | 33 | 5 | 24 |
| | N-cert. | 2.7 | 1.204 | 6 | 43 | 3 | 21 | 5 | 36 |

* $p<0.05$

## CONCLUSIONS

This study indicated that there is a general positive attitude in combination with indicative patterns of gaps in understanding and limited awareness with the regards to forest certification, especially among non-certified forest industry companies.

The study revealed statistically significant dissimilarities in responses associated with benefits of forest certification, when it comes to discussion of access to leasing contract and additional sales of wood products. The legality of wood origin, company's image and competitiveness of wood products were identified as of higher importance among other benefits associated with forest certification. The respondents were cautiously to associate certification with long-term sustainability on domestic market. However the large domestic market could also be a powerful catalyst to promote the utilization of forest certification among forest industry companies in Russia.

The analysis of the barriers associated with forest certification revealed statistically significant difference in responses to economic inaccessibility and initially low level of preparedness of management system, where non-certified companies recognized those factors as more feasible. The fact that certification is not mandatory requirement was recognized by both groups of respondents as a primary barrier constraining the development of forest certification associated in Russia. In addition both groups

indicated the subjectivity in assessment and awareness of company's top management as of least importance.

When attempting to assess the attitudes among forestry companies and to predict the development of forest certification several factors need to be taken into account, including the possibility of governmental incentives and support; actual market demand; communication of benefits and barriers among stakeholders, and customer recognition. For the time being Russian forest industry companies appeared to be under the process of involvement of forest certification into their business model.

The study suggested the need for further research with regards to forest certification in Russia to increase the awareness of the stakeholders involved into certification process and to develop a coherent conceptual framework for multi-purpose analysis. The topic may receive more attention as forest certification could become a part of compulsory procedure due to enforcement of EU Regulation and as prerequisite for placing wood products on international market for Russian export-oriented forest industry companies.

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**REFERENCES**

All about Russian forests, 2000. First FSC certificate indicating sustainable forest management practices in Altay region (in Russian). http://www.forest.ru/rus/sustainable_forestry/certification /woodmark.html

FSC 2011. List of Russian companies holding a forest management and chain of custody certificates. http://fsc.ru/upload/fm_2011_12_30.xls

Gerasimov, Y., Karvinen, S., Leinonen, T. Atlas of the forest sector in Northwest Russia 2009. http://www.metla.fi/julkaisut/workingpapers/2009/mwp131-en.htm

Industrial business handbook in Russia, 2012. Otraslevoy biznes-spravochnik predpriyatiy Rossii. (In Russian). http://www.actinfo.ru/forestind

Tysiachniouk M. 2003. International environmental NGOs: actors of ecological modernization in Russian forest sector. Ecological modernization of forest sector in Russia and USA, eds Tysiachniouk M., Kulyasov I., Pchelkina S. Saint-Petersburg, Research chemistry center of Saint-Petersburg state University p.8-25.

Yaroshenko 2012. Improving the legal procurement to tackle illegal logging. http://www.forestforum.ru/viewtopic.php?f=9&t=11555&view=unread

# SPECTRAL IMAGES COMPRESSION USING PCA AND WAVELET TRANSFORMATIONS WITH INFORMATION LOSSES CONTROL

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**Abstract**: There are quite a lot of practical tasks which are solved by means of spectral images. The advantage of their using is that the spectral images contain much more information than standard RGB images. Each pixel of the image stores the reflectance spectral information of the object. Thus in contrast to the usual image spectral image represents object in a certain spectral range of the wave's lengths. One of the main problems of the spectral image is a large amount of the memory, which is allocated for their storage. Traditional approach to compression of spectral images is the method of principal component analysis (PCA). In this paper the algorithm for compression of spectral images using wavelet transform is proposed. The peculiarity of the proposed approach is the controlling losses at compression. The effectiveness of the method is shown by the example.

***Keywords:*** *Spectral Image, Compression, Principal Component Analysis, Wavelet-transform, Compression Ratio, Mean Square Error*

## 1 INTRODUCTION

The spectral image represents by a three-dimensional data matrix with the size M×N×L, where M×N is image size, and L is the dimension of the spectral space. The formal problem of spectral images compression is considered in this section. We introduce the following notation: $I_0(x,y,\lambda)$ is the original spectral image, $I_C(x,y,\lambda)$ is the compressed image, where $x$ and $y$ are coordinates of the image pixel, λ is a value of the wavelength in a certain spectral range. We introduce the following criterion for the compression ratio of spectral images:

$$CR = \frac{size(I_0(x,y,\lambda))}{size(I_c(x,y,\lambda))} \qquad (1)$$

which defines relation between size of the original and compressed images. Characteristic of information losses:

$$F = \frac{1}{MN}\sum_{i=1}^{MN}\left(\sum_{j=1}^{L}\left(I_{i,j}^{0} - I_{i,j}^{'}\right)^2\right) \qquad (2)$$

Mean square error (MSE) (2) is a characteristic that shows average value of a square of Euclidean distance between pixels of original and transformed images. Thus, the problem of the criterion (1) maximization taking into account admissible losses constraint, defined by (2), is considered.

## 2 COMPRESSING USING PCA

Spectral image can be represented as a sequence of vectors $X_i$ of dimension L, where L is the dimension of spectral space; number of these vectors is equal to MN.

$$I_0(x,y,\lambda) = \{X_i\}_{i=1}^{MN}, X_i \in R^L \quad (3)$$

The purpose of PCA is to reduce the dimensionality of $X_i$ by searching a subspace of lower dimension, in an orthogonal projection to which axes the data dispersion is maximal. The main idea of the method consists in the calculation of the covariance matrix C:

$$C = \frac{1}{MN}\sum_{i=1}^{MN}(X_i - \mu_x)(X_i - \mu_x)^T \quad (4)$$

where $\mu_x$ is the expectation of vectors $X_i$. After that its eigenvalues and corresponding eigenvectors are calculated, *t* of vectors corresponding to the maximum eigenvalues are selected. These vectors are called principal components. They define the directions of largest dispersion of the data and form basis of a new subspace with the dimension *t*. Thus, after projection of the data to the principal components the sequence of vectors has dimension *t* less then L. The projection of vectors is calculated by the formula

$$Y = P(A - \mu) \quad (5)$$

where A is a matrix of vectors $X_i$ with the size L*MN, $\mu$ is a matrix with the size L*MN, whose columns are equal to the average value of vectors, P is the matrix with the size t*L, whose rows are the principal components, and Y is a matrix of projections with the dimension t*MN.

$$I_c = \{Y_i\}_{i=1}^{MN}, Y_i \in R^t, t < L. \quad (6)$$

Here $I_C$ is a compressed image. In order to restore original image $I_0$ it is necessary to use $I_C$, $\mu_X$ and matrix P. Using the method of the principal components the losses of information is simply controlled. Mean square error (2) is equal to the sum of matrix C rejected eigenvalues.

## 3 COMPRESSION USING WAVELET TRANSFORM

This section is devoted to the application of wavelet transform for compression of spectral images and to the description of the proposed method for controlling compression losses.

### 3.1 The basic ideas of wavelet transform

Wavelet transform allows making the transition from the initial images to the four new images, which dimensions are equal to half of the original. The first image is average value of the original, and three others are the images of the details removed by averaging. Smoothed image's pixels are called the coefficients of approximation, image's pixels of detail - detail coefficients. The wavelet transform is realized using the filtering and the thinned sample. For a filtration two filters are used: high and low frequencies. At the same time filtering is performed sequentially, first - by columns, then by rows. After each stage of a filtration the thinned sample is carried out. In the proposed work Haar's filters are applied. It is possible to subject the average image to wavelet transform, having increased there by depth of decomposition. Feature of the wavelet transform is that the detail coefficients are close to zero in areas of image's smooth values and they can be neglected, and the number of coefficients approximation

exponentially decrease with increasing depth of the expansion.

### 3.2 Application of wavelet transform for spectral images compression

As the result of application of the method of principal components the spectral image with the size MN*t is received. To each layer the wavelet transform is applied. The resulting set of the coefficient quantization is subjected to the following rule:

- if $\left|c_{ij}^{k}\right| \le q$ then $c_{ij}^{k} = 0$;
- if $\left|c_{ij}^{k}\right| > q$, then is rounded to k decimal places, so that $\left|c_{ij}^{k} - \hat{c}_{ij}^{k}\right| \le q$,

where $c_{ij}^{k}$ are coefficients of the wavelet transform and $\hat{c}_{ij}^{k}$ are quantized coefficients $\left(k = \overline{1,t}, i = \overline{1,M}\ \ j = \overline{1,N}\right)$, $q$ is the coefficient of quantization, which is equal for all layers. This rule ensures that the quantized coefficients will be different from the original smaller than q. When q is large, most coefficients will be zero, or approximated by an integer. So, sparse matrixes are obtained as a result of quantization. For their storage it is necessary to remember only non-zero elements and their location in a matrix.

We consider two images: A1, which is recovered after application of the method of principal components to the original spectral image, and A2, which is recovered after application of the method of principal components and wavelet transform to the original image. It is necessary, that information's losses in A2 in relation to A1 were less than beforehand given number $\alpha_1$.

It can be achieved by changing coefficient of quantization *q*. For this purpose it is necessary to find a column of a matrix P (see section 2), whose sum of modules of elements is maximum, and to designate the received value of the sum by γ. After that it is necessary to denote by $T^{-1}(1)$ the inverse wavelet transformation from vector consisting of units, number of elements in the vector is equal to number of coefficients of the wavelet transform.

Next formula gives a sufficient condition of a choice of quantization coefficient

$$q = \frac{\sqrt{\alpha_1}}{\gamma \max\left(\left|T^{-1}(1)\right|\right)\sqrt{L}} \qquad (7)$$

where max(T-1(1)) is the maximum element of inverse wavelet transform from unit vector. If *q* is calculated using (7), than mean square error (2) between A1 and A2 will be less than *α1*. Thus, the number of principal components and the quantization coefficient can be chosen in such a way that the data losses (2) does not exceed a prescribed value *α*. Suppose that λi are eigenvalues of the covariance matrix *C* (3) arranged in descending order. The number of the principal components is found by the condition

$$\sum_{i=t+1}^{L} \lambda_i < \alpha; \quad \sum_{i=t}^{L} \lambda_i > \alpha \qquad (8)$$

and the quantization coefficient *q* is calculated using (7) for

$$\alpha_1 = \alpha - \sum_{i=t+1}^{L} \lambda_i \qquad (9)$$

Choosing *t* and *q* by the proposed method we can guarantee that the mean square error will be less than beforehand set value.

## 4 SPECTRAL IMAGE COMPRESSION EXAMPLE

Consider spectral image with the size 152x91x61, which occupies 6.5MB of memory. For $\alpha$ =0.1 it is necessary to use 2 principal components. Thus, mean square error for the method of principal components is equal to 0.017. Then, the compressing of the image by wavelet transform for $\alpha_1$=0.083, q=0.043 is performed. Information losses (2) after that is equal to 0.0179. The memory which is required for compressed image storage is equal to 37.3 KB.
Compression results for different spectral images are shown in Table 1.

**Table 1.** Experimental data

| Size of the image | 5.95mb | 128mb | 14.6mb |
|---|---|---|---|
| $\alpha$ | 0.01 | 0.5 | 0.0001 |
| Number of PC | 6 | 1 | 71 |
| Mean error (2) after using PCA | 0.003 | 0.29 | 9.6e-5 |
| Compression ratio (1) after using PCA | 10.3 | 44.3 | 1.5 |
| $\alpha_1$ | 0.007 | 0.21 | 3e-6 |
| q | 0.002 | 0.14 | 1.3e-5 |
| Mean error (2) after using wavelet transform | 0.034 | 0.3 | 9.7e-5 |
| CR (1) after using wavelet transform | 26 | 300 | 1.9 |

## CONCLUSION

In this paper the algorithm of compression of spectral images using wavelet transform is offered. It is shown that information losses at compression don't exceed givrn specified value. Efficiency of the algorithm is shown by the example.

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## REFERENCES

Gonzalez Rafael C, Woods Richard E (2002) Digital image processing. Published by Pearson Education, Inc, publishing as Prentice Hall. ISBN 0-201-18075-8

Stephen Welstead (2004) Fractal and Wavelet Image Compression Techniques. A Publication of SPIE - The International Society for Optical Engineering Bellingham, Washington. ISBN 0-8194-3503-1

Pomerancev A, Principal Component Analysis http://www.chemometrics.ru/materials/textbooks/pca.htm

# CONTENT POPULARITY

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**Abstract**: We present the review of content popularity research results, based on such web systems as: Daum UCC, Digg, YouTube, and others. We classify these systems according to the content they provide to two main groups, namely user-generated content (UGC) and non-UGC systems, and present research results on this classification basis. Details of the research results vary significantly from one system to another, regardless of which group a system belongs to, and even can vary greatly between different categories within the same system. However, content popularity for most of the presented systems follows distribution laws of the same fashion – Zipf, Power or Pareto distribution laws, which suggest possibility of caching small amount of content that will serve large number of requests.

***Keywords:*** *content popularity, content popularity prediction, videos*

## 1 INTRODUCTION

Constant increase in information flows causes servers' overload and poor web systems' performance characteristics. For that reason, content distribution schemes should be continually optimized. Cache design improvement is one of the main possibilities to serve for this optimization. Content popularity research studies can be helpful to optimize cache resources, to identify the best cache size or the number of cache levels, as well as to identify other possible cache design improvements. Content popularity analysis of a system can provide valuable results only given that this system has been running for some, preferably long, time. In our paper we present some web systems content popularity studies.

## 2 METHODS AND MATERIALS

### 2.1 UGC and non-UGC systems

Focusing on the end users, we can distinguish two development stages of the Web: (a) users get access to professionally created web content, where they perform consumer role and can not affect this content; (b) users get access to publishing their own web content, thus performing producer role themselves. The latter web content is known as User Generated Content (UGC), which is contrasted with non-UGC. UGC systems include, for instance, blogs, forums, and wikis (e.g., YouTube, Twitter and Wikipedia). Both UGC and non-UGC belong to the so called "traditional Web" (Gummadi K.P., et al. 2003) or "Web 1.0" development stage of the Web; whereas in late 2004 "Web 2.0" term was already introduced. Some of the main features of the Web 2.0 are: users' collaboration (e.g. rating, voting and commenting); more user-interface, software and storage facilities for users through their browser; virtual communities for UGC (social networks). Thus, for instance, YouTube and Twitter systems include features of Web 2.0. In fact, Web 2.0 is inseparable from UGC. Content popularity studies are separated for non-UGC and UGC systems as these systems have very different features. UGC systems are characterized by a larger scale, more dynamic environment and decentralized video producers, which is not typical for traditional Web systems (Cha M. et al. 2007). Moreover, users' behavior in UGC systems becomes completely different –

users now can access almost any information they are interested in at any time. In Figure 1 we summarize systems classification assumed in this paper.

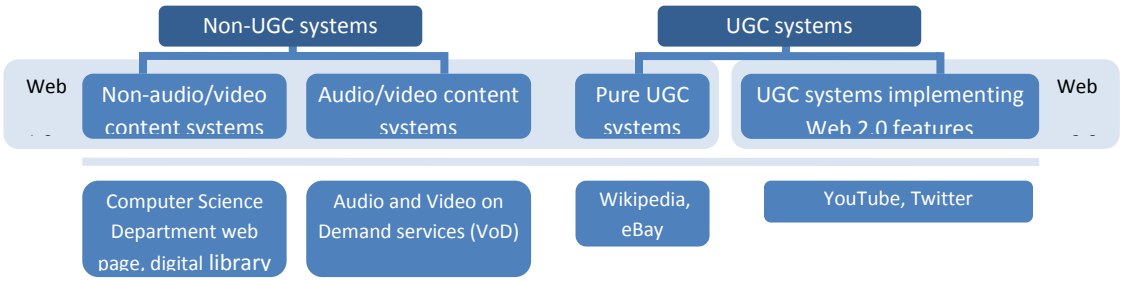


**Figure 1.** Systems classification

### 2.2 Dataset of non-UGC systems

For the group of non-audio/video content systems we present integrated research results based on the six different communities groups' web requests (Breslau L., et al. 1999). These groups include academic, corporate and Internet service provider communities. Research was carried out with time intervals from 1996 to 1998. The registered number of requests also varies significantly from 1,766,409 to 4,815,551.

For the group of audio/video content systems we present results of PowerInfo VoD system (Yu H. et al. 2006) and another VoD system of a leading European telecom operator (Famaey J. et al. 2011). PowerInfo was traced during seven month from May to December of 2004, registering 150,000 users' accesses from a single city. For this period traced users requested 6716 unique videos. For the European telecom operator requests were registered from 12 different cities, tracing 8,392 unique users. Traced users made 75,013 requests for 4,971 different videos during 32 days in 2010.

### 2.3 Dataset of UGC systems

We present research results of Daum UCC, Digg and YouTube systems as UGC systems that implement Web 2.0 features (Cha M. et al. 2007, Szabo G. et al. 2010). Daum UCC was traced during March 2007, registering 196,037 new videos and 207,555,622 views for the period (Cha M. et al. 2007). In research purposes, Digg was traced for five and a half months in 2007. During this period there were 1,321,903 links submitted, 7% of which were promoted to the main page. YouTube system was analyzed within two information categories – "Entertainment" (Ent) and "Science & Technology" (Sci) (Cha M. et al. 2007). Ent category was traced for one day in December 2006, registering 1,687,506 uploaded videos and 3,708,600,000 views. Sci category was traced six days in January, one day in February and one day in March of 2007, registering 252,255 uploaded videos with 539,868,316 views.

## 3 RESULTS

### 3.1 Access patterns of non-UGC systems

For the group (a) of non-UGC systems, strong access patterns that integrate all the users from different communities are not registered. Web accesses to the popular documents are different for various community groups. In general, approximately 70% of web accesses refer to the 25% - 40% of documents (Breslau L., et al. 1999).

Access patterns analysis of PowerInfo VoD system shows explicit regularities (Yu H. et al. 2006). On an hourly basis, there are two peaks of users' accesses – from 12 p.m. to 2 p.m. and from 6 p.m. to 9 p.m. – and two lowest values periods of users' accesses – from 12 a.m. to 7 a.m. and from 2 p.m. to 5 p.m. On the daily basis number of requests starts growing in the second half of the week and reaches its peak on Sunday. These hourly and daily access patterns observations show us that user's web behaviour is closely related to the users' working habits (Yu H. et al. 2006). In terms of session length, it is shown (Yu H. et al. 2006) that more than a third (37.44%) of the terminated sessions end within the first 5 minutes of the video, more than a half (52.55%) of the terminated sessions end within the first 10 minutes of the video, and three-quarters (75.25%) of the terminated sessions end within 25 minutes of the video.

Research results for the access patterns of the VoD system of European telecom operator (Famaey J. et al. 2011) also show regular patterns. On the daily basis peaks occur on the weekends. On the hourly basis, there are two peaks on weekdays – from 1 p.m. to 5 p.m. and from 8 p.m. to 12 p.m.; and high requests rate from 9 a.m. to 12 p.m. on the weekends.

### 3.2 Access patterns of UGC systems

Digg users' requests on an hourly basis vary up to threefold. On a daily basis users are about 50% less active on weekends than on weekdays. A plot of YouTube's and Daum's normalized video ranks against fraction of aggregate views shows that 10% of the top most popular videos gather 80% of the users' requests. These results suggest possibility of caching 10% of content that will process 80% of requests (Cha M. et al. 2007).

### 3.3 Content popularity of non-UGC systems

For the group of non-audio/video content systems, web requests are shown to follow Zipf distribution on a log-log plot of document ranking against number of the documents' references, with $a$ varying from 0.64 to 0.83 for different community groups (Breslau L., et al. 1999). In terms of an individual item, it is proved that the item access frequency does not depend on the document size, as correlation between these factors is too low. Though, popular documents are generally shorter than unpopular ones. Moreover, access frequency on the individual item also does not depend on the document's average modification per request, as correlation between these two factors is also too low to be considered.

For the group of audio/video content systems on the VoD PowerInfo example it is shown (Yu H. et al. 2006) that content popularity also follows Zipf distribution on a log-log plot of movie index (rank) against access frequency. However, there is a truncated tail or sharp decay of access frequency for unpopular videos (videos with low rank). Further, according to the rate of change in users' interest for PowerInfo system content, authors (Yu H. et al. 2006) conclude that there will be little gain to cache 200-top popular videos instead of 100-top popular. Furthermore, two-level cache for PowerInfo system is suggested (Yu H. et al. 2006). The first level of cache should store 10-top popular videos and should be the fastest one; the second level cache should store 100-top popular videos and can be slower.

### 3.4 Content popularity of UGC systems

YouTube and Daum content popularity properties (Cha M. et al. 2007) are different for popular and unpopular content. For the popular content, it is shown that video popularity distribution mostly follows power-law behavior on a views against number of videos with $\geq x$ views plot, with truncated tail of frequency for the content with most views. Such deviations from the pure power-law distribution are possible and commonly registered on the most or least popular items, which indicates different bottlenecks (e.g., information bottleneck) for the content popularity. For the unpopular content, popularity distribution follows Zipf distribution on a video rank against views plot, with a truncated tail of views for the lower-ranked videos (Cha M. et al. 2007). Among some potential causes of the tail, information filtering is suggested to play the most significant role. Information filtering implies search engines feature of favoring the most popular items and displaying less popular items further away to users.

## CONCLUSIONS

In this paper we reviewed content popularity research results, based both on non-UGC and UGC systems. We conclude with the following observations:

1. For non-UGC systems, if users' access patterns can be revealed, they are usually closely related to the users' working habits in the way that users mostly access systems at their free time (either during working break or weekend). These users' access patterns can serve for identifying maintenance time of the servers and other updating work. Analyzing sessions' length can help cache designers to identify number of cache levels, their sizes and portion of the storing content. Thus, for instance, for PowerInfo system, caching first 10 minutes of videos will be enough for serving 50% of users requests; and there will be a little gain of having second level cache enough to store 200-top popular videos instead of 100-top popular ones.
2. For UGC systems content popularity follows quite similar (Zipf or Power) distribution laws, which suggests the possibility of caching small amount of content that will serve large number of requests. The details of cache design should be identified according to these high-precision distribution graphs.

We believe that content popularity research results can be valuable not only for web systems' cache designers, but also for content providers of non-UGC systems, systems administrators of UGC systems, sociologists, philologists and for many others specialists not necessarily in IT field.

## REFERENCES


Breslau L., Cao P., Fan L., Phillips G., Shenker S. (1999) Web Caching and Zipf-like Distributions: Evidence and Implications, Proc. IEEE Infocom '99, pp 126-134.

Cha M., Kwak H., Rodriguez P., Ahn Y.-Y. and Moon S. (2007) I Tube, You Tube, Everybody Tubes: Analyzing the World's Largest User Generated Content Video System, Proceedings of the 7th ACM SIGCOMM conference on Internet measurement (IMC '07).

Famaey J., Wauters T., and De Turck F. (2011) On the Merits of Popularity Prediction in Multimedia Content Caching, Integrated Network Management (IM), 2011 IFIP/IEEE International Symposium.

Gummadi K.P., Dunn R.J., Saroiu S., Gribble S.D., Levy H.M., and Zahorjan J. (2003) Measurement, Modeling, and Analysis of a Peer-to-Peer File-Sharing Workload, Proc. of ACM SOSP.

Szabo G., Huberman B.A. (2010) Predicting the popularity of online content, Communications of the ACM, vol. **53**, no. 8, pp. 80-88.

Yu H., Zheng D., Zhao B.Y. and Zheng W. (2006) Understanding User Behavior in Large-Scale Video-on-Demand Systems, Proc. ACM EuroSys'06.

# FOREST STAND SEGMENTATION FROM LIDAR DATA BASED ON MEAN SHIFT AND SPECTRAL CLUSTERING

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**Abstract**: Forest stand delineation is important in forest management. Traditional manually stand delineation is a labor intensive process. It is not only time consuming, but also partial subjective. In this work, we studied a new approach for automatic stand segmentation from LiDAR data. The method is based on Mean Shift and Spectral Clustering. Three features, height, density, and applied 3D texture variables, which are solely extracted LiDAR point clouds, are used in the method. Experimental results were compared with manually segmented results made by professional foresters based on aerial color-infrared (CIR) images. It showed our method worked well on the test LiDAR data. The forest stand segmentation accuracy may be further improved by combing LiDAR data and aerial CIR images that have more accurate tree species information.

***Keywords:*** *forest stand segmentation, LiDAR, ALS, spectral clustering, mean shift*

## 1 INTRODUCTION

Forests provide numerous benefits to human beings. To well maintain these valuable resources, forest management is quite necessary. The traditional methods to collect the data for forest management are based on forest stand level field inventories. Forest stands are homogeneous forest areas that have different characteristics with the adjacent areas (Koivuniemi and Korhonen 2006). Traditional, forest stands are manually delineated based on aerial images and filed surveys. However, it requires professional foresters and is time consuming. And the results are partial subjective. Therefore, the automatic forest stand delineation is needed. Light detection and ranging (LiDAR), also known as Airborne Laser Scanning (ALS), provides abundant high spatial resolution data on the vertical structure of forests. It works more stable in various conditions compared to aerial Color-Infrared (CIR) images. Therefore, LiDAR has drawn much attention recently and has good performance in forest stand delineation (Naesset 1997).

Mean Shift (MS) algorithm (Comaniciu and Meer 2002) and Spectral Clustering (SC) (Ng et al. 2001) are two quite popular image segmentation algorithms currently and have been successfully used in many applications. However, they are seldom used in LiDAR based forest stand segmentation tasks.

In this work, the forest stand segmentation from LiDAR data was studied based on MS and SC combined segmentation method. The flowchart of the method is shown in Fig. 1.

## 2 FOREST STAND SEGMENTATION

### 2.1 Feature Extraction

The quality of forest stand segmentation is highly affected by the features extracted from LiDAR return point clouds. Extracted features should represent the forest stands accurately based on some stand-defining criteria and also be easily calculated. Three features were exacted from LiDAR return point clouds in this work: tree size indicator (TSI), forest density indicator (FDI), and tree species indicator (SPI). The first two

represents the size and density of trees: TSI is 85% of the Canopy Height Model (CHM) in each 4 m x 4 m cell derived from LiDAR point clouds; FDI is the proportion of vegetation hits in all LiDAR returns within a 4 m x 4 m cell. The last feature, SPI, gives information on tree species based on the linear combination of 3D variables determined by its first principle component (Tokola et al. 2008). Fig. 2 (a) shows the 3 band image combined by the three features rendered by pseudo colors.

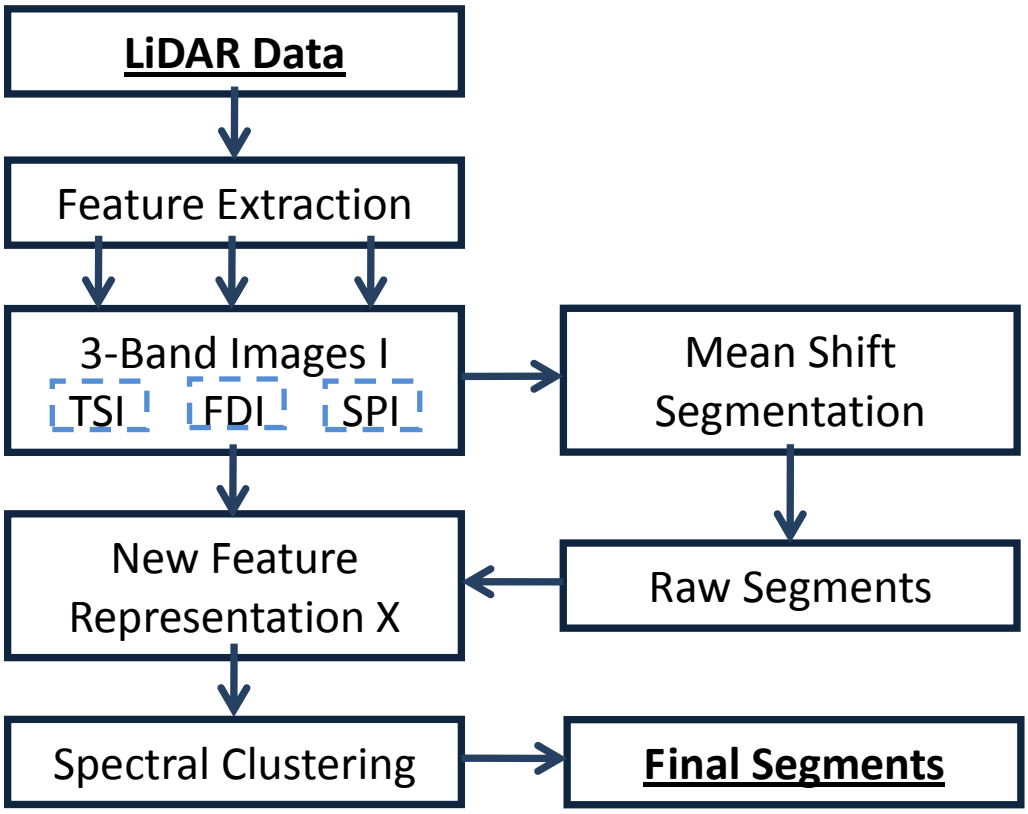


**Figure 1.** Flowchart of the segmentation method.

## 2.2 MEAN SHIFT AND SPECTRAL CLSUTERING

Mean shift (MS), a non-parametric density estimator based on Pazen window technique, is a popular feature-space analysis method that has been successfully used in image segmentation tasks (Comaniciu and Meer 2002). The MS procedure is an adaptive gradient ascent method, where the center of the kernel is iteratively updated. The MS image segmentation is a merging process of regions obtained from MS procedure performed in the joint spatial-range domain.

Spectral clustering (SC), a relaxation of the graph partitioning problem, is based on the eigen-decomposition of the Laplacian matrix derived from dataset (Ng et al. 2001). The eigenvectors induce a new data representation of the original one. By using this new representation, the dataset can be easily clustered by any other clustering algorithms.

## 2.3 SEGMENTATION METHOD

The forest stand segmentation method is a combination of MS and SC, following the idea of Tao et al. in color image segmentation (2007). The combination of these two powerful techniques brings more robust and accurate segmentation results by enforcing

their advantages and eliminating their drawbacks. The flowchart of our forest stand segmentation method is shown in Fig. 1.

We first combine three features (TSI, FDI, and SPI) into a three band image I. Secondly, the image I is segmented into several raw segments, usually over-segmented, by MS segmentation algorithm. Then a new presentation X of the image I is generated by each raw segment based on the mean values of each pixel in the corresponding segment. Finally, the new presentation X is clustered by SC into less number of segments by merging the segments obtained by MS to achieve the final segmentation results.

In SC, we construct the 1-nearest neighbour (1-NN) similarity matrix S for $X = \{x_1, \ldots x_n\}$ with $x_i \in \Re^3$ based on Gaussian function, as

$$s_{ij} = \begin{cases} \exp(-\dfrac{\left\| x_i - x_j \right\|^2}{2\sigma^2}) & \text{if } x_i \text{ and } x_j \text{ are adjacent} \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

, where $s_{ij}$ is the element in S and $\sigma$ is the scaling parameter controlling the rapidity of the decay of $s_{ij}$. We use 1-NN similarities instead of commonly used full connected similarities in SC to keep the spatial connectivity in the image. And in the last step of SC, we use k-means (KM) algorithm to obtain the final segmentation results.

## 3 EXPERIMETNAL RESULTS

We applied the forest stand segmentation method in the LiDAR data. In the experiment, the parameters of MS were as follows: spatial bandwidth 16, range bandwidth 26, and the minimum number of pixel in each segment 20. In SC, $\sigma$ was 2 and KM algorithm was repeated 100 times. The one with lowest MSE was the final segmentation result. For the number of segments needed in SC, we set it to 50.

### 3.1 LiDAR Dataset

The LiDAR data were acquired on July 13, 2005 in Juuka at eastern Finland over a 67 ha commercial forest property owned by United Paper Mills and managed in a manner typical of Scandinavian conditions. The Optech ALTM 3100C sensor was used with nominal average point density 0.6 pulses/m$^2$, varying in the range of 0.5-1 pulses/m$^2$. The average flight altitude was 2000 m above ground level and the field of view was 30 degree, with a 60 cm beam footprint. Four returns were recorded by the sensor, and the first and last pulses were attributed. The returns were classified into two classes: “ground” and “default”. Using the mean of the ground returns as the z-value and the bilinear interpolation for the cells with no ground returns, a 2.5 m DTM was created from LiDAR return point clouds. Also based on LiDAR return point clouds, a vegetation height model was made by replacing the z-values with the difference between the point and the DTM altitudes.

### 3.2 Results

The final segmentation result of our method is shown in Fig. 2 (b). To compare the results, one segmentation result manually made by a professional forester based on CIR

image is shown in Fig. 2 (c) (Leppänen et al. 2008). We can see that the upper parts of the two results are similar with each other. However, our method produced more small stands compared to the manually delineated one.

## DISCUSSION

The results showed that our method generally worked well for forest stand segmentation on the three features extracted from LiDAR data. Compared to results based on the same feature using region growing and watershed techniques (Tokola et al. 2008), our results don't have very small segments and are more similar with the one manually made my professional forester as in Fig. 2 (c). However, some parts of our results have more segments compared to the manually delineated one. To further evaluate the results, some statistical values, such as F-value, are needed to calculate from plot information. It can be estimated that the segmentation accuracy may be further improved by including the aerial CIR images, since they contain more accurate tree species information.

One drawback of our method is that the number of segments should be known for SC. In Future, we may consider applying bi-partition SC recursively to cluster the segments from MS into two parts recursively. Then a threshold value can be used to automatically stop the bi-partition process, so that there is no need of the segment number.

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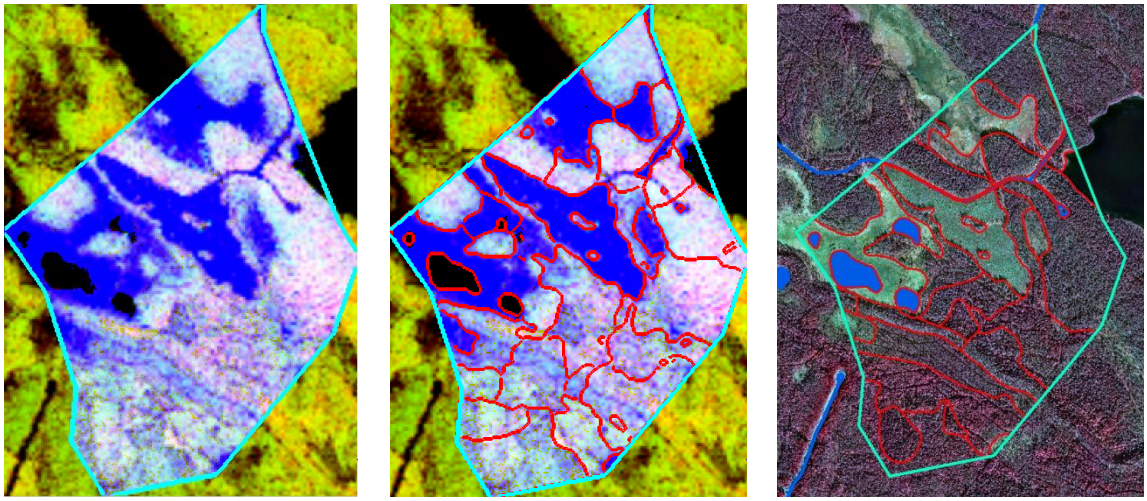

(a) (b) (c)

**Figure 2.** (a) Features used in segmentation rendered by pseudo colors. The area with cyan edge is the region used in segmentation. (b) Segmentation result based on our method shown on (a) with each segment edge represented by red lines. (c) Segmentation result based on manual delineation from CIR image by a professional forester with each segment edge shown by red lines (Leppänen et al. 2008).

## REFERENCES

Comaniciu C and Meer P (2002) Mean shift: a robust approach toward feature space analysis. IEEE Trans. Patt. Analy. Mach. Intell. , 24, 603–619..

Koivuniemi J and Korhonen K (2006) Inventory by compartments. Forest inventory: methodology and applications, , Springer, pp. 271.

Leppänen V, Tokola T, Maltamo M, Mehtätalo L, Pusa T, Mustonen J (2008) Automatic delineation of forest stands from LIDAR data. Proc. ISPRS Conf. on GEOBIA 2008.

Naesset E (1997) Determination of mean tree height of forest stands using airborne laser scanner data. ISPRS J. Photogrammetry & Remote Sensing, 52, 49-56.

Ng A, Jordan M, Weiss Y (2001) On spectral clustering: analysis and an algorithm. Proc. Advances in Neural Information Processing Systems 14, 2001.

Tao WB, Jin H, Zhang YM (2007) Color image segmentation based on mean shift and normalized cuts, IEEE Trans. Sys. Man Cyber. B 37, 1382–1389.

Tokola T, Vauhkonen J, Leppänen V, Pusa T, Mehtätalo L, Pitkänen J (2008) Applied 3D texture features in ALS based tree species segmentation. Proc. ISPRS Conf. on GEOBIA 2008.

# CROSS-BORDER PROSTITUTION IN THE NORTH

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***Keywords:*** *mobile prostitution, East-prostitution, poverty, time-sensitivity, northern region*

## INTRODUCTION

Increase in supply and demand of commercial sex in Northern Countries timing after the collapse of Soviet Union 1991. The collapse of Soviet Union catalysed enormous changes inside the country and in the East-Europe. Differences in standard of living between the East and the West led increase a welfare gap. Russian society is still in the state of transition; many previous social institution and structures have collapsed and lost their meaning, and they still haven't been replaced by new structures. Macro-level changes caused by the societal transition often appear at the micro level in women's everyday life as insecurity, poverty, and problems related to social security. (Urponen 2002.)
Prostitution has understood here as mobile prostitution directed from the Murmansk region Russia to the Northern parts of Finland, Sweden and Norway. This based on my research data (Skaffari 2010, only Finnish).

## KEY FACTORS

Women often choose prostitution in situations that do not fully allow a person to choose freely. Entering prostitution often occurs as a process-like chain of events. Women's individual life situations and opportunities offered by the environment, or a lack of them, guide women to the risk zone that provides them a way to enter prostitution. Prostitution defines as supplementary means to earn a living, or as a main livelihood, and prostitution can also define as a problem-solving method that can be returned to when facing economic problems. The feminization of poverty is the one main underlying factor. The globalization has open the way "to shuttle" between the home country and foreign countries behind the borders. There is a question of migration behind a job. (Agustin 2007.)

Prostitution is time-sensitive phenomenon. Behind the Northern prostitution can be seen various factors committed in time: Soviet Union collapse, border's open to the West, nearness of geographical location, also demand of commercial sex was small in the North, and because of that supply for commercial sex was existing. Prostitution phenomenon didn't settle down in social vacuum (Urponen 2002). Also tourism to Russia was increasing, partly sex tourism. Interaction between people in North and Russia added up. Schengen contract (from 2001) provided for free moving between Finland, Norway and Sweden. The support structures for prostitution were organized by step by step in the North.

## PROSTITUTION EXPANSION PERIODS

Cross-border prostitution in the North can be shared in time-periods: The first period begins in the middle of the 1990s, when first girl busses from the Murmansk region arrived in Finland. Prostitution existed first in the Northern parts of Finnish Lapland and

also as a transit-traffic via Lapland to the North-Norway. At the time volume of women was high and prostitution activity was not yet well organized. The second period begins in 2000s, when prostitution mainly existed in the Southern parts of Lapland. Then prostitution was observable in private houses, ”informal bordels”, camping areas, hotels and special Inn’s. Traffic via Finland to the North-Sweden was quite common. Transportation from Murmansk direct to the North-Norway for prostitution Inn’s was organized. At this time criminal elements involved in prostitution increase. Many changes have been made in Finnish Legislation (in 2003; 2004); in Criminal Law, in Law of Order and Regulation and in Foreign Law. Also Visa control became tighter. (Skaffari & Urponen 2004.)

The third period placed time after the Kapernaum Inn in Finland after 2004. This in was very well known place in prostitution field in Lapland. Prostitution activity was smaller and very well organized. Women have got now enough courage to travel independently or they travel in small groups. Contact’s with clients has been built before and more often new contacts were established via Internet. At this time invitation and visa trade “factoring” became larger. Action was more often business-like and volume of different actors was bigger now. Behind the variation of prostitution traffic to Norway and Finland mediate Visa practices. (Skaffari 2010.)

## CURRENT TREND

Today is possible to find the fourth period because prostitution as a social phenomenon changes all the time and often all at once. Behind the phenomenon is strong social control, moral and political pressure. Prostitution is not openly present and it has taboo-like elements. Because of prostitution’s illegal nature and reforms in legislation have push together prostitution behind the doors in the North. On the region have been first signals about new actors in prostitution field (2009) from Nigeria, Venezuela, Brazil, Hungary and Poland.

In 2012 political discussion has activated again. There is a strong pressure to harmonize prostitution legislation in the Northern region and after this buying sex should be prohibited also by Law in Finland.

## CONCLUSIONS

Cross-border prostitution is time-sensitive phenomenon in the North. After the Collapse of Soviet Union borders open to the West. The collapse catalysed enormous changes inside the country and in the East-Europe in macro level, but also in micro level in citizen’s everyday lives. Feminization of poverty is the one meaningful underlying factor which has push women to look different surviving strategies. Mobile prostitution has open the way to shuttle between home country and some other countries. Women often choose prostitution in situations which are not fully allowed a person to choose freely. Behind the Northern prostitution has be seen various factors committed in time.

## REFERENCES

Agustin L., M. (2007) Sex at the Margins: Migration, Labour Markets and the Rescue Industry. Zed Books. London, New York.

Skaffari P. (2010) Rajat ylittävä prostituutio. Tutkimus naisten kokemuksista pohjoisen itäprostituutiossa. Acta Universitatis Lapponiensis 185. Lapin yliopistokustannus. Rovaniemi.

Skaffari P. and Urponen, K. (2004) “Ei vain rakkaudesta, vaan myös…” Esiselvitys lapin seksimarkkinoista ja prostituutiosta. Lapin yliopiston yhteiskuntatieteellisiä julkaisuja, Työpapereita c 48. Rovaniemi.

Urponen, K. (2002) The underlying social factors in the social and health problems in Finland’s neighbouring areas. In Aaltonen, U. and Arsalo, A. and Sinkkonen, M.: BEING POSITIVE. Perspectives on HIV/AIDS IN THE EU’s Northern Dimension and Finland’s Neighbouring Areas. Gummerus.Saarijärvi, 81–104.

# CO-DESIGN AS A METHOD OF INCLUSION FOR OLDER ADULTS IN PUBLIC SOCIAL AND HEALTH CARE SERVICES?

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**Abstract**: IKÄEHYT (promoting older adult's wellbeing and coping in Northern Finland) is a research and development project conducted by Lapland University Consortium. The project is multidisciplinary, combining research interests of design, art as well as health and social sciences. One of the central principles of project is to co-produce knowledge of the lives of older adults and on the basis of this knowledge to co-develop services and working methods to support older adults' wellbeing and inclusion. Overall aim of research is to explore participation, inclusion and positions of older adults in the context of health and social services. This presentation focuses on the possibilities for co-design to enhance older adults' participation, inclusion and positive subject positions. Possibilities for co-design are: (1) offering discussion forum for the decision-makers, service users and local residents, (2) users' voice and needs are raised and listened, (3) co-design methods are in themselves inclusive in providing sense of community, community spirit and hearing of people's voices. Threats in co-design are: (1) portion and participation of participants that at are in most vulnerable position may be weak, e.g. older adults in 4th age, (2) communication gap in design process may result in unsatisfied outcome from service user's point of view, (3) quality initiatives may be developed but their overall impact and implementation may remain weak, (4) workshops remain one-time occasions regardless of the changing user needs and circumstances.

***Keywords:*** *co-design, participation, older adults, wellbeing, public social and health care services*

## INTRODUCTION

IKÄEHYT - Ikäihmisten elämänhallinnan ja hyvinvoinnin tukeminen (promoting older adult's wellbeing and coping in Northern Finland) is a research and development project conducted by Lapland University Consortium: Kemi-Tornio University of Applied Sciences, University of Lapland and Rovaniemi University of Applied Sciences. The project is multidisciplinary, combining research interests of design, art and social sciences. Fourteen Northern Finnish municipalities, numerous 3rd sector actors and enterprises are involved in the project.

One of the central principles of IKÄEHYT-project is to co-produce knowledge of the lives of older adults. This knowledge is used as a basis to co-develop services and working methods to support older adults' wellbeing and inclusion.

Working methods consists of:
(1) enhancing the use of communal art and culture based working methods in different settings for elderly (e.g. reminiscence, music, visual arts)
(2) piloting service design methods with service providers and older adults in the context of assisted living and day care: co-designing, envisioning, testing, prototyping and implementing
(3) organizing education and training sessions
(4) conducting research from the perspectives of service users and providers
(5) piloting broader functional capacity assessment tool at home care
(6) listening the elderly: panel discussions, seminars, workshops, research

Primary funder of the project is European Social Fund (approximately 80 % of funding). Project time duration is 1.3.2011–31.8.2013.

## CO-DESIGN AS INCLUSIVE SERVICE DESIGN TOOL?

Service design is about understanding human activities, feelings, needs and motives – it is about creating services from the users' perspective. Technically service design is generally defined as a systematic, creative and empathic approach to uncover unmet explicit and hidden customer needs and desires and to correspondingly develop new human centred service solutions (or improve existing ones) that are usable, useful, efficient, effective and desirable from the users' point of view and feasible, viable and valuable from the producer's point of view. Service design process can be divided into six phases: understanding, thinking, generating, filtering, explaining and realising (see figure 1). (Moritz 2005.)


**Figure 1.** Service design process (Moritz 2005).

Co-design is a term that is often mentioned when talking about service design: it can be used in all stages of the design process but especially in the ideation or conceptualization phase. Co-design is a user-shared design process where the service is designed collaboratively with service users, local residents, service providers and professionals. For example the roles of users, designers and researchers are different comparing to classical design process (see figure 2).

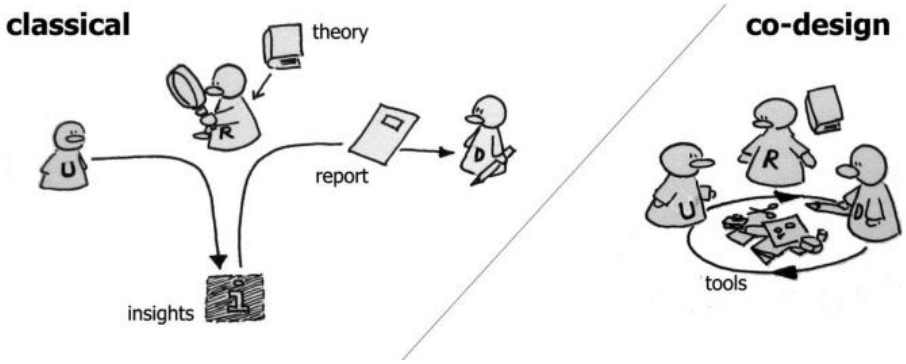


**Figure 2.** Roles of users, designers and researchers in design process: classical and co-design (Sanders & Stappers 2008, 11).

Co-design can be understood as a way to design solutions for a community with that community. By using co-design methods, user data can be exported quickly to

the service development as well as used to provide feedback from the user. When the users' needs and expectations are the starting point of the design process, usability of the product or the service is easier to ensure. (Sanders & Stappers 2008, 11.)

According to Jäppinen (2011) co-design has increased in popularity in many businesses and organizations – especially in public sector services. As a result of this development the traditional way of participating in decision making on services through representative or direct democracy is accompanied by and a new, more innovative way where residents participate in the planning and development of service provision through user-driven innovation activities.

## RESEARCH QUESTION

Overall aim of research in IKÄEHYT-project is to explore participation, inclusion and positions of older adults in context of health and social services (home care, day care and assisted living). Our research question in this presentation focuses on the possibilities for co-design methods to enhance older adults' participation, inclusion and positive subject positions. Research questions are:

- Do co-design methods enhance older adults' inclusion?
- How is inclusion achieved? What are the possibilities and threats in co-design methods from the perspective of inclusion?
- How does interaction in co-design workshops enhance inclusion and what are the limitations or threats for achieving older adults' positive subject positions?

## DATA AND METHODS

Research data consists of observations, videotapes, questionnaires and other documents (e.g. meeting notes, invitations and workshop outcomes). Results in this paper are based on questionnaires and other textual materials. Analyzing of video materials is still in progress but preliminary video material analysis will be available in presentation.

The main data (videotaped interaction) was gathered in three co-design workshops organized in one Northern Finnish assisted living surrounding in January and March 2012 (third workshop will be organized in May 2012). Total amount of participants in two co-design workshops was 51. Main participants in workshops were older adults (service users and local residents), local service providers (both public and private) and 3$^{rd}$ sector actors.

Videotaped interaction in co-design workshops will be analysed by discourse analysis methods (e.g. Wetherell 1988, van den Berg et al. 2004). The data is seen as part of collective and cultural discourses that represent and reproduce our understanding of older adults and their position in society. Questionnaires, text and other data will be used to produce understanding of the social and cultural context (e.g. working culture) and how it is preventing or supporting successful implementation of co-design methods.

## PRELIMINARY RESULTS

Possibilities for co-design:

- Co-design workshops offer a new kind of discussion forum for the decision-makers, service users and local residents.
- Users' voice and needs are raised and listened to at the early planning phase of services.
- Co-design methods are in themselves inclusive in providing sense of community, community spirit and hearing of people's voices.

Threats of co-design:

- Portion and participation of participants that at are in most vulnerable position may be weak, e.g. older adults in 4th age.
- Communication gap in design process may result in unsatisfied outcome from service user's point of view.
- Quality initiatives may be developed but their overall impact and implementation may remain weak.
- Co-design workshops remain one-time occasions regardless of the changing user needs and circumstances.

**REFERENCES**

Jäppinen T (2011) Kunta ja käyttäjälähtöinen innovaatiotoiminta. Kuntaliiton verkkojulkaisu. Acta nro 230.

Moritz S (2005) Service design. Practical access to an evolving field. http://stefan-moritz.com/welcome/Service_Design_files/Practical%20Access%20to%20Service%20Design.pdf

Sanders E and Stappers P (2008) Co-creation and the new landscapes of design. CoDesign: International Journal of CoCreation in Design and the Arts. Vol. 4, Iss. 1, 5–18.

van den Berg H, Wetherell M & Houtkoop-Steenstra M eds. (2004) Analyzing race talk: Multidisciplinary perspectives on the research interview.

Wetherell M (1998) Positioning and interpretative repertoires: Conversation analysis and post-structuralism in dialogue. Discourse and Society Vol. 9, No. 3, 387–412.

# SOCIAL DETERMINANTS OF HEALTH IN 'WELLBEING'

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## THE THEORETICAL BACKGROUND

### 'Wellbeing' - what does it mean, how does the term function?

At the outset, I want to make some observations about how the term 'well-being' behaves in real-life usage.

Well-Being Institute at the University of Cambridge: "positive and sustainable characteristics which enable individuals and organizations to thrive and flourish".

It is clearly the subject of much public discourse - media, books, Television and more.
Work, education and health are also arenas in which wellbeing features strongly, and where it is constructed as both instrumental in, and an outcome of, personal development.

"Personal wellbeing makes a significant contribution to young people's personal development and character. It creates a focus on the social and emotional aspects of effective learning, such as self-awareness, managing feelings, motivation, empathy and social skills (SEAL[1]).

Finally, the commercial sector, too, is full of references to wellbeing - in food sectors and in other consumer goods; alternative health; retail; wellbeing portals and services. There is clearly a 'wellbeing' industry where wellbeing is a commercialized commodity; this holds out the promise of "well" identities to be purchased and consumed to achieve a state of virtue.

There are new domains of expertise for sale and "Wellbeing consultants" to deliver wellbeing products and services, to help people achieve these identities.

Yet, looking across these contexts, wellbeing has a 'holographic' quality; different meanings are being projected by different agents and what is apparently meant by the use of the term depends on where we stand. There are few fixed points or commonalities beyond 'it's a good thing'. Effectively, wellbeing acts like a cultural mirage: it looks like a solid construct, but when we approach it, it fragments or disappears.

### What specifically can we see by close examination of 'wellbeing' *language* and how it behaves?

There are issues lurking under the surface, on a number of levels.
There are many explicit and implicit questions around which different versions of 'wellbeing' are constructed, including:

- Individual or collective?
- Subjective or objective?
- Permanent or temporary?
- General or specific?
- Reducible to components, or an irreducible holistic totality?
- Whose responsibility? (structure vs. agency)
- A neutral state (nothing wrong) or a positive state (better than neutral)
- A state or a process - a place or a journey?
- An end in itself - or necessary to another end?

"Wellbeing is both a state and a process, and it is multi-dimensional… Similarly, ill-being cannot be simplistically equated with material poverty, misery or frustrated goal achievement." (ESRC Research Group on Wellbeing in Developing Countries, June 2007).

On one level, the lack of a clear opposite to 'wellbeing' is just an interesting quirk, but on another it gives us some clue as to the nature of what is being claimed or evoked by some common uses of the word. It seems it commonly represents an ideal, a generically desirable state. It is 'just good' - but not set against any specific kind of 'bad'.

**Wellbeing as a social construct and site of contest**

Today, there seems a clear contest for dominance - wellbeing is definitely 'up for grabs'. This invites the question - *why* the current instability around wellbeing? We cannot know, but can hypothesise a number of factors in play.

As a culture, we have long held tight to the idea that the route to fulfilling our potential is through economic prosperity, but this belief is now being shaken or challenged - we have for example an emerging discourse of the 'toxicity' of affluence. This is coupled with the apparent paradox whereby subjective well-being has since remained static in recent decades in most modern societies (Layard, 2006), notwithstanding rises in standards of living and personal wealth in the developed world over the same period. Economic discourses also indicate that current levels of consumption cannot be maintained. So there are big questions being asked about what does and might constitute 'wellbeing'.

The 'Joined-up Government' ambition has actually entailed the systematic destabilisation of old boundaries in the creation of new structures, Departments and agencies. One likely consequence is to engender contests over meaning amongst old and new Departments and agencies, including over core concepts like 'wellbeing'. The reason for such a struggle - over whose version gets 'heard' and normalised - is that it is also a contest for legitimacy, resources, and for ideological authority.

As we noted earlier, wellbeing is a cultural construct - it is a very general term for what people collectively agree makes 'a good life'. We also noted that this kind of construct changes through time. 'Wellbeing' in practice at the moment seems a usefully comprehensive construct - it is able to hold at the same time all sorts of problematically conflicting demands.

Politically, this malleability and lack of specificity makes ‘wellbeing’ potentially useful to bring together various policies and actions. But the same malleability makes clarity elusive and accountability for ‘wellbeing’ problematic.

**Multiple discourses of wellbeing**

1. Wellbeing and the medical heritage

   What is ‘health and wellbeing’ about? Looking closely at it in context, it seems consistently to link into the discourse of ‘modern’ medicine, a discourse in which the remit of medicine goes beyond bodily health.

   WHO first included ‘wellbeing’ in its definition of health in 1947; perhaps an early indicator of subsequent trends in medicine. That is, since then, we have seen significant changes in the ‘medical model’ including the rise of psychology, and a serious challenge (even within the medical profession) to mind-body dualism. It is now taken for granted that minds and bodies interact - and that ‘health’ must entail the health of both.

2. A ‘candidate’ operationalised discourse: outcomes and indicators

   An operationalised discourse means one in which a concept is known defined and treated as real in terms of a set of indicators or measures. So IQ ‘is’ that which IQ tests measure.

   For an operationally-defined wellbeing, people are aware of equating wellbeing with the five outcomes (SEAL) as are represented in a recent definitional claim. People are also well aware of the strength of the medical construction and that ‘wellbeing’ can easily be heard and used to stand in for ‘emotional wellbeing’.

3. Wellbeing within the sustainability discourse

   Another discursive context for wellbeing in this data was that of (environmental) sustainability. Here, sustainable development is expressly linked to wellbeing, being defined as “(1) Living within environmental limits (i.e. the need for environmental sustainability) and (2) Ensuring a strong, healthy and just society (i.e. the need to ensure well-being for all, now and in the future)”.

   Wellbeing in this context is effectively ‘super-holism’ - perhaps a next-generation holism that includes all physical environments, and ultimately the planet, in its sphere of concern. Interestingly, in use it can function as kind of a trump card - ‘without this kind of wellbeing, all others are nonsense’.

4. Wellbeing within a discourse of holism

   In Western cultures, holism (as a way of thinking, talking and knowing) has been moving from the fringe to a more mainstream, taken-for-granted position. As a cultural idea and ‘way of knowing’, holism may also resonate with emerging ideas in several other fields: chaos theory, ‘emergence’, networks, the ‘wisdom of crowds’ (Surowiecki 2004) and more.

Holism goes beyond bodily or emotional health, entailing other ideas like spirituality, environment and more - it goes well beyond that of the simple 'mind - body' connection seen in today's medical discourse.
There are clear relationships between holism and 'joined up' Government - but also some problematic implications, perhaps visible in the slightly uneasy status of wellbeing we observed.

That is, holism also tends to entail *unknowable* mechanisms - the forces that link the visible to the invisible and which make the system more than the sum of the parts. This is an uneasy fit with a parallel rational political discourse that requires 'measurement' and 'accountability'.

Holistic therapeutic discourse also centres on the idea of the omniscience and multiple skills of the practitioner who sees and treats 'the whole person'. Again, *holistic* wellbeing as an aspiration for Government may get uncomfortably close to 'Big Brother' and / or 'Nanny State'.

5. Wellbeing and philosophy

Wellbeing is an *ideal* - the culmination of a person's idealised journey to 'actualise' all their potential. In this form, *it has no opposite* - there is the ideal of *wellbeing*, and the person's *potential for wellbeing,* but no 'ill-being'. Aristotle influenced European thought about 'the good life' for 1500 years - it is possible that we can we see a fossilised legacy in today's use of wellbeing. The recent discourse of 'happiness' (e.g. Layard) and growth of 'positive psychology' (e.g. Seligman) are perhaps reworking for today of an Aristotelian construction of 'wellbeing'.

Importantly, 'wellbeing' in this form continues to conjure a vision of all that is best and desirable for a person. But it does so *theoretically* - philosophical 'wellbeing' is a tool for thinking, an idealised aspiration rather than a real state to be attained or measured.

## INTRODUCTION

Life chances differ greatly depending on where people are born and raised. A person who has been born and lives in Japan or Sweden can expect to live more than 80 years; in Brazil, 72 years; India, 63 years; and in several African countries, less than 50 years. Within countries, the differences in life chances are also great. The poorest people have high levels of illness and premature mortality—but poor health is not confined to those who are worst off. At all levels of income, health and illness follow a social gradient: the lower the socioeconomic position, the worse the health.

The poor health of poor people, the social gradient in health within countries, and the substantial health inequalities between countries are caused by the unequal distribution of power, income, goods, and services, globally and nationally, the consequent unfairness in the immediate, visible circumstances of people's lives—their access to health care and education, their conditions of work and leisure, their homes, communities, towns, or cities—and their chances of leading a flourishing life. This

unequal distribution of health-damaging experiences is not in any sense a natural phenomenon but is the result of a combination of poor social policies and programmes, unfair economic arrangements, and bad politics. Together, the structural determinants and conditions of daily life constitute the social determinants of health and cause much of the health inequity between and within countries.
Society has traditionally looked to the health sector to deal with its concerns about health and disease. Certainly, maldistribution of health care i.e. not delivering care to those who most need it—is one social determinant of health. But much of the high burden of illness leading to appalling premature loss of life arises because of the immediate and structural conditions in which people are born, grow, live, work, and age.

All health systems in the world face the challenge of the increasing burden of chronic diseases. This is the result of changing life expectancy patterns i.e. greater longevity, unhealthy lifestyles and an increased exposure to chronic disease risk factors. Ukraine is different in that the most important concern is the early onset of such diseases compared with other European countries, not merely the increasing burden of chronic diseases. The result is premature deaths especially among working age males, changing both the age and gender structure of the Ukrainian population with significant economic and social consequences.

Ukraine has the fastest depopulation rate in Europe. Here, declining fertility rates combined with high mortality is resulting in declining life expectancies. While there are indications of improvements in some health indicators (infant mortality, maternal mortality etc.), many health problems especially those pertaining to chronic illnesses persist and high mortality rates are now largely due to premature deaths from chronic illnesses among the adult population. Ukrainians, especially working age males, are not only dying younger but also have fewer years lived in full health relative to their European counterparts. These changes in the age and gender structure of the population have significant social and economic consequences.

Non-communicable diseases (NCD) and chronic conditions comprise the bulk of mortality in Ukraine, especially among working age males. Eighty two percent out of the about 1 million age-standardized deaths in 2004 were caused by NCD. This is followed by external causes (12 percent) and communicable, maternal, perinatal and nutritional conditions (6 percent).

With this preamble, we present an excerpts from the recent study (Human Development Sector Unit Europe and Central Asia, The World Bank: May 2010) on ‘what underlies Ukraine’s mortality crisis’

**This study has addressed three broad questions**

1. *What are the key determinants of poor health adult outcomes and what socio-economic factors explain differences in adult health outcomes?*
2. *What is the level of understanding of the population on chronic illnesses, impact of unhealthy lifestyles etc. on health outcomes?*
3. *What are the patterns of health care utilization especially for select chronic conditions?*

**The uniqueness of this study**

- It uses primary data from a recent nationally and regionally representative household survey that includes not only self reported health status information but biomarkers as well.

- The information available allows for analyzing health outcomes by socio-economic category and regions as well as for analyzing the determinants of health outcomes.

- Lifestyle-related causes as well as health system related causes are considered in the analysis. Conducted at both the aggregate level and by sub-populations, the analysis allows for a more robust policy response and stronger targeting of interventions.

## DATA AND STUDY METHODOLOGY

The study uses the Ukraine Household Survey on Chronic Conditions, Lifestyle Factors and Health Care Utilization. The survey is representative at the national and regional level. Conducted between September and October 2009, the survey sampled individuals from households from 8 oblasts of the Ukraine i.e. Kyiv, Autonomous Republic of Crimea, Vinnytsia, Rivne, Lviv, Dnipropetrovsk, Luhansk, Odessa, representing four regions: West (Volyn, Transcarpathian, Ivano-Frankivsk, Ternopil, Chernivtsi, Lviv and Rivne), North and Center (city of Kyiv, Kyiv, Vinnytsya, Zhytomyr, Kirovohrad, Poltava, Sumy, Khmelnytskyi, Cherkasy, Chernihiv), South (Autonomous Republic of Crimea, Odessa, city of Savastopol, Kherson, Mykolayiv) and East (Dnipopetrovsk, Donetsk, Zaporizhya, Kharkiv and Luhansk). The survey followed a multi-stage stratified random sampling procedure where enumeration areas were first selected random (equal number of urban and rural enumeration areas except for Kyiv city), then streets within each enumeration areas were selected randomly and then households within each streets.

1408 household heads were identified, and in each household a household head or best informed person reported on household level information. Then, each household member between 18 and 65 years old within the household was asked to complete a detailed questionnaire about their general health (SAH), outpatient care utilization in the past 30 days, hospital utilization in the last 12 months, chronic disease prevalence, lifestyle factors (smoking, alcohol use, exercise, stress, and eating habits), and opinions about the Ukrainian health system. The total sample size was 3430. In addition to the questionnaire, anthropometric and repeated blood pressure measurements were taken for each household member 18-65 years of age, by trained medics.

## MAIN FINDINGS

***Pre-mature mortality risk among the Ukrainian population is high – nearly half of the adult Ukrainian population, many young, suffers from one or more chronic disease.***

Over 40% of the adult Ukrainian population, 18 to 65 years of age, has a chronic disease or condition - around 7 % have multiple (3 or more) chronic diseases or conditions. Some striking results are:

- Chronic disease is widespread in the general population as a whole and is not restricted to one or more regions in the country. While, chronic disease prevalence is highest in the West (40%), the intensity, as measured by people with multiple chronic conditions, is the highest in the East. Even, where prevalence is lower i.e. the South, nearly a quarter of the adult population suffers from a chronic disease.

- More women suffer from chronic diseases but this is not surprising given women live longer in Ukraine while premature mortality is high among the male population. Though women live longer in Ukraine, they spend more years and a greater proportion of their lives in states less than perfect health.

- More and more young adults are getting inflicted with chronic diseases. About 1 in 3 respondents with hypertension in the East are under 40 years old and even worse, 47.5% of hypertensives are under 40 years old in the West. About one in five, 18-29 year olds are hypertensive in Ukraine compared with 8.75 in Romania.

- Chronic disease is not a disease of the rich – it affects rich and poor alike. Hypertension prevalence is highest among women in the lowest two wealth quintiles. This is a rising equity concern since chronic diseases are expensive to treat and control and require medications which are paid out-of-pocket.

**Unhealthy lifestyles especially among young males put them at risk for chronic disease in the future**

- Unhealthy lifestyles among the adult population indicate that many Ukrainians fail to grasp the seriousness of the risks they face. Lifestyle factors, such as smoking, heavy drinking, poor diet and physical activity underlie much of the disease burden.

- Thirty six percent of the Ukrainian population are current smokers while 31% of them smoke daily. More than 58% of men and nearly 7% of women are current smokers of which nearly 52 percent of men and 12% of women smoke daily. This is above the WHO European region average of 28.6% for the population 18 years and older.

- Not only does smoking start early; the average starting age among daily smokers has been decreasing over time. Now the average age at first smoking is 16 years among the <30 years olds while it was 19 years for those who are currently between 60 and 65 years of age.

- A daily smoker smokes an average of 18 cigarettes per day, which is nearly one pack. Men not only had higher prevalence of smoking, but they also smoked more on average (19 cigarettes) compared to women (13 cigarettes).

- Twenty percent of Ukrainians indulge in heavy or binge drinking, having one or more days in the last month where they had more than 5 drinks that day. Over 80% of heavy or binge drinkers are men and they account for a third of the adult male population. In comparison only 7.4% of the adult female population falls in this category.

- Heavy or binge drinking starts young and increases with age initially and peaks between 40-49 years after which it starts to decline which also may be an indication of the low survival rates among heavy or binge drinkers in the older age groups, especially males. Among heavy or binge drinkers, the highest share was in the youngest age group studied; the 18-29 year olds (28.0%), followed by 40-49 year olds (26.7%). Among men, the highest share of heavy or binge drinkers was among the 18-29 year olds, but there is a higher concentration of non-heavy drinkers in this same age group (31.8%). Among females, the highest share of heavy or binge drinkers fell in the 40-49 year age range (35.8%).

- About 10% of Ukrainians are sedentary while 6.3% has insufficient physical activity per week. Most surprising is the high rates of sedentary behaviour among the 18-29 year olds. With 10.9% of 18-29 years olds being sedentary, this is perhaps one of the highest rates in the region – in comparison, in Czech Republic 3.7% of the same age group are sedentary, and in Hungary it is high at 7.1% but still lower than Ukraine. Females are more likely to be sedentary than males. Sedentary behaviour is also more prevalent among those residing in urban areas and increases with wealth.

**A failing health system and an unaware and sometimes indifferent population compounds the problem**

- Despite high chronic disease prevalence however, a majority of the Ukrainian adult population rate their health status as being satisfactory or better. Underlying this is both a low awareness of one's own health conditions as well as an even lower awareness of the seriousness of the risk one faces.

- One third of those classified as hypertensive by the survey were unaware of their hypertensive status, with twice as many men being unaware compared to women. More hypertensive men were unaware of their status than hypertensive women – 48% of hypertensive men compared with 24% of hypertensive women. Of note, 61% of men and 74% of women unaware of their hypertensive status were classified as having stage II hypertension through survey measurements.

- Since routine screening of adults for hypertension and obesity when visiting a facility is not always the norm, diseases sometime go undiagnosed. Measuring blood pressure levels and weight should be a routine procedure for any visit to the doctor. Among Ukrainians whose hypertension status was revealed through survey measurements, 14.1% had had a medical appointment in the last 30 days with 4.3% having visited a medical facility more than once. Of those for who were classified as obese by survey measurements but were unaware of their obesity status, nearly a quarter had visited a health facility in past 30 days. Of these 7.8% had made more than one visit to a facility.

- Compliance to prescribed treatment is low - half of the population under treatment for key chronic conditions – hypertension; diabetes and high cholesterol do not take the medication or follow recommendations as prescribed. About a quarter do not taking the drugs according the dosage and frequency prescribed, while the rest do not take their medication at all. Key reasons given for lack of compliance include forgetting to take medication and respondent's own view that they no longer need the medication. Therefore it is not surprising as the data shows, that one fifth of hypertensive men and 36% of hypertensive women, while aware and being treated still have stage 1 or2 level hypertension. Less than a quarter of those who are obese and diagnosed as such are following any program to lose weight.

## CONCLUSION

Many of the causes of premature-death and disease in Ukraine are linked to risk-factors which are largely modifiable and preventable. Risk factors related to lifestyle such as smoking, alcohol and diet, as well as environmental conditions play key roles in many diseases, including poisonings, injuries and the biggest killer in Ukraine, circulatory system diseases such as ischemic heart disease and stroke. These causes of chronic diseases are expressed through common chromic conditions (or intermediate risk factors) such as high blood pressure, high blood glucose levels, high cholesterol and overweight/obesity.

Meeting the health challenge of reducing premature mortality and morbidity is important and will require multi-sectoral coordination and a targeted approach. Recent experience - in the region however, has shown that poor adult health outcomes are not immutable. Yet, achieving sustainable improvements requires multi-sectoral policy coordination, a deeper understanding of health seeking behaviour and regional differences in health outcomes and underlying factors that explain risky behaviour and improving the capacity of health services to detect, treat and monitor chronic illnesses at the appropriate level.

Yet, the specific determinants of key health outcomes and health seeking behaviour that explain differences across regions, especially those related to chronic diseases, are not well understood. Moreover, timely utilization of health services in Ukraine which is crucial for prevention and control of chronic illnesses. This points to the need for continued efforts to ensure that a multi-pronged approach targeted to the specific population aimed at increasing the timely utilization of appropriate services (e.g. through health promotion, education measures, improvements in quality) etc.

As is known worldwide, chronic disease management and control is not merely a within the control of the health sector. It requires involvement of the government, the private sector and more importantly the adult Ukrainian population. Key to reducing the risk of chronic diseases is both preventing the underlying risk factors especially those that behavioural and are modifiable as well as controlling and managing the disease through early detection, control and treatment. In both cases, the participation of the individual at risk is critical.

**REFERENCES**


1. Alcohol and Drug Information Centre (ADIC - Ukraine). http://adic.org.ua/adic/. (*Accessed 23 June 2008)*
2. Andel M., Grezeszczak W., Michaelek M., Norkus A., Rasa I., Niewada M., Kaminski B., Kraml P., Madacsy L., DEPAC Group. (2008). *A Multinational, Multi-Centre, Observational, Cross-Sectional Survey Assessing Diabetes Secondary Care in Central and Eastern Europe (DEPAC Survey).* Diabetes Medicine, Vol. 25, No. 10: 1195-1203
3. DCP2 (2007). *Disease Control Priorities in Developing Countries*. Second Edition.
4. Dorobanut et al (2010). *Prevalence, Awareness, Treatment, and Control of Hypertension in Romania: Results of the SEPHAR Study*. M. Dorobantu, R. O. Darabont, E. Badila, and S. Ghiorghe, International Journal of Hypertension, Volume 2010, Article ID 970694, 6 pages
5. Grimes, DA and KF Schulz. 2009. Making Sense of Odds and Odds Ratios. Obstetrics & Gynecology, 111(2); Part 1: 423-426.
6. Holland WW (ed.). (1997). *European Community Atlas of "Avoidable Death"* 1985–89. Oxford: Oxford University Press
7. Jernigan D. (2001). *Global Status report: Alcohol and Young People.* WHO Report. http://whqlibdoc.who.int/hq/2001/WHO_MSD_MSB_01.1.pdf
8. Khalangot M., Tronko M. (2007). *Primary Care Diabetes in Ukraine.* Primary Care Diabetes, Vol. 1, No. 4: 203-205
9. Kopp M., Skrabski A, Szekely A., Stauder A., Williams R. (2007). *Chronic Stress and Social Changes*, Socioeconomic Determination of Chronic Stress http://www.stress07.com/binx/annals_7d.pdf
10. Lehan V., Rudiy V. (2007). *Key Strategies for Further Development of the Health Care Sector in Ukraine (Joint report)*. Kyiv, Rayevsky Scientific Publishers
11. Lekhan V., Rudiy V., Nolte E. (2004). *Health Care Systems in Transition (HiT): Ukraine.* Copenhagen, WHO Regional Office for Europe on behalf of the European Observatory on Health Systems and Policies, 2004.
12. Libanova E. et. al. (2007). *Mortality of Working Age Population in Ukraine* (collective monograph) (2007) / ed. by E.M. Libanova – Kyiv, Institute for Demography and Social Studies at the NAN of Ukraine. ― 211p.
13. Marquez V. (2005). *Dying Too Young. Addressing Premature Mortality and Ill Health Due to Non–Communicable Diseases and Injuries in the Russian Federation.* The World Bank. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/0,,contentMDK:20661159~pagePK:146736~piPK:146830~theSitePK:258599,00.html
14. McMichael A., McKee M., Shkolnikov V., Valkonen T. (2004). *Mortality Trends and Setbacks: Global Convergence or Divergence?* Lancet, Vol. 363, No. 9415: 1155-1159
15. Merkiel S., Chalcarz W. (2006). *Modifying Salt Intake to Prevent Hypertension*. New Medicine, Vol. 9, No. 2: 31-34
16. Meslé F. (2004). *Mortality in Central and Eastern Europe: Long-term Trends and Recent Upturns.* Demographic research - Special collection, Vol. 2:45-70.

17. Ministry of Economy and European Integration of Ukraine (2003). *Millennium Development Goals: Ukraine*. Kyiv
18. Ministry of Health of Ukraine State Statistics Committee of Ukraine United Nations Population Fund (2003). *Ukraine at the Threshold of the 10th Anniversary of the International Conference on Population and Development.* Kyiv http://www.unfpa.org.ua/en/icpd10/
19. Ministry of Health of Ukraine. (2008). *Tobacco Control Report: The National Report.* Unpublished Draft Report. Kiev, Ukraine.
20. Nolte E. and McKee M. (2004). *Does Health Care Save Lives? Avoidable Mortality Revisited.* European Observatory. http://www.euro.who.int/observatory/Studies/20050812_1
21. Nolte E. and McKee M. (2008). Caring for people with chronic conditions, a health system perspective. European Observatory on Health Systems and Policies.
22. Nolte E., Scholz R., McKee M. (2004). *Progress in health care, progress in health? Patterns of amenable mortality in central and eastern Europe before and after political transition*. Demographic research special collection, Vol. 2, published 16 April 2004, www.demographic-research.org
23. The World Health Survey 2002-2003. http://www.who.int/healthinfo/survey/en/.
24. Toomey T., Wagenaar A. (1999). *Policy Options for Prevention: The Case of Alcohol.* Journal of Public Health Policy, Vol. 20, No. 2: 192-213
25. Ukrainian Center for Social Reforms (UCSR), State Statistical Committee (SCC) [Ukraine], Ministry of Health (MOH) [Ukraine], and Macro International Inc. 2008. *Ukraine Demographic and Health Survey 2007*. Calverton, Maryland, USA: UCSR and Macro International.
26. USAID (2006). *Non-communicable diseases and injuries in Eastern Europe and Eurasia*, prepared by John Hopkins University Bloomberg School of Public Health.
27. Webb et al (2005), EPIDEMIOLOGY OF HEAVY ALCOHOL USE IN UKRAINE: FINDINGS FROM THE WORLD MENTAL HEALTH SURVEY, HARLES P. M. WEBB, EVELYN J. BROMET, SEMYON GLUZMAN, NATHAN L. TINTLE, JOSEPH E. SCHWARTZ, STANISLAV KOSTYUCHENKO and JOHAN M. HAVENAAR, Alcohol and Alcoholism 2005 40(4): pages 327-335.
28. WHO (2002). *The Tobacco Atlas.* http://www.who.int/tobacco/media/en/title.pdf
29. WHO (2004c). *Global Status Report: Alcohol Policy.* http://www.who.int/substance_abuse/publications/en/Alcohol%20Policy%20Report.pdf
30. WHO (2004d). *Global Status Report on Alcohol 2004.* http://www.who.int/substance_abuse/publications/global_status_report_2004_overview.pdf.
31. WHO (2004e). *World Report on Road Traffic Injury Prevention.* http://whqlibdoc.who.int/publications/2004/9241562609.pdf
32. WHO Regional Office for Europe (2000). *Highlights on health in Ukraine.* http://www.euro.who.int/highlights
33. WHO Regional Office for Europe (2002). *The European health Report 2002.* WHO Regional Publications, Copenhagen, European Series, No. 97. http://www.euro.who.int/europeanhealthreport
34. WHO Regional Office for Europe (2004a). *10 health questions about the 10*: http://www.euro.who.int/document/e82865.pdf

35. WHO Regional Office for Europe (2004b). *Asthma, allergies and environment in schools in Slovenia* // Children's Health and Environment Case Studies Summary Book – Actions and Intervention www.euro.who.int/document/che/43SLOweb.pdf
36. WHO Regional Office for Europe (2005e). *Highlights on health in Ukraine.* http://www.euro.who.int/highlights
37. WHO Regional Office for Europe (2005f). *The European health Report 2005: Public health action for healthier children and populations.* WHO Regional Publications, Copenhagen http://www.euro.who.int/europeanhealthreport
38. WHO Regional Office for Europe (2006a). *Nutrition, physical inactivity and prevention of obesity: recent policy developments in the WHO European Region*. — WHO European Ministerial Conference on Counteracting Obesity http://www.euro.who.int/Document/NUT/Instanbul_conf_ebd01.pdf
39. WHO Regional Office for Europe (2006b). *Physical activity and health in Europe: Evidence for Action*, ed. Cavill, Nick, S. Kahlmeier and F. Racioppi, Copenhagen, WHO Regional Office for Europe.
40. WHO Regional Office for Europe (2008a). *European health for all database (HFA-DB)* [online database]. Copenhagen, WHO Regional Office for Europe http://www.euro.who.int/hfadb
41. WHO Regional Office for Europe (2008b). *European mortality database (HFA-MDB)* [online database]. Copenhagen, WHO Regional Office for Europe http://www.euro.who.int/mortdb
42. Willison K.D. (2006) *Integrating Self-Care and Chronic Disease Management through a Community Based Research Approach* http://www.ohpe.ca – Ontario Health Promotion E-Bulletin
43. World Bank (1999). *Curbing the Epidemic: Governments and the Economics of Tobacco Control*. Washington DC, World Bank
44. World Bank (2004). *The Millennium Development Goals in Europe and Central Asia*. Washington DC, World Bank.
45. World Bank (2006b). Poverty Reduction and Economic Management Unit (ECSPE) Europe and Central Asia Region. *Ukraine. Creating Fiscal Space for Growth: A Public Finance Review*. September 14, 2006. Ukraine. Report No. 36671 – UA.
46. World Bank (2008). Poverty Reduction and Economic Management Unit (ECSPE) Europe and Central Asia Region. *Ukraine. Improving Intergovernmental Fiscal Relations and Public Health and Education Expenditure.* February 28, 2008. Report No. 42450– UA.
47. World Bank (2009). *An Avoidable Tragedy: Combating Ukraine's health crisis, Lessons from Europe*. Health and Demography Series.
48. World Bank (2010a). Prevalence and Determinants of Alcohol, Tobacco and Illicit Drug Use in Ukraine. Amber Peterman and Rekha Menon.
49. World Bank (2010b). Local Multisectoral Collaboration: Preventing Premature Mortality Among the Working Age Population in Ukraine. Anjali Dotson, Natalya Zaytseva-Chipak and Joel Gittlesohn.

# HEALTH CARE QUALITY IN SPARSELY POPULATED AREA: HEALTH CARE UTILIZATION IN MURMANSK REGION

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**Abstract**: Sparsely populated or rural areas have being priority for international organizations and governments over last decades. There are evidences of unequal geographical distribution of health, where the rural population is more vulnerable and characterized by poorer health outcomes, than urban (Patterson 2002). Health care availability is an important characteristic of health care quality.

The current study reveals differences in health care utilization between tree study areas in Murmansk Region in years 2003-2005. Analysis of the Air Medicine Centre missions' data was performed using semi-quantitative methods. The most number of cases occurred in deprived and rural areas. There were differences in types of medical interventions, transportation modes and disease profiles between regions. The personnel involved ranged from medical doctor specialists and advanced nurses to medical assistants and local nurses.

These results prove the imbalance of health care services availability in rural areas of Kola Peninsula. There is need for health care services system renovation in order to implement more effective and efficient system.

***Keywords:*** *public health, health care, population density, Russian Federation.*

## INTRODUCTION

Sparsely populated or rural areas have being priority for international organizations and governments over last decades. There are evidences of unequal geographical distribution of health, where rural population is more vulnerable and characterized by poorer health outcomes, than urban (Patterson 2002). Population density or other criteria of rurality and urbanicity interact as a proxy for health outcomes in a population (Burns et al 1998).

Characteristics of health care, such as availability (presence of the health care facilities), accessibility and quality are especially important when there is identified deprivation and isolation of the population. It was found in previous studies, that both distance to care and population density negatively affect admission rates and patients' propensity to seek care (Nemet & Bailey 2000, Twigger & Jessop 2000, van der Gaag et al 1975). More densely populated areas are supplied by more physicians and have wider spectrum of health facilities, than sparcely populated (Herzig et al 2003, Vehviläinen et al 1995). A longer distance plays barrier role not only in emergency conditions like cardiovascular diseases (Feero et al 1995), but also in chronic diseases, leading to delays in diagnosing and worsened outcomes (Stitzenberg et al 2007, Liff et al 1991). Some diagnoses have 24-fold difference in mortality rates between rural and urban hospitals (Mosciwice 1987; European Observatory on Health Systems and Policies 2008).

There are indications to population health differences in Murmansk Region (Semenova 2008) associated with rurality. The current study aims to analyze health care services utilization in tree administrative areas of Murmansk Region, using data on Air Medicine Centre missions. It is a part of PhD research on the population health in urban and rural areas of Russian Federation (Murmansk Region) and Finland (Lapland). The whole

study project will describe health care quality differences within countries and cross-border; and how geographic, demographic and socio-economic characteristics associated with rurality affect the population health.

The study would be very important for starting the future intercollegiate projects of University of Eastern Finland and Russian-Finnish Cross-Border University.

## METHODS AND MATERIALS

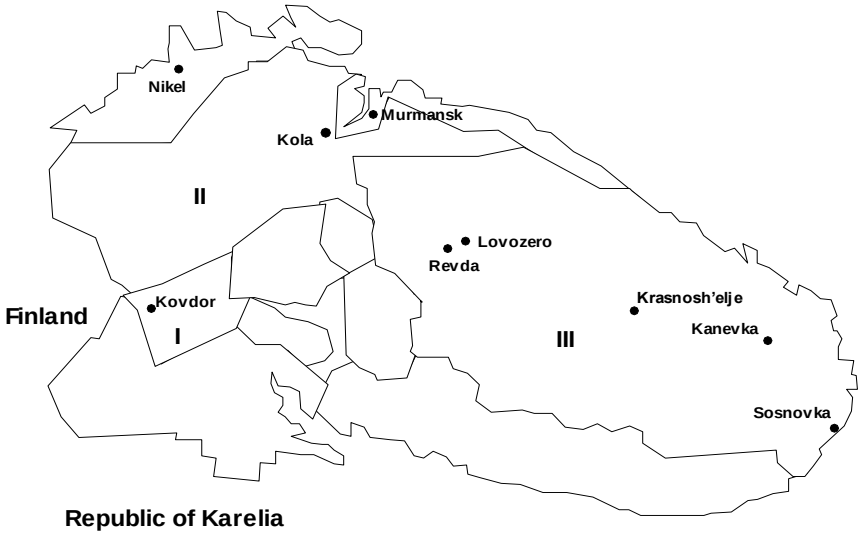


**Figure 1.** Administrative Map of Murmansk Region.

**Table 1.** Air Medicine missions in tree Murmansk regions during years 2003-2005.

| | Lovoz | | | Revda | | | Krasno | | | Sosnov | | | Deer | | | Kola | | | Koydor | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year: 2003/2005 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 05 |
| Missions, total | 1 | 5 | 3 | 2 | 2 | 3 | 2 | 1 | 5 | 6 | 8 | 3 | 2 | 2 | | 4 | 3 | 4 | 2 | 3 | 39 |
| Executed | 1 | 5 | 3 | 2 | 2 | 3 | 2 | 1 | 5 | 6 | 8 | 2 | 2 | 2 | | 4 | 2 | 4 | 2 | 3 | 39 |
| Dismissed | 1 | | | 2 | 1 | | | | | | | 1 | | | | 1 | 2 | | 1 | 1 | |
| Urgency | | | | | | | | | | | | | | | | | | | | | |
| Urgent | 1 | 4 | 2 | 1 | 2 | 3 | 2 | 1 | 5 | 3 | 7 | 2 | 2 | 2 | | 4 | 2 | 4 | 2 | 3 | 33 |
| Deferred | 1 | 1 | 1 | 3 | 3 | 3 | 4 | 1 | | 3 | 1 | | | | | 1 | 3 | | 5 | 7 | 5 |
| Planned | 1 | | | 1 | | | 1 | | | | | | | | | 2 | | | 1 | 1 | 1 |
| Transportation | | | | | | | | | | | | | | | | | | | | | |
| Motor transportation | 1 | 5 | 1 | 2 | 2 | 3 | | | | | | | | | | 4 | 2 | 3 | 1 | 2 | 29 |
| Air transportation | 3 | | 1 | 1 | | 1 | 2 | 1 | 5 | 6 | 8 | 2 | 2 | 1 | | | | | 1 | 8 | 8 |
| Self-transportation | | | | | | 2 | 1 | | | | | | | 1 | | 1 | 2 | 2 | | | |
| Patient's age | | | | | | | | | | | | | | | | | | | | | |
| Adult > 18 years | 1 | 4 | 3 | 2 | 2 | 3 | 2 | 1 | 3 | 6 | 7 | 3 | 2 | 2 | | 3 | 2 | 2 | 1 | 2 | 26 |
| Children 0-18 years | 2 | 1 | | 2 | 1 | 3 | 7 | 2 | 2 | | 1 | | | | | 5 | 1 | 1 | 8 | 1 | 13 |
| Disease profile | | | | | | | | | | | | | | | | | | | | | |
| Obstetrics/Gynecolo | | | | | | 1 | 3 | 1 | | 1 | | | | | | 2 | 2 | | 2 | | 3 |
| Surgery | 9 | 1 | 1 | 1 | 2 | 2 | 1 | 9 | 2 | 1 | 7 | 1 | 2 | 1 | | 3 | 1 | 1 | 1 | 1 | 22 |
| Therapeutics | 4 | 4 | 2 | 7 | 6 | 1 | 8 | 3 | 3 | 4 | 1 | 2 | | 1 | | 1 | 1 | 2 | 9 | 1 | 14 |
| Results | | | | | | | | | | | | | | | | | | | | | |
| Consultations | | 2 | | 3 | | | | | | | | | | | | 1 | 7 | 1 | 1 | 2 | 6 |
| Consultation by | | | 1 | | 5 | 4 | 1 | | | | | | | | | | 1 | 2 | | 2 | 2 |
| Transportation | 1 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 4 | 6 | 6 | | | | | 1 | 1 | 1 | 1 | 2 | 22 |
| Operation | | | | 1 | 3 | 3 | | | | | | | | | | 1 | 4 | 1 | 4 | 3 | 3 |
| Operation + | | | | 1 | 5 | 2 | | 1 | | | | | | | | | 3 | 1 | | 1 | |
| Trans. by med | 1 | | | 2 | 1 | | 7 | 1 | 1 | | 2 | 1 | 2 | 1 | | 1 | 1 | | 4 | 5 | 3 |
| Speciality | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Staff total | 2 | 1 | 6 | 4 | 5 | 5 | 5 | 1 | 8 | 7 | 1 | 3 | 2 | 1 | | 7 | 4 | 6 | | | |
| Anestesiologist | 1 | 5 | 2 | 1 | 1 | 3 | 2 | 3 | 2 | | 3 | | | | | 1 | 1 | 2 | | | |
| Surgeon | 3 | 1 | 1 | 5 | 1 | 1 | 5 | | 1 | | 4 | 1 | | | | 1 | 5 | 1 | | | |
| Nurses | 3 | 3 | 1 | 5 | 5 | 1 | 8 | 3 | 1 | | | | | | | 1 | 8 | 1 | | | |
| Medical Assistant | 1 | 2 | 1 | 1 | 1 | | 2 | 9 | 3 | 1 | 4 | 2 | 2 | 1 | | 1 | 8 | 6 | | | |
| Local medical staff | | | | | | 2 | | 2 | 1 | 5 | | | | | | 2 | 2 | | | | |

Administrative, social and economic characteristics of Murmansk Region were described elsewhere (Semenova 2008). The study objects are tree regions (see Figure 1): I Kovdor region, II Kola region and III Lovozero region.

Kovdor district (I) is one of the most developed regions in Kola Peninsula and characterized by high industrialization. Resident population is 24.400 people (2, 7% of Murmansk Region). The urban population (Kovdor city) is about 20.900 people, rural population is 3.500. There are 6 rural settlements in the region, population ranges from 12 inhabitants (Sluda) to 2.022 (Ena), the average distance to the regional centres is 26, 2 km. The distance from Kovdor to Murmansk is 300 km.

Kola region's (II) development and wellbeing depend more than 66% on agriculture. Resident population is 50.700 people (5, 9% of Murmansk Region), where urban is 37.700 people, rural – 13.000 people. There are 10 settlements with average distance to the centre 55, 2 km and population is more aggregated (733 – 16.300 inhabitants).

Lovosero region (III) is the most remote and deprived area in Kola Peninsula. The distance from the local center Revda to Murmansk is 199 km. A transport infrastructure is very poor developed. The connection with local centers Lovozero and Revda is by motor transport; with remote villages Krasnoshjelje (150 km from Revda), Kanevka (225 km from Revda) and Sosnovka (895 km from regional centre) by air transport only and by sea transport during navigation with village Sosnovka. Resident population is 12.613 people (1, 4% from Murmansk Region), 3.700 rural (Semenova 2009).

Data for analysis were provided by Murmansk Air Medicine Centre. It is a state health care facility that organizes and maintains urgent and planned medical health care to the populations of remote areas; in emergency situations (humanitarian crisis) provides guidance of all medical health care facilities in Murmansk Region. Data on Air Medicine Centre missions as characteristic of health care utilization in Murmansk Region for the years 2003-2005 were analyzed for tree study regions – Lovozero, Kola and Kovdor. Data presented in table 1.

## RESULTS

There were total 70 missions in Lovozero region in 2003, 55 missions in 2004 and 49 in 2005. Vast territory and sparse localization of settlements resulted in the distribution of missions across the whole region and even to the reindeer farms. Transportation modes reported predominant motor transportation in Lovozero and Revda, air transportation in remotest settlements. Air transport is the only available way in Krasnoshhelje, Kanevka and Sosnovka settlements. In the cases of reindeer camp missions air transport was used, 1 patient was transported using own reindeer sledge. In patients' age structure adults (> 18 years) dominated. Disease profile presented mainly by surgery. Urgency and seriousness of the diseases resulted in the type of medical services applied – in majority of cases patients must be transported to regional and central hospitals, although

operations in situ and following transportation were done. Among personnel medical doctors present more than half. There is wide list of medical specialties among staff involved that allows providing a spectrum of medical services from phone consultations to operations and reanimations.

In Kola region number of missions per year is more constant, as well as the role of motor transport. As in the Lovozero region, majority of the patients are adults; among children newborns (<1 month) prevailed. In disease structure surgical pathology equals to therapeutic; the major types of interventions are consultations (also by phone), and operations. Transportation to bigger hospitals occurs rarer than in Lovozero region. As well as in Lovozero, in Kola region medical doctors predominated. The proportion of local medical staff involved is also low (2 in 2003-2004).

Kovdor region characterized surprisingly high number of missions (compare to two fold lower population in Kola region). Transportation by air occurs more often, than in Kola region. Proportion of children is low. The major type of intervention is transportation to central hospitals, also by medical assistant. Kovdor region personnel data were not presented.

## CONCLUSION

The medical performance of the air medicine team depends on the local medical facilities available and distance to the secondary and tertiary health facilities. While in remote areas poor medical supply and absence of hospital settings do not allow to perform treatment such as operations etc, transportation to bigger settings is the only possible way to action. The role of consultations as a part of telemedicine system is not overestimated.

## REFERENCES


Patterson K: Rural health inequalities and challenges. World Rural Health. 2002. International Conference, Melbourne. http://www.abc.net.au/rural/worldhealth/papers/71.htm

Burns N, Carney K, Slinkman C. Development of the Rural-Urban Demand Indicator (RUDI). Res Nurs Health. 1998 Oct;21(5):453-66.

European Observatory on Health Systems and Policies: Health system profiles. World Health Organization. http://www.euro.who.int/observatory

Feero S, Hedges JR, Stevens P. Demographics of cardiac arrest: association with residence in a low-income area. Acad Emerg Med. 1995 Jan;2(1):11-6.

Herzig R, Urbánek K, Vlachová I, Krupka B, Janout V, Mares J. Facilities for acute stroke patients care in the Czech Republic: nationwide epidemiological study. Eur J Epidemiol. 2003;18(1):19-26.

Liff JM, Chow WH, Greenberg RS. Rural-urban differences in stage at diagnosis. Possible relationship to cancer screening. Cancer. 1991 Mar 1;67(5):1454-9.

Moscovice IS. Rural hospitals: a literature synthesis and health services research agenda. Health Serv Res. 1989 Feb;23(6):891-930. Review.

Nemet GF, Bailey AJ. Distance and health care utilization among the rural elderly. Soc Sci Med. 2000 May;50(9):1197-208. Review.

Semenova M. Population health in sparsely populated areas: the comparative study in Murmansk Oblast' in 2003-2005. Master thesis, 58 p. November 2008 University of Eastern Finland.

Stitzenberg KB, Thomas NE, Dalton K, Brier SE, Ollila DW, Berwick M, Mattingly D, Millikan RC. Distance to diagnosing provider as a measure of access for patients with melanoma. Arch Dermatol. 2007 Aug;143(8):991-8

Twigger JP, Jessop EG. Small area variation in hospital admission: random or systematic? Public Health. 2000 Sep;114(5):328-9.

van der Gaag J, Rutten FF, van Praag BM. Determinants of hospital utilization in the Netherlands. Health Serv Res. 1975 Fall;10(3):264-77.

Vehviläinen AT, Kumpusalo EA, Voutilainen SO, Takala JK. General practice consultations in central and northern Finland. Scand J Prim Health Care. 1995 Sep;13(3):197-204.

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**BCBU**

The Barents Cross-Border University project (BCBU) is the result of cooperation of 13 universities in Norther Finland, Northwest Russia, Sweden, Norway and Canada with international Master´s programmes covering five study fields: Social work, Information technology, Health and Wellbeing, Environmental Engineering and Law.

The 13 universities are: University of Lapland and University of Oulu from Finland, Karelian State Pedagogical Academy, Petrozavodsk State University, Murmansk Humanities Institute, Murmansk State Humanities University, Murmansk State Technical University, Northern (Arctic) Federal University, Northern State Medical University from Russia, Narvik University College from Norway, Luleå University of Technology from Sweden, University of Southern Denmark from Denmark and University of Manitoba.

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The Finnish-Russian Cross-Border University is the result of cooperation of ten universities in Russia and Finland, with international Joint Master's degree programmes currently in five study fields: Business and Administration, Forestry and Environmental Engineering, Information and Communications Technology, International Relations and Public Health.

The ten partner universities are: University of Helsinki, University of Eastern Finland, Lappeenranta University of Technology, University of Tampere from Finland and St. Petersburg State University, St. Petersburg State Polytechnical University, St. Petersburg State Forest Technical University, Moscow State Forest University, Petrozavodsk State University and the European University at St. Petersburg from Russia. For more informaation please visit http://cbu.fi/en/

**BCBU+**

The aims of Kolarctic ENPI CBC Barents Cross-Border University development project is further develop, harmonize, expand and integrate BCBU master´s degree programs to regular activities of partner universities. The main activities are developing the models of good practices and the eLearning facilities for implementation and co-operation for master´s programs. The project is funded by Kolartic ENPI CBC

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