Better Life with Energy and Intelligence Technology

The Third Research Forum of Changzhou University and Satakunta University of Applied Sciences

Marina Wikman (ed.)

Satakunta University of Applied Sciences

Pori

2014

:

Satakunnan ammattikorkeakoulu (SAMK)
Satakunta University of Applied Sciences

Series B, Reports 14/2014
ISSN 1457-0696 | ISBN 978-951-633-150-1
ISSN 2323-8356 (pdf) | ISBN 978-951-633-151-8

Publisher:
Satakunta University of Applied Sciences
Tiedepuisto 3, (FIN) 28600 Pori
www.samk.fi

C Satakunta University of Applied Sciences and the authors

Cover lay-out: SAMK Communications

Papers: MultiOffset 170 (cover), 120 (inside)
Printing house: Plusprint, Ulvila

SAMK Publications can be read online:www.theseus.fi

Contents

Participants of the Third Research Forum of Changzhou University and Satakunta University of Applied Sciences

Sitting (left-right): Zou Ling, Li Jinchun, Petteri Pulkkinen, Juha Kämäri, Chen Qun, Su Xuping, Du Wenping, Yu Qiang, Li Dinglong. Standing (left-right): Chen Ying, Marina Wikman, Suvi Karirinne, Merja Sallinen, Sirpa Sandelin, Liu Zhen, Liang Yuting, Zhao Wenchang, Ye Shiren

Foreword

The publication contains brief articles, based on the presentations given at the third joint research forum of Changzhou University (CCZU) and Satakunta University of Applied Sciences (SAMK). The forum was held in the beginning of year 2014 in Changzhou, China, and was called "Better Life with Energy and Intelligence Technology".

In general, the regularly organised forum provides an opportunity to faculty members to present their research on an international forum to colleagues, and it enables exchange of ideas and networking among the researchers. The forum themes are decided based on the diversity of topics studied at CCZU and SAMK, ranging this time from environmental research to welfare technology.

The co-operation between CCZU and SAMK started already in 2008. The joint activities extend from student and faculty exchanges to projects and research collaboration. Internationality is, thus, brought to all levels of educational operations.

This publication aims at introducing current themes of research carried out by faculty members at CCZU and SAMK, and the articles serve as an indication of research topics. Fellow researchers and any stakeholders whose business and operations could benefit from the introduced studies are also invited to learn more about the research discussed, and are welcome to contact CCZU and SAMK.

Satakunta, October 2014

Marina Wikman, Editor

Satakunta University of Applied Sciences Serving the Needs of Regional Commercial and Public Life

Juha Kämäri, Adjunct Professor, President and CEO, Satakunta University of Applied Sciences

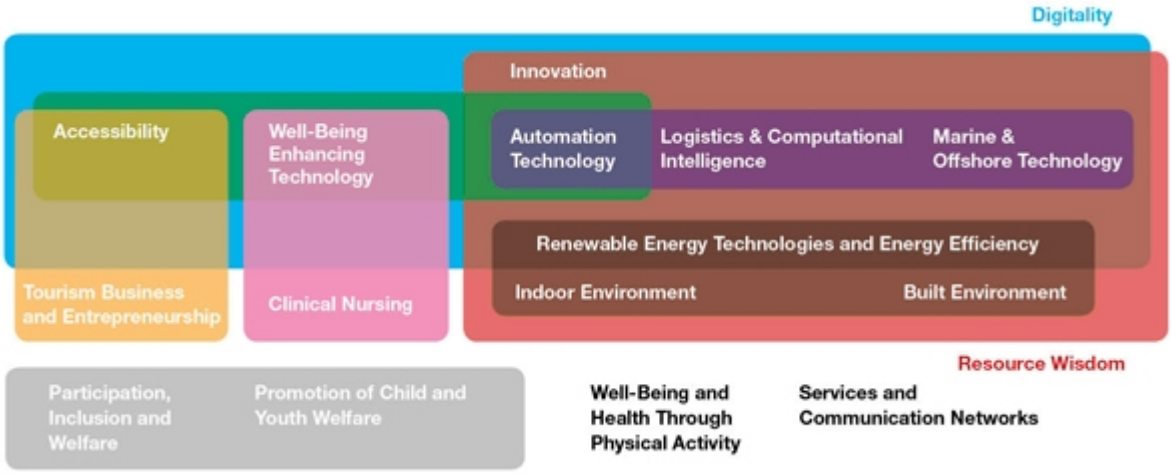
Satakunta University of Applied Sciences (SAMK), named after the region of Satakunta, is a versatile, multidisciplinary, internationally and professionally oriented university with more than 6000 students and 450 staff members. The Satakunta region is characterized by maritime and offshore industry, energy production, heavy engineering, process industry, ports and logistics services as well as diversified food industry. The University is the region's key actor in advancing innovations, entrepreneurship and internationalisation. The University has currently over 100 partner universities mainly in Europe, East Asia and Northern America.

SAMK's ideology for matching the needs of the work life is to cooperate closely with enterprises, public service providers and various development organizations. To this end, more than 300 cooperation projects with companies are carried out annually. In addition, more than 1000 theses are prepared by graduating students, supporting the economic life in multiple ways. Moreover, annually more than 1000 professionals participate in further education provided by SAMK. Finally, around 20 new companies are formed every year with the help of SAMK's own enterprise accelerator, offering mentoring service to student entrepreneurs.

There are five strategic focus areas recognised in the agreement with the Ministry of Education and Culture for the years 2013-2016: i) student entrepreneurship, ii) welfare expertise, iii) future energy solutions, iv) innovative services and processes, and v) the marine cluster. These focus areas together with the regional strategies drive the development of the research and development activities of the University. Presently there are 17 research groups at SAMK with a main interest to develop

tangible cooperation with the companies and public organisations. This working strategy leads to rapid utilizations of the research results.

The focus of SAMK's research is on applied research and development and product and service development. The research groups on Digitality and Resource Wisdom are thematically overriding the other research groups, and utilize the competence and resources of them. The diagram below describes the structure and relation of the various research groups.



The two Universities, SAMK and CCZU, have a well-established partnership that has resulted in successful student and faculty exchange programs as well as research forums. This collaboration with CCZU is highly respected at SAMK. Looking into the future, we at SAMK would see great potential for extending the collaboration even further, into project-based research and development work in several possible areas, including renewable energies, sustainable water and waste management and ICT. The focus could be on joint research teams, staff exchange, joint publications and tangible cooperation with companies. SAMK is committed to coordinate a significant research and business project between Changzhou Region and Satakunta Region, involving Finnish and Chinese companies and universities. The main objective of the planned project is to help clean-tech companies from Finland and China to establish partnerships and customerships.

Changzhou University Aiming at Scientific Achievements

Cheng Qun, Vice President, Professor, Changzhou University

Changzhou University (CCZU) is named after the city, which boasts abundant human and cultural treasures and highly developed economy in China. Founded in 1978, the university has changed its name four times and got its current name in 2010. The university has over 20,000 undergraduates, 1,600 postgraduates and over 50 overseas students. There are 16 faculties covering most academic fields, including science, engineering, management, economics, law, medicine, agriculture.

CCZU is well equipped in scientific facilities. There are 15 key laboratories and 5 engineering technology research centers in the field of green catalytic material, comprehensive utilization of solar energy, gas storage and transportation engineering, innovative materials, biological medicine and fine chemicals. The university has won four national science and technology awards. Its simulation technology, catalytic technology, oil and gas wellhead equipment, innovative materials and other technology have been widely applied in Chinese petroleum and petrochemical industry.

In 2011, CCZU was granted joint funding by Jiangsu provincial government and three biggest petrochemical corporations in China, which are Sinopec, Petrol China, and China National Offshore Oil Corporation. In addition, the university has also established long-term cooperative relations with 10 large enterprises such as Lenovo Group, China Chemical Group, and Sinochem. Some of them have established an independent research center to share resources. CCZU also pays great attention to technological service for local enterprises. It has established more than 10 technology transfer centers with local companies and governments which contribute to the development of local small-and-medium sized enterprises.

Its science fund has been increasing by 25% annually in the last 3 years. The scientific

fund in contract amounted to more than 200 million CNY, and we have received 128 million CNY in 2013. National Natural Science Foundation projects and other national projects also increase steadily. In 2013, the university undertook 54 national-level research projects. Its technological inventions and patents increase rapidly and rank among the top 50 in China. The year 2013 witnessed 221 inventions and patents. The university published more than 1000 papers in the domain of the natural science in 2013. According to the Web of Science, the research achievements of CCZU have attracted the attention of researchers from 49 countries including the US.

CCZU emphasizes international cooperation and has established international cooperation with universities and research institutes from e.g. Canada, Europe, Japan, Russia, US, in the fields of innovative materials, membrane science, environmental management. The university especially values the collaboration with SAMK in Finland. The student and faculty exchange program, which started in 2008, has closely bound the two universities together. The research forum between CCZU and SAMK also offers a convenient platform for faculty and researchers from both sides to share ideas and discuss cooperation. The first forum was held in Changzhou in 2010, the second in Pori, 2011, and the third in Changzhou, 2014. We will provide full support for the collaboration between CCZU and SAMK and we believe in a closer relationship between the two universities.

Microbial Enzymatic Dynamics and Responses to Water Quality of Urban River

Xian Xiao, M.S. & Yuan Zhao, Dr., Professor & Chaopeng Song, M.S., School of Environment and Safety Engineering, Changzhou University

Yuting Liang, Dr., Associate Professor, State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences

Introduction

Physical, chemical and bacteriological measurements commonly form the basis of monitoring, because they provide a complete spectrum of information for proper water management (Matavulj et al., 1990). Biomonitoring has been proven to be a necessary supplementary to those traditional monitoring techniques for fully understanding the impact of water quality on ecological environments (Soininen & Könönen, 2004). The enzyme reaction is the biochemical basis of biological growth and reactions. The activity of the enzyme and its dynamic characteristics can also make a more precise description of a certain specific biochemical process or material cycling mechanism.

The Beishi river is located in the downtown of Changzhou City, Jiangsu Province, and it is more than two kilometers long. Recently, a series of projects has been carried out to improve the water quality. Here, changes of microbial enzyme activity together with water geochemical variables were studied to address the following questions: (i) How microbial enzymes change spatially and temporally in such ecological restored urban river? (ii) Is there any linkage between microbial enzyme activities and water contaminants?

Materials and Methods

Five monitoring sections are selected along the Beishi river from upstream to downstream, A, B, C, D, E (Fig. 1). Three biological replicates were sampled from each monitoring section. In total, 180 water samples were collected monthly from November 2011 to October 2012. Water geochemical variables were measured, including: water temperature, pH, dissolved oxygen (DO), chemical oxygen demand (COD), total phosphorus (TP), ammonia-nitrogen (NH_4^+-N), total nitrogen (TN), nitrate-nitrogen (NO_3^--N) and chlorophyll a (Chla). Five microbial enzyme activities (dehydrogenase, total enzyme, phosphatase, urease, proteinase) were monitored with chromogenic assay. The bacterial community structure was analyzed with the DNA fingerprinting method, denaturing gradient gel electrophoresis (DGGE).

A canonical correspondence analysis (CCA) was performed to identify the relationship between the microbial enzyme activities, microbial structures and the water geochemical variables using CANOCO for Windows version 4.5 (Braak & Smilauer, 1998). All correlation analyses were performed with SPSS 13.0 (SPSS, Inc., Chicago, IL).

Figure 1. Map of the sampling urban river with ecological restoration. Five sampling sections from upstream to downstream: A, B, C, D, E, from Nov. 2011 to Oct. 2012

Results

Water quality in the ecologically restored urban river was monitored for one year from November 2011 to October 2012 (Fig. 2). Generally, the variations of water geochemical variables showed more temporal changes than spatial changes. The comprehensive pollution index of water quality (P) was calculated and the result indicated that the pollution in Beishi river was serious most of the time ($P > 1.0$). However, it presented a decreasing tendency and was below 1.0 in most sampling sections in the late monitoring period (Fig. 3).

Figure 2. Variations of geochemical variables from Nov. 2011 to Oct. 2012 in the ecological restored urban river. TN=total nitrogen; TP=total phosphorus; DO= dissolved oxygen. The standard value of class V based on the environmental quality standards for surface water of China (GB3838-2002).

Figure 3. Variations of Comprehensive pollution index of water quality (P) in Beishi river.

Five microbial enzymes of the 180 water samples were monitored simultaneously (Fig. 4). Generally, microbial enzyme activities varied only a little among the five sampling sections. In contrast, temporal changes of microbial enzyme activities were pronounced and remarkably variable, with the only exception of Shannon-Weaver total enzyme activity with no obvious spatial and temporal changes.

Shannon-Weaver index (H) of microbial enzyme activities was calculated (Fig. 5). The Pearson correlation of Shannon-Weaver index (H) and comprehensive pollution index of water quality (P) is 0.194 ($P < 0.01$).

Figure 4. Variations of microbial enzyme activities (dehydrogenase, total enzyme, phosphatase, urease, proteinase) from November 2011to October 2012 in the ecological restored urban river.

Fig. 5 Variations of Shannon-Weaver index (H) of microbial enzyme activities in Beishi river.

A correlation analysis was conducted between each geochemical variables and microbial enzyme activity (Table 1). CCA was performed to discern possible linkages between the enzyme activities in the study sites and the measured environmental variables (Fig. 6) in the future. Temperature, TN and NH_4^+-N were the main factors influencing the microbial enzyme activities. Samples showed a general grouping pattern seasonally. CCA was also performed to analyze microbial community structures and water geochemical variables. However, bacterial community structure inferred from DGGE bands revealed neither temporal nor spatial patterns.

Table 1 Pearson correlations between microbial enzyme activities and geochemical variables.

		COD	DO	NH_4^+-N	NO_3-N	TN	TP	Chla	Temperature	pH
Dehydrogenase	Pearson correlation	0.13	0.124	-0.059	-0.114	-0.064	-0.103	0.029	-0.026	0.035
	Sig.	0.082	0.099	0.434	0.129	0.396	0.168	0.699	0.726	0.643
Total enzyme	Pearson correlation	0.076	0.003	0.201**	0.158*	0.285**	0.139	-0.006	-0.079	0.059
	Sig.	0.31	0.963	0.007	0.035	0.000	0.063	0.940	0.294	0.431
Phosphatase	Pearson correlation	0.240**	-0.294**	-0.272**	-0.407**	-0.242**	-0.141	0.472**	0.733**	0.000
	Sig.	0.002	0.000	0.000	0.000	0.002	0.072	0.000	0.000	0.996
Urease	Pearson correlation	0.044	-0.231**	-0.265**	-0.16*	-0.001	-0.149*	0.164*	0.472**	-0.103
	Sig.	0.562	0.002	0.000	0.032	0.993	0.047	0.028	0.000	0.169
Proteinase	Pearson correlation	-0.159*	0.171*	0.59**	0.231**	0.431**	0.136	-0.337**	-0.525**	-0.014
	Sig.	0.033	0.022	0.000	0.002	0.000	0.07	0.000	0.000	0.849

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

TN=total nitrogen; TP= total phosphorus; Chla=Chlorophyll a; DO= dissolved oxygen.

Figure 6. CCA ordination biplot between sampling sites concerning enzyme activities and geochemical variables. Sampling sections from upstream to downstream: A, B, C, D, E. Numerical labels 1 to 12: January to December.

Discussion

The ability of enzymes to recognize specific molecules as substrates has led to the proposal of a number of enzyme-based analytical approaches for detecting pollutants in heterogeneous samples (Balestri et al., 2013). In accordance with changes of water geochemical variables, most of microbial enzyme activities depended on seasonal temperature changes instead of spatial changes. This suggests much greater importance of temporal dynamics than spatial heterogeneity in affecting specific ecosystem functions in urban ecological restored rivers. Here, significant positive correlation was observed between Shannon-Weaver diversity index of microbial five enzyme activities (H) and comprehensive pollution index of water quality (P) ($P < 0.01$), indicating potential stimulation effect of contaminants in overall microbial activities in urban river. Furthermore, CCA of microbial enzyme activities indicated that samples were mainly grouped by seasonal change and highly correlated with water geochemical variables, indicating the sensitivity of microbial

enzyme activities to environmental disturbance. In addition, here we observed disconnect of microbial community structure and enzyme activities; microbial community structure showed neither spatial nor temporal pattern and did not response to environmental changes. A potential reason could be that specific metabolic functions are likely to be more tightly linked to the particular populations constituting a given microbial community (Langenheder et al., 2006). All the results indicated that the response of microbial enzyme activities seemed to be more sensitive to water quality than microbial community structures, especially in the highly connected urban rivers.

Dehydrogenase is one of the most important enzymes for the degradation of organic matter. Here, dehydrogenase activity showed no significant correlation with water geochemical variables and only presented a tendency to relate with COD and DO ($P < 0.1$). This could be due to that COD is only a coarse measurement of water organic matter. A further detailed analysis of the component composition and structures of the organic contaminant by three-dimensional excitation and emission matrix fluorescence spectra (Chen et al., 2003) is required to link the component changes with microbial dehydrogenase changes.

The total microbial activity measured by the hydrolysis of fluorescein diacetate (FDA) was found to be correlated well with bacterial respiration activity (Schnürer & Rosswall, 1982) and can represent the total metabolic potential of a biological community (Zablotowicz et al., 2010). Here, a significant positive correlation was observed between the total enzyme activity and major water contaminant, NH_4^+-N, NO_3^--N and TN ($P < 0.05$), indicating the potential use as an indicator of nutrient status of urban river.

Phosphatase activity has been used as indicator in water monitoring (Chappell & Goulder, 1995; Matavulj et al., 1990). Phosphatase responded dynamically to seasonal changes in nutrient supply and requirement (Ellwood et al., 2007). In

accordance with previous study, phosphatase activity showed temporal changes instead of spatial changes in the ecologically restored urban river. Of the five microbial enzyme activities monitored, phosphatase seemed to be the most sensitive to water contaminant.

Urease is an important hydrolase in transforming urea into ammonia and carbon dioxide. Urease was monitored in remediation of polluted water and found to be well correlated with nitrogen transformation (Truu et al., 2009; Wei et al., 2010). In this study, urease activity was significantly negatively correlated with NH_4^+-N and NO_3^--N ($P < 0.05$).

Proteinase catalyzes protein degradation and has been used for assessment of water self-purifying capacity (Korneeva, 2002). As a large portion of contaminant in urban rivers comes from domestic waste water of residents along the river, protein could be a major contaminant component (Liao et al., 2011). Here we observed significantly positive correlations between proteinase and water nitrogen ($P < 0.01$), confirming the results that protease was highly related to nitrogen cycle in water (Admiraal & Tubbing, 1991).

Conclusion

In conclusion, this study profiled the enzymatic variations in an ecologically restored urban river and linked it to changes of water quality. The results indicated that microbial enzyme activity responded quickly to contaminant disturbance and could be a potential bio-indicator in an ecologically restored urban river.

References

Admiraal, W. & Tubbing, G.M.J. (1991). Extracelular enzyme activity associated with suspended matter in the river Rhine. *Freshwater Biol., 26,* 507-517.

Balestri, F. et al. (2013). Impact on enzyme activity as a new quality index of wastewater, *J. Environ. Manage., 117,* 76-84.

Chappell, K.R. & Goulder R. (1995). A between-river comparison of extracellular-enzyme activity. *Microb. Ecol., 29,* 1-17.

Chen, W., Westerhoff, P. & Leenheer, J.A. (2003). Fluorescence excitation emission matrix regional integration to quantify spectra for dissolved organic matter. *Environ. Sci. Technol,. 24,* 5701-5710.

Cui, W. et al. (2010). The monitoring and application of urease and phosphatase in remediation of polluted water body. *Shanghai Chem. Ind., 35,* 1-4.

Ellwood, N.T.W. et al. (2007). Seasonal changes in the surface phosphatase kinetics of aquatic mosses in northern England. *J. Bryol,. 29,* 174-182.

Jiang, H. et al. (1999). The relationship between comprehensive pollution index assessment and water quality type distinguishing. *Environ. Monit. China, 15,* 46-48.

Korneeva, G.A. (2002). Biochemical (enzymatic) indication and testing of the ecological state of the hydrosphere. *Biol. Bull. Russian Acad. Sci., 29,* 43-45.

Langenheder, S., Lindstrom, E.S. & Tranvik, L.J. (2006). Structure and function of bacterial communities emerging from different sources under identical conditions. *Appl. Environ. Microbiol. 72*, 212-220.

Liao, R. et al. (2011). Research on the effect of ozonation on dissolved orgnic matter in the polluted surface water. *Water Waste Water Eng., 37,* 127-132.

Magnussen, S. & Boyle, T.J.B. (1995). Estimating sample size for inference about the Shannon-Weaver and the Simpson indices of species diversity. *Forest Ecol. Manag. 78,* 71-84.

Matavulj, M. et al. (1990). Phosphatase activity of water as a monitoring parameter, *Water Sci. Technol., 22,* 63-68.

Schnürer, J. & Rosswall, T. (1982). Fluorescein diacetate hydrolysis as a measure of total microbial activity in soil and litter. *Appl. Environ. Microbiol., 43,* 1256-1261.

Soininen, J. & Könönen, K. (2004). Comparative study of monitoring South-Finnish rivers and streams using macroinvertebrates and benthic diatom community structure. *Aquat. Ecol., 38,* 63-75.

Braak, F., C.J. & Smilauer, P. (1998). CANOCO reference annual and user's guide to canoco for windows: Software for canonical community ordination. 4th ed. Centre for Biometry Press.

Truu, M., Juhanson, J. & Truu, J. (2009). Microbial biomass, activity and community composition in constructed wetlands. *Sci. Total Environ., 407,* 3958-3971.

Zablotowicz, R.M. et al. (2010). Effects of land management practices on water quality in Mississippi Delta oxbow lakes: Biochemical and microbiological aspects. *Agric. Ecosyst. Environ., 139,* 214-223.

Urban Ambient Air Quality Investigation and Health Risk Assessment during Haze and Non–Haze Periods in Shanghai

Zhao Wenchang, PhD, School of Environmental and Safety Engineering, Changzhou University

Introduction

Haze is defined as the weather phenomenon which leads to atmospheric visibility less than 10 kilometers due to the suspended solid or liquid particles, smoke, and vapor in the atmosphere, which seriously affect human health. Haze pollution has attracted much interest during the past decade for its impact on visibility, public health, and even global climate. Local and regional haze occur frequently in many Chinese cities, mainly caused by emissions from vehicle exhausts, coal combustion, biomass burning, and re-suspended dust.

In China, the variation of characteristics and the different formation mechanisms of aerosols in dust, haze, and clear days in Beijing were investigated. Carbonyl compounds in ambient air were measured in haze and clear days of Guangzhou, the provincial capital of Guangdong province. Population exposures and the corresponding health risks of particulate matters in the ambient air of Yangtze River Delta Region (YRDR) were reported recently. Nevertheless, to our best knowledge, there is still poor understanding of health risks in haze days and non-haze days due to air pollutants exposure in China. In the study this article discusses, the levels and health-risks of pollutants (PM_{10}, NO_2, and SO_2) in haze and non-haze days in Shanghai have been investigated as has the new information about the relationship between health risks and air pollution in Shanghai, which may have implications for local environmental and social policies.

Results and Discussions

There were 134 haze days in Shanghai in 2009, during which PM_{10}, NO_2, and SO_2 concentrations ranged from 21.0μg/m^3 to 355.6μg/m^3, 24.0μg/m^3 to 117.6μg/m^3, and 14.0μg/m^3 to 128.0μg/m^3 respectively, while the average concentrations were 110.9μg/m^3, 67.7μg/m^3, and 48.8μg/m^3. The other 231 days were non-haze days, during which PM_{10}, NO_2 and SO_2 concentrations ranged from 14.0μg/m^3 to 300.0μg/m^3, 12.8μg/m^3 to 93.6μg/m^3, and 11.0μg/m^3 to 90.0μg/m^3 respectively, while the average concentrations were 63.6μg/$m^{3,}$ 45.3μg/m^3, and 27.5μg/m^3 (Table 1). The average PM_{10}, NO_2, and SO_2 concentrations during haze days were 1.74, 1.50, and 1.78 times the values of those during non-haze days, indicating that pollution of PM_{10}, NO_2, and SO_2 in haze days was more serious than that in non-haze days.

Table 1 Hospital admissions and average concentrations of PM_{10}, NO_2, and SO_2.

	Average daily admissions of pediatric department (Mean±SD)		Pollutant concentrations (μg/m^3)		
	Shanghai Sixth People's Hospital	Children's Hospital of Fudan University	PM_{10}	NO_2	SO_2
Jan	294.4±76.0	231.5±83.7	83.0±64.7	60.8±18.3	50.8±24.6
Feb	258.7±30.4	245.9±43.5	75.0±43.6	53.6±13.4	34.0±16.2
Mar	334.5±32.4	308.5±53.5	83.3±45.7	61.2±19.9	35.8±16.0
Apr	330.4±26.4	321.2±30.9	86.1±43.7	56.2±23.0	32.9±16.1
May	359.8±34.9	339.1±35.5	79.6±29.5	55.4±15.2	36.0±13.7
Jun	363.3±32.3	340.1±32.4	88.1±48.9	49.4±18.7	32.2±14.5
Jul	355.8±34.2	338.5±37.5	58.8±22.3	42.1±14.0	26.3±7.0
Aug	447.1±90.8	368.8±54.4	60.3±31.0	34.4±13.1	22.6±6.1
Sep	458.3±39.7	424.7±37.5	53.6±15.6	40.6±11.0	18.8±7.4
Oct	406.2±97.3	383.2±96.7	96.6±46.2	57.5±18.8	29.0±11.6
Nov	604.1±138.9	541.8±88.9	84.4±46.1	61.9±21.8	40.5±24.0
Dec	471.7±74.4	447.8±65.3	121.8±69.8	69.1±21.6	63.6±31.4
Winter	455.2±161.5	405.6±152.6	96.5±63.2	63.9±20.7	51.8±28.2
haze	373.6±108.4	338.9±99.5	110.9±49.5	67.7±20.4	48.8±24.4
non-haze	401.6±110.9	370.8±96.7	63.6±36.8	45.2±14.5	27.5±13.2
Year of 2009	356.4±98.5	262.6±70.6	81.0±47.7	53.5±20.1	35.3±20.8

Table 2 Health risk values for different age categories due to PM_{10}, NO_2, and SO_2.

	New born	Children (1 year)	Children (8-10 years)	Adult
PM_{10}(haze)	2.01±0.90	2.02±0.90	1.34±0.60	2.02±0.90
PM_{10}(non-haze)	1.15±0.67	1.16±0.67	0.77±0.45	1.16±0.67
NO_2(haze)	16.14±4.86	16.17±4.88	10.78±3.25	16.19±4.88
NO_2(non-haze)	10.79±2.58	10.81±4.93	7.21±3.04	10.82±1.98
SO_2(haze)	2.45±1.23	2.47±1.23	1.64±0.82	2.44±1.22
SO_2(non-haze)	1.38±0.66	1.39±0.67	0.92±0.44	1.38±0.66

All the annual average concentrations of PM_{10} and NO_2 were over the concentration limits of "WHO Air quality guidelines". The PM_{10} concentrations were similar to those reported for other densely populated regions of China, such as Beijing (142.0μg/m^3) and Guangzhou (134.0μg/m^3), but were substantially higher than those reported for big cities in Europe and East Asia, such as Dublin, Ireland (18.0μg/m^3) and Tokyo, Japan (29.0μg/m^3). NO_2 concentrations were also higher than those reported for big cities in Europe, such as Antwerp, Belgium (38.9μg/m^3). A recent report showed that the average outdoor level for NO_2 in Stockholm, Sweden was only 12.4μg/m^3. The average SO_2 concentrations in Shanghai were also very high, compared to the big cities in Europe and North America, such as Antwerp, Belgium (4.8μg/m^3) and Boston, USA (32.3μg/m^3 in winter, 10.3μg/m^3 in summer).

The highest PM_{10} levels during haze and non-haze days were 150.3 μg/m^3 in October and 99.2 μg/m^3 in December. The highest NO_2 and SO_2 levels during haze days were both found in December, which turned out to be 80.7 μg/m^3 and 79.6 μg/m^3. The respective highest levels during non-haze days were 56.1 μg/m^3 in March and 41.6 μg/m^3 in December. In 2009, hospital admissions were recorded for pediatric department of Shanghai Sixth People's Hospital and Children's Hospital of Fudan University. Average daily admissions of pediatric department during the winter were 455.2 and 405.6 for the two hospitals respectively, while the average admissions for the year of 2009 were 356.4 and 262.6 respectively (Table 1).

Comparison of HR values, which is shown in Table 2, indicated that health risks for all

age groups in haze days were also always higher than those in non-haze days. However, average daily hospital admissions of pediatric department of Shanghai Sixth People's Hospital and Children's Hospital of Fudan University during the non-haze period were higher than haze days (Table 1). It is not surprising. Statistically significant associations were observed for some lag structures of pollutants' concentrations in Shanghai, and outpatient visits were statistically significantly associated with the 3-day lagged pollution for NO_2 and SO_2. Similar results were also found in other regions of the world, such as Taiwan and the USA.

Adults, and children aged 1 year or less suffered from the highest health risk (16.19 and 16.17 respectively) due to NO_2 in haze days (Table 2). The health risks due to NO_2 were about 8.02 times more risky than PM_{10} and about 6.58 times more risky than SO_2. NO_2, which is an indicator of traffic-related air pollutants, turns out to be the most risky pollutant in Shanghai. NO_2 has long-term effects on respiratory systems and it results in decreasing lung function especially in children. However, an earlier study revealed that PM_{10}, NO_2, and SO_2 were relatively highly correlated with each other (Pearson correlation coefficients ranged from 0.64 to 0.73), which limited the ability to separate the independent effect for each pollutant.

Conclusion

This study provides the levels, seasonal variations, and the health risks assessment of pollutants (PM_{10}, NO_2, and SO_2) in the ambient air of haze and non-haze days in Shanghai. The average PM_{10}, NO_2, and SO_2 concentrations during haze days were 1.74, 1.50, and 1.78 times the values of those during non-haze days, respectively. Daily admission counts of pediatric department during the winter were higher than the other seasons and the daily admission counts during the non-haze period were higher than those during haze days. Health risks for all age groups in haze days were higher than those in non-haze days. Adults and children (1 year) suffered from the highest health risk due to NO_2 in haze days.

Acknowledgement

This work was financially supported by the Shanghai Environmental Protection Bureau (SEPB) (No. 09-26).

Enhancing Resource Wisdom with Research and Development

Sirpa Sandelin, Licentiate of Science (Technology), Principal Lecturer, Faculty of Energy and Construction, Satakunta University of Applied Sciences

Current global environmental, social and economic challenges

The growth of the world economy and the rising global population, 9 billion by 2050, mean that the earth's natural resources are being used up fast. Resources such as water, soil; clean air and ecosystem services are vital for our health and quality of life, but they are only available in limited supplies. Growing competition for certain resources will create scarcities and rising prices. Resources need to be managed more efficiently throughout their life cycle, from extraction, transport, transformation and consumption, to the disposal of waste. Climate change is a fundamental threat to sustainable development. Economic growth and resource efficiency are both prerequisites for the sustainable growth of our modern societies and are essential to facing the current challenges.

Resources include all material resources, living and non-living, so in addition to materials this also includes land, soil, air, water, energy, waste, biodiversity and ecosystems. Resource efficiency involves improving the efficiency and effectiveness of how we use these resources, i.e. using less to do more, and causing less impact from those resources we do use. Resource wisdom is a concept devised to convey a more positive take on sustainability issues. Resource wisdom takes a more cross-sectorial and holistic approach, and it can open up new opportunities and innovations.

Europe 2020 strategy and resource efficiency

The Europe 2020 Strategy puts forward three mutually reinforcing priorities:

- Smart growth: developing an economy based on knowledge and innovation;
- Sustainable growth: promoting a more resource efficient, greener and more competitive economy;
- Inclusive growth: fostering a high-employment economy delivering social and territorial cohesion.

The resource efficiency flagship initiative – producing more value using less material and consuming differently – aims to help decouple economic growth from the use of resources, support the shift towards a low carbon economy, increase the use of renewable energy sources, modernize the European Union's transport sector and promote energy efficiency.

SAMK's key research and development forums in resource wisdom

Satakunta University of Applied Sciences (SAMK) has taken a strong strategic focus on the development of resource wisdom. The focus area relies on the European level, Finland's country level and Satakunta regional level commitments and the development programmes related to resource wisdom. One very important factor is also the work done in the Intercity Collaboration Network of the South-West Coast of Finland.

In this network the four major cities in the south-west coast of Finland cooperate with the educational institutes, public and private organizations, and with the companies on several strategic focus areas. Water technology and business opportunities, resource efficiency and energy, especially renewable energy are the main areas, where cooperation is very active. In this network SAMK, Turku University

of Applied Sciences and Pyhäjärvi Institute together with their own international cooperation networks tackle the emerging issues of resource wisdom.

The ongoing research and development activities at SAMK include the following:

- Water technology and business opportunities
- Resource wisdom
- Materials in contact with drinking water
- Hygiene and materials
- In the water technology and business opportunities study about 60 companies were surveyed. Their research and development activities and themes were looked into very detailed in order to create new projects.

SAMK's material testing facility provides a Living Lab in real estate for hygienic and microbiological studies of materials in contact with drinking water. Tests can be done in full scale and pilot scale for cold and hot water. The testing system consists of four 18 mm copper pipes, and four 22 mm PEX pipes of 1a length of 11 each. Cold water studies can be conducted also in a composite material pipeline. The testing system's water is delivered by the water works of the city of Rauma.

Case project on resource wisdom 2014

SAMK and the town of Huittinen started a resource wisdom cooperation project in the beginning of the year 2014. This project responds to the key areas of the Satakunta Regional Development Programme: clean energy, reuse of waste materials, food production, bio-economy, clean water, resource wisdom, development of environmental technology, entrepreneurship, networking, internationalization and citizen's involvement.

Huittinen is a small town of about 11000 inhabitants. Its land area is 540 km^2, of which only 7 km^2 is fresh water sources, i.e. lakes or rivers. The town's commercial and industrial structure is versatile, and small and medium sized enterprises are

predominant. Key branches of industry are trade, agriculture, food production and metal industry. Food industry provides the majority of the jobs. Agriculture is highly specialized. The current development trend can be seen in the construction industry, logistics and industrial services, which are the fastest developing branches.

The town of Huittinen has led the way to the efficient use of resources. Since 2010 the company Biofactory (VamBio) has used manure from pig farms to produce bioenergy and fertilizers. In the town's power plant peat is used for heating purposes. There are preliminary plans for a bio-carbon plant, plans for biodiesel production from excess crop, and land reservation has been made for mining and other industrial activities, agriculture and energy supply (biogas plant), contaminated soils.

The rationale of the development project is based on the strategic cooperation between the Town of Huittinen and SAMK. The project target area includes the town and its surrounding areas. The concentration on the local perspective enables real and concrete actions, practical tests and pilots. Further research and development possibilities will be drawn up from the reviewed information on the companies' waste and material streams. Information will be gathered from the companies' raw materials, energy and water consumption, waste type and amount, packaging and transport data.

The development project will foster ecological sustainability, economic growth and social welfare. The objective is to create a resource-wise urban area in which recycling, efficient use of energy, and cooperation between enterprises produce savings in raw materials and create new innovative opportunities for business.

The main target of the first phase (Phase I) is to increase the resource wisdom expertise in the town of Huittinen and the surrounding area, especially in enterprises and organizations. The project aims at accelerating the cooperation between actors

working with resource wisdom issues. In the first phase information on best practices on resource wisdom completed in the resource efficiency projects at Turku University of Applied Sciences and the Finnish Innovation Fund (Sitra) will be shared. The concrete task is to create innovative resource wisdom pilots in enterprises and between enterprises (industrial symbiosis). The waste streams of industries are redirected for reuse in another industry. The process creates business opportunities, achieves significant carbon reduction and contributes to landfill diversion.

The objective of the project is to promote wiser use of resources and reduce environmental harm, in cooperation with local residents, enterprises and organisations. Enterprises will find sustainable success and will become more competitive through synergy between companies: increased energy efficiency, lower emissions, economic growth, increased self-sufficiency, and new project proposals.

Further information

Biotehdas (Biofactory). 2014. Vambion laitos (Vambio). Web page, available in Finnish http://www.biotehdas.fi/biotehdas/toimivat-biolaitokset/vambion-laitos/

European Commission. 2011. A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy. Available http://ec.europa.eu/resource-efficient-europe/

Town of Huittinen. 2014. Web page, available http://www.huittinen.fi/

Solar Devices Based on Silicon Nanowire/Organic Hybrid Junction

Zhen LIU，Dr., Lecturer, School of Materials Science and Engineering, Changzhou University

Solution-processed solar cells have been considered as a promising way for obtaining low-cost sustainable energy. In recent years, hybrid bulk heterojunction (BHJ) solar cells based on blend composites of inorganic nanowires (or nanorods) and conjugated polymers have received much attention for their advantages of low-cost solution-processability, feasibility of making larger-area devices and stability over purely organic devices. In all hybrid solar cells formed by blending polymers with free-standing nanowires reported so far, the polymers are used as major photoactive materials for their high optical absorbance. On the other hand, depending on the band gaps of the inorganic nanowires, they might or might not play major roles in light absorption and they are mainly exploited for high carrier mobilities. Based on this strategy， a variety of inorganic nanowires such as CdSe,ZnO,TiO_2 and GaAs, have been used in such nanowire/polymer blend solar cells to achieve power conversion efficiency (PCE) of 1%~3%. However, these efficiencies are much lower than what is expected from their theoretical values. Two reasons are considered to be the main factors limiting the PCE. The first is the recombination loss in the polymer, due to their short exciton diffusion lengths and the uncontrollable morphology of the active layer. The other limiting factor is the carrier loss at the nanowire/polymer interfaces.

The problems of uncontrollable morphology in the nanowire/polymer blend type solar cell can be solved by using nanowire arrays, instead of freestanding nanowires. For example, arrays of aligned silicon nanowires (SiNWs) obtained by wet etching of silicon wafer have been extensively explored for solar cell applications. Among these works, high efficiency hybrid solar cells based on SiNWs arrays/polymer composites have been reported with PCE of ~ 10%. However, unlike the nanowire/polymer blend

type devices which only use the freestanding nanowires, these SiNW array solar cells also consume the original silicon wafer. This means that the consumption of high purity silicon is not less than that of the commercial single crystalline silicon solar cells with PCEs over 18%.

To suppress carrier losses at the polymer/nanowire interfaces, two approaches have been reported. One approach involves surface modification by attaching suitable organic dye molecules to the inorganic nanowires and the device performance was significantly improved by enhancing charge separation and suppressing back recombination. In the other approach, the surface of the nanowire was passivated with TiO_x to reduce surface recombination and to further improve the photovoltaic performance. Nevertheless, the problem of recombination loss in the polymer matrix has so far not been addressed.

In this work, we propose a new design of polymer/nanowire BHJ solar cell. Here, we replace the typically photoactive polymer with a highly transparent (i.e. non-photoactive) and conductive polymer. As all excitons are now generated in the narrow band gap nanowire (SiNW in this work) which has a long exciton diffusion length, a much higher proportion of the photogenerated excitons can reach the nanowire/polymer interface for charge separation. Without the requirement of using polymer with high optical absorbance, it is now much easier to optimize the electrical performance of the polymer matrix. By using glycerol doped PEDOT:PSS (here after referred as G-PEDOT:PSS) with good electrical conductivity and freestanding SiNW high optical absorbance, we fabricated a hybrid BHJ solar cell with a PCE of 4.68%. This design not only alleviates the problem of short exciton diffusion lengths in common photoactive polymers, it also addresses the issue of high material consumption in the SiNW array based solar cells.

Upon photo irradiation, most of the light passes through the highly transparent G-PEDOT:PSS matrix and been absorbed by the SiNWs. Electron-hole pairs generated

in the SiNWs can migrate to the SiNW:G-PEDOT:PSS interface and be~~en~~ separated by the heterojunction along the radical direction of the nanowire (Figure 1 a). The separated holes would transfer through the G-PEDOT:PSS to the ITO while the electrons move along the SiNWs and are collected by the a-Si/ ZnO/ Al electrode.

Figure 1 (a). A schematic diagram of the SiNW:G-PEDOT:PSS solar cell. (b) top view and (c) side view SEM images of the SiNW:G-PEDOT:PSS composite film.

Figure 2: (a) Transmission spectra of a 3 μm thick SiNWs (90 wt%):G-PEDOT:PSS composite film coated on a SiO_2 substrate (red on-line). For comparison, transmission spectra of two films prepared by spin-coating with the same amount of SiNWs (green on-line) and G-PEDOT:PSS (blue on-line) respectively were also shown; (b) Reflectivity spectra of the composite film, SiNW array (nanowires of about 5 μm long) prepared by etching and a Si wafer.

As shown in Figure 2a, most of the light of 300 ~ 1100 nm wavelength can pass through the G-PEDOT:PSS film. In contrast, only a small fraction of light can pass through the SiNWs film, the transmission of which is similar to that of the SiNWs:G-PEDOT:PSS composite film. An array of aligned SiNWs has been reported to have good light-trapping properties. It was found that the present composite film of freestanding SiNW:G-PEDOT:PSS does have similar light-trapping properties (Figure 2b). As the absorption of G-PEDOT:PSS was relatively very weak (Figure 2a), most of the light was absorbed by the SiNWs. This phenomenon could be explained by the fact that the optical path in the device was largely extended by the reflection and

scattering in the composite film. In fact we have fabricated a control device identical to the SiNWs:G-PEDOT:PSS device in figure 3a except that no SiNW was added. The control device shows negligible photoresponse (supporting information) confirming that the SiNW is the main photoactive material in the present design.

Figure 3: (a) I-V characteristics of solar cells with active layer of SiNW:G-PEDOT:PSS and SiNW:PEDOT:PSS (i.e. with and without glycerol) (b) Average Isc, FF and Voc (each point being the average data of three devices fabricated in the same conditions) of the SiNW:G-PEDOT solar cells plotted as functions of Wt% of SiNWs in the composite film.

Due to the low electric conductivity of typical photoactive polymers, thickness of their devices is typically limited to tens of nm. To circumvent this limit, we use a glycerol doped PEDOT:PSS polymer which has been reported to have a conductivity ~1000 times higher than that of unmodified PEDOT:PSS.[21] While the G-PEDOT:PSS polymer is non-photoactive, its high conductivity allows us to use a 3 µm thick active

layer dispersed with enough light-trapping SiNWs to maximize photo absorption. Figure 3a shows current density–voltage (I-V) characteristics of SiNW:G-PEDOT:PSS and SiNW:PEDOT:PSS devices under AM1.5G solar irradiation. Obvious increases in short-circuit current density (Isc), open-circuit voltage (Voc), fill factor (FF), and PCE were observed upon glycerol doping. The Isc was improved from 1.27 mA/cm^2 to 22.89 mA/cm^2, the Voc from 0.34 to 0.47 V, and the FF from 17% to 43.5%, resulting in an improvement of the PCE from 0.08% to 4.68%. This confirms that the present approach of specializing the function of the polymer matrix and the nanowires does have good potential for low-cost solar cells.

In Figure 3b, key performance parameters of the SiNW:G-PEDOT: PSS cells (Isc, Voc, FF,) are plotted as functions of the weight percentage of SiNWs in the SiNWs:PEDOT:PSS composite film. It can be seen that both the Voc and the FF increases with the decreasing weight percentage of the SiNWs. This is attributed to the more continuous hole-conducting path at lower SiNW weight fractions. However, when the SiNWs fraction is less than 90 Wt%, the Isc decreases significantly to the decreased amount of photoactive SiNWs. The device has the best power efficiency of 4.68% for a SiNWs weight percentage of 90%.

In conclusion, we present a solution processed hybrid BHJ solar cell based on freestanding SiNWs:glycerol modified PEDOT:PSS (G-PEDOT:PSS) composite film with a PCE of 4.68%. In our strategy, the inorganic nanowires were mixed with a highly transparent conductive polymer (G-PEDOT:PSS) instead of the photoactive polymer such as the P3HT. Electron/hole pairs are only generated in the narrow band gap inorganic nanowire (SiNWs here), thus reducing the recombination losses in typical low-conductivity photoactive polymers. In addition, our method also addresses the problem of high material consumption in the etched SiNWs array but take the advantages of the long diffusion length of the electron/ holes pairs and broad absorption spectrum of the SiNWs. It was also demonstrated that the PCE could be greatly increased through improving the carrier transfer mobility of the PEDOT:PSS

via adding glycerol. It is expected that the present approach can be a promising strategy for highly efficient hybrid BHJ solar cells.

Intelligent Solutions in Automation Technology – Case Examples of Innovative Student Projects

Petteri Pulkkinen, PhD, Dean, Faculty of Energy and Construction, Satakunta University of Applied Sciences

Future-oriented technologies necessitate intelligent solutions based on systems which can be used flexibly. Cutting the engineering costs will be more and more important in the future. Finnish industry is facing fierce competition and high customer demands on the global market. Efficient development of both products and production systems is required in order to deal with this situation. Also the use of IT-tools is getting more and more important.

As a research area intelligent automation is continuously developing at a high pace and that is of profound relevance to industry. Problems from for instance mechanical engineering, electronics, and computer science and project management are united in an interdisciplinary research area. Satakunta University of Applied Sciences (SAMK) focuses its research within intelligent automation on the development of the next generation of industrial production systems. Attention is also paid on the use of different kinds of simulation tools during the development process and the operation phase of a production system. In order to succeed in research there is need for innovative personnel. In order to cultivate innovation talents in universities, a correct, advanced concept of innovation education needs to be established.

Classical education pays more attention to imparting knowledge, and the evaluation of students is based on how much knowledge they master, but ignores the cultivation of students' potential and innovation ability. Teacher-centered teaching mode focuses on imparting knowledge and emphasizes the students' learning results, so it can only make the students accept knowledge passively and negatively,

and cause lack of interest and passion for exploring issues. To a great extent, this restricts the students' innovation thinking and the cultivation of innovation spirit and innovation ability.

Students are the main body of innovation talent cultivation. When a student participates in an activity of a research group, the student’s learning interests and abilities are determined, and the student is helped to independently find the professional direction, to design knowledge structure, so that he or she fully enjoys the pleasure of autonomous learning and can give full play to the initiative and enthusiasm in the learning process. Students' innovation spirit, innovation thinking and innovation ability are put on a prominent position. The focus is shifted from merely imparting knowledge to cultivating students' ability of independent thinking, asking questions, analyzing and solving problems, through which the transformation of teaching contents, teaching methods and the management system are promoted. Students are encouraged to apply what they have learned to innovate. The following examples present innovative approaches designed by the students of SAMK.

The first example presents the automated measurement process for the re-bars. The re-bars used in concrete building are strictly standardized. A certified third party makes sure that the standards are followed. In re-bar manufacture process the generally used measurement method is to measure a sample from production with a caliper. In order to speed up the measurement process and to make it more precise, it needs to be automated. That is why a machine vision system for measuring re-bars’ geometrical characteristics was designed so that its accuracy meets the measurement requirements set by the standard. The goal was to automate the measurement process so that it would be faster, more accurate and repeatable. This goal was achieved, manual labor is needed only when the re-bar is set into the machine and taken off. The re-bar attachment into the machine and the software is done so that the measurement can be repeated. The next version of the system will

be integrated in the production line which makes the real time measurements possible and the samples are no longer required.

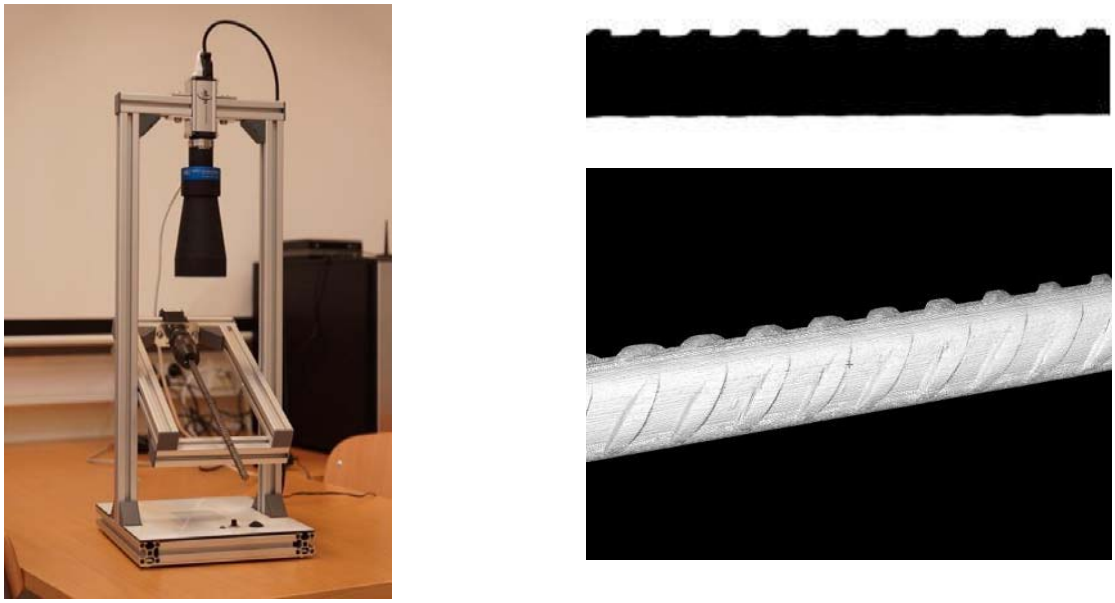


Figure 1. Left: Machine vision system for measuring geometrical characteristics of reinforcing bar Right: A 2D-silhouette of a re-bar and a 3D-model created from a silhouette images (Photo and images by MIrka Leino)

The second example presents an automated quality control system for retail nails. The nails are zinc coated, in order to secure the quality, manual inspections have been used. A group of students had an idea to use machine vision to improve the speed and accuracy of the quality control. Each nail is inspected by the system that consists of a machine vision camera and a computer. In the setup each nail is put to a spinning motion and each side of the nail is photographed, photos stored and processed. The image analysis reveals whether the zinc coating is adequate or not. The components of the measurement system as well as the imaging software were created by the students.

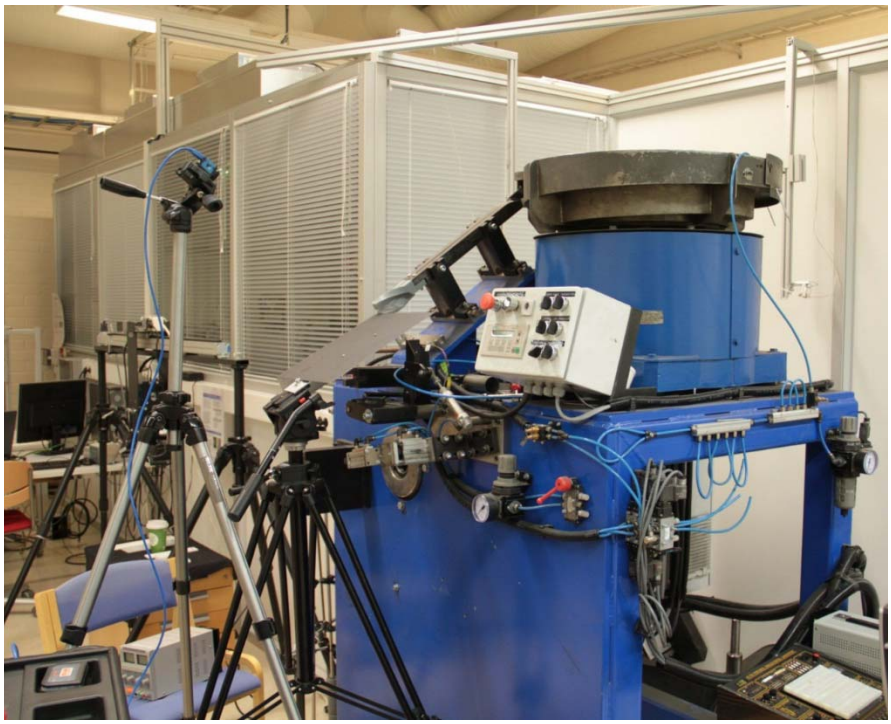


Figure 2. The setup of an automated quality control system based on machine vision. (Photo by Mirka Leino)

The third example presents an electric car built by the students. The donor car was an old Volkswagen Kleinbus from 1974. The donor car was stripped down, all the mechanical parts were replaced or repaired. The combustion engine was replaced with a DC-motor and a large battery pack installed. The car is equipped with two large LCD-screens and massive speakers. The most innovative part of the project deals with the control system. The functions of the car and the monitoring are controlled by an industrial PLC-system, which operates on an MS Windows based computer. This makes the car a moving laboratory. Students can practice their programming skills and use the car as a testing platform. Various sensors can be added to the system and tested in real life environment. The car is used to promote the university; the students line up to use the car in their special events.

Figure 3. A sympathetic electric car built by the students promotes the university in a very positive way. (SAMK Communications / Photo by Tomi Glad)

Learning by doing is not a new instructional theory but is exactly what it sounds like. Learning by doing is applied in educational activities, both in schools and beyond. It is not discovery learning, where students are let loose to discover things for themselves based on their natural curiosity. Rather, learning by doing involves a careful design of activities that allows students to have meaningful, relevant learning experiences that they will then be able to use in the future. Improving students' practical and innovation abilities has both economic and social impacts. Learning by doing not only makes the studies interesting but also enhances students' employment competitiveness. The enterprises benefit from innovative, resourceful employees. Based on the experiences from the student projects, learning by doing should play an important role in education by teaching skills that students will use in their careers and in their lives.

Intelligent Scheduling in Transport System

Shiren Ye, Hui Wang, Dr., School of Information Technology, Changzhou University

Transport System in Singapore

We briefly present the overall of Singapore transport system and an intelligent application called SignalGuru that could help drivers to meet less red traffic lights.

There are over 5 million people in Singapore, a small island of 710 square km. The government had to use 12% of land area to build roads, the length of road network being 3,300 km (rail network 177 km). According to the latest report from Singapore Land Transport Authority, 969 thousand vehicles，including 620 thousand cars，use these roads, and lead to 12 million trips every week. Nevertheless, more than 60% of the people in Singapore mainly use the public transport system. In general, the public transport system exhibits excellent performance. For instance, the average speed of buses achieves 27 km per hour, whereas buses in London and Tokyo run at the average speed of 16 km and 11 km per hour respectively. The physical integration of public transport called seamless transfer and integrated information lead people to enjoy a fast and comfortable public transport system.

Challenges in Intelligent Transport System and Motivation of SignalGuru

The primary issue in an intelligent transport system is how to obtain sufficiently good data, which are consistent, accurate, reliable and efficiently gathered. We need surveillance and detection devices to form relevant and timely information so that we can spend less fuel and time in transport. For instance, traffic lights improve the safety of our cars, however, they lead to a 17% fuel consumption increase and a 15% dioxide emission increase.

Researchers from Singapore-MIT Alliance launched an application, called SignalGuru, to help drivers avoid red lights and reduce fuel consumption by means of dashboard-mounted smartphones. SignalGuru can predict when a traffic signal is about to change, and the speed that should be driven when approaching an intersection in order to cruise through without stopping.

Considering the limited processing power of mobile devices such as iPhone 3GS/4, SignalGuru needs to process traffic-adaptive traffic signals in an uncontrolled environment. An efficient traffic light detection method and accurate prediction of light transferring are essential to SignalGuru.

SignalGuru: Collaborative Traffic Signal Schedule

In general, SignalGuru utilizes the following steps to detect the traffic lights accurately as shown in the left figure:

Detect module: it examines a new frame every 2 seconds using features such as bright color, round and arrow shape, location in frame as well as black housing. The output of this module is to detect the current signal status such as red/yellow/green from the capturing video.

Transition Filtering Module: it is used to compensate for light weight but noisy signals. For example, a short false transition of less than 2 seconds, due to which and traffic lights appear in improper location, will be ignored.

Collaboration module: In order to improve the mutual information between nearby cars from different directions, and to enable advance advisory, these cars will exchange the last 5 cycles of time-stamped red-green transitions by means of real-time ad-hoc and non-center server approach.

Prediction Module: it is used to predict the next transfer phase based on what happened in the past phase at the current traffic point. Usually, we can retrieve the transfer phase from database for fixed length signals. When we collect test data from about 200 transitions from 5 cars running over 3 hours, the average error of prediction is 0.66 second (about 2%). We use support vector regression (SVR) to find the pattern based on the history settings for traffic adaptive signals. We use 26 transitions from 2 signals from 8 cars running over 30 minutes to train SVR, it shows that the transition detection error, phase length prediction error and average error are 0.6 second (0.9%), 1.85 second (2.9%) and 2.45 second (3.8) respectively.

During the test, if the drivers switch off SignalGuru, they will meet 17 stops in 3 traffic points, but under the direction of SignalGuru they do not need any stops. The further experiment shows that SignalGuru helps drivers to reduce average fuel consumption by 20.3%.

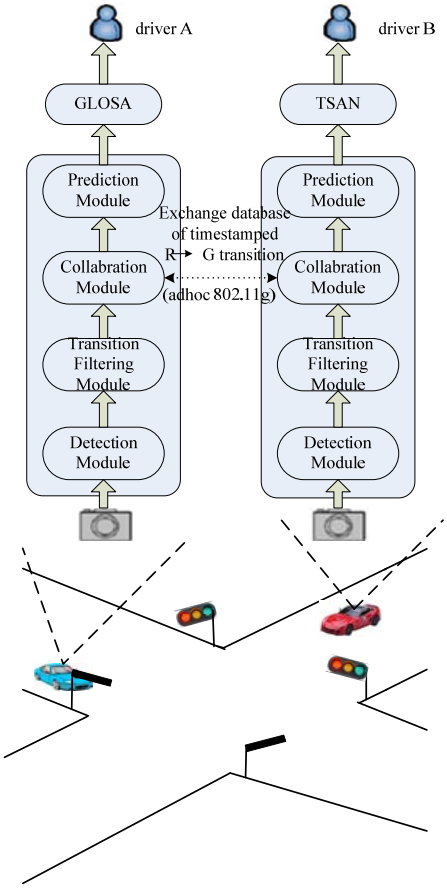


Figure 1. Four modules in SignalGuru

Conclusion

Compared with pedestrian countdown timers, vehicular countdown times and road-side signs, SignalGuru exhibits high predictability, continuous advisory and advance advisory, as well as low infrastructure cost. However, it could predict length of a phase by measuring and collaboratively collecting the prior traffic signal transition history, and feeding it to a support vector regression prediction model. One-week-long history is enough to train the SVR, and one may train it every 4-8 months to refresh the SVR model.

References

Koukoumidis, E., Peh, L. & Martonosi, M. SignalGuru: Leveraging Mobile Phones for Collaborative Traffic Signal Schedule Advisory. In 9th Int'l Conf. on Mobile Systems, Applications, and Services (MobiSys), June 2011

Koukoumidis, E., Martonosi, M. & Peh, L. Leveraging Smartphone Cameras for Collaborative Road Advisories. In the IEEE Transactions on Mobile Computing, 2012.

Gao, J & Peh L. "RoadRunner: Infrastructure-less Vehicular Congestion Control", In 21st World Congress on Intelligent Transport Systems (ITSWC), Detriot, Michigan, September 2014

Basak, K., Hetu S., et al. Modeling reaction time within a traffic simulation model. In IEEE Intelligent Transportation Systems. 2013

Bose, R., Brakensiek, J. et al. Morphing smartphones into automotive application platforms. IEEE Computer, 44(5), May 2011.

ICT-Software Solution for Home Area Network and Home Energy System Integration

Suvi Karirinne, D.Sc. (Tech), RDI-Team Leader, Faculty of Energy and Construction, Satakunta University of Applied Sciences

Introduction

Expansion of solar energy markets has been rapid during the whole 21st century. EPIA (2011) predicts, that majority of the European subsidized solar energy markets will gain grid-parity -point by the year 2020. At this time, solar energy technologies should claim their place as mainstream energy production technologies and function as one among other established technologies. The efficient operation of solar energy systems is challenging because solar energy is diurnal and seasonal. It results to solar energy systems being part of a hybrid energy system, when energy should be able to be used and retained soundly.

Development in the future will lead in to a situation, where different parts of a home area network (HAN) will be controlled by gateways and control boxes, resulting in a complete home energy management system (HEM) (Mayank et al., 2012). For the end user, all this should be as easy as electric heating, with reasonable investment cost, and with the technology which makes it possible for the consumer to get real time data about the consumed and produced amount of energy. It should be equally easy to use the gained data to control operations towards efficient use of energy.

Amin (2001) and Massoud et al. (2005) have pointed out that strong independence and complexity of energy infrastructures means that an action in one part of one infrastructure network can rapidly create global effects. A wide area can be disturbed by a change in conditions at any one location, and the effect of a local disturbance can magnify as it propagates through a network. Because of the

potential of widespread disturbances, smart controlling systems are crucial. With current control and measurement systems and especially the building automation systems, major problems are closed interfaces. These interfaces complicate, slow down and sometimes even prevent the development and expansion of the systems towards an open interface building automation and control system that corresponds to changing conditions and intelligent energy infrastructure development.

Java Distributed Data Acquisition and Control

JDDAC software package (Java Distributed Data Acquisition and Control) that is published under the BSD license and is based on open-source software, is used as the basis of the measurement and control system. It loosely adapts IEEE 1451 standards (IEEE 1451 is for smart actuators) and offers tools executed with Java to build measurement and control applications. JDDAC is purely a software-based system, designed to present a solution to the problem of various, different interfaces in the world of measuring, hardware control, automation and, most importantly, intelligent control of the entireties. Where most solutions in the mentioned areas above are manufacturer- or device-specific, and therefore most often unable to communicate with each other, JDDAC's basic structure makes it ideal to be used as a communicating layer between these variable systems. As it is possible to add intelligence and analysis between these devices with JDDAC, benefits will multiply. It will also be possible to increase the amount of gained benefit from all types of systems and solutions, including the outmoded ones.

JDDAC's basic idea and structure somewhat differs from what is often thought of as a software solution, or a software package. A program is often considered to be a single entity, designed to overcome a particular problem or at least present a solution for minimizing the effects of this problem. JDDAC is more or less a community of these entities, which in JDDAC are called blocks**.** Each problem or addition to the system can be approached as an individual, separate block. Once a

solution has been found, and the block has been created, it can be easily implemented within JDDAC without causing unnecessary alterations to the existing system.

The system consists of 3 types of blocks, all working within NCAP (IEEE 1451), which is a network that defines the boundaries of JDDAC (figure 1). Blocks and NCAP are more of a theoretical way of describing the operation of the system. In a more practical approach, a single JDDAC-system consists of one JDDAC-Server and as many JDDAC-Clients as there are desired target devices or technologies.

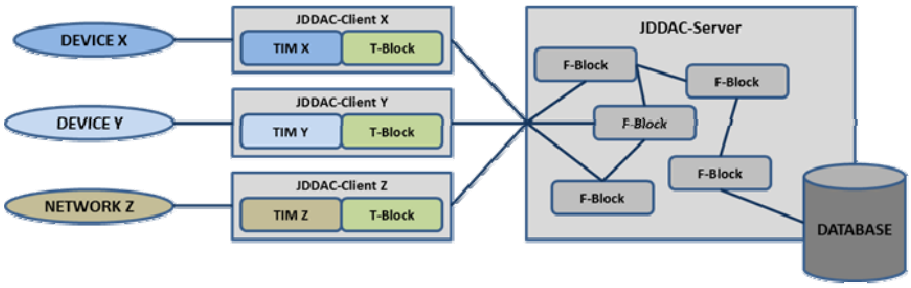


Figure 1. Simplified operation chart of JDDAC-system

TIM-Block (Transducer Module Interface) is the interpreter between the transducer, or the target device, that translates the data and the messages from the device into JDDAC-standard messages. This works both ways; when the control functionalities on the JDDAC-server sends a command to the target device via NCAP, TIM is the block that translates that command into a format that the device understands and can react to, then sends it to the desired location. Some logic can be applied within the TIM, although it is generally preferable to try to keep as much of the logic on the server side as possible. Each TIM has unique configuration files for flexibility.

T-Block (Transducer Block) is similar within all JDDAC-Clients, only the configurations vary. T-Block can be considered being the engine that runs the JDDAC-Client while TIM-Block, along with T-Block configurations, is the difference between the clients.

T-Block configurations are mainly alike; differences consist of used classes, reading intervals, NCAP-addresses and identification information. F-Blocks (Function Blocks) contain most of the analysis-properties, control functionality and the overall logic of the system. They are Java-classes that grab the desired results from the dataflow and are capable of picking out desired proportions of the data or go through it all at once.

Physical location of the clients and the server is irrelevant, as long as there is a TCP-connection between each object. They can each reside on a different device (PC, Mobile Phone, etc.), all on the same device or anything in between. The system core itself is very small and light-weight, but this does not restrict the possibilities of the system, since each functionality, property and feature, can be added to an already working environment when needed. Of hardware, only target device(s), a computer and a way to connect the aforementioned, are required. On a computer, Java environment is required and for storing data, a database is preferred.

Conclusion

In the world of electrical appliances, all operational intelligence is based on algorithms. In automation, focus has traditionally been in general functionality and robustness, while software development has been based mainly on complexity and the development of new properties. JDDAC combines both of these worlds; robustness comes from the existing hardware, complex intelligence from the software. Since the true intelligence behind JDDAC, the algorithms, are not restricted by hardware requirements, capabilities or the different interfaces of the designated system, there is no actual limit of what can be achieved. Because algorithms, and therefore general functionality, can be easily created, implemented, tested, improved and configured, even with a remote connection, the benefits of JDDAC versus a more conventional environment become obvious. The question of what can be done turns into what one can come up with.

Since JDDAC is a purely software-based solution, interfaces towards the end-users and the internet already exist in a way that has seldom been seen in this type of solution. This also presents the issue with software security, but within JDDAC this has been solved so that the actual user interfaces are not an actual part of the system itself, but additions. These interfaces are made secure by using the latest security protocols. The other level of security in the JDDAC-side of the solution is a server security solution. This way the security is effectively doubled. The user can give commands to JDDAC via the interface, within primarily defined safety limits, and the user can receive data from the system. This kind of structure also makes it very easy to implement secure mobile control- and remote monitoring to any kind of infrastructure, either to an existing one or to something that is still in a planning phase.

JDDAC system can be as simple as desired or as complex as imagined. Simplicity brings cost-effectiveness, as JDDAC in its most simple form does not require more than ARM-based architecture to function. All the possibilities combined enable the development of a home energy management system (HEM) that is intelligent, modular, scalable, cost-effective and corresponds to changing conditions and intelligent energy infrastructure development. Using JDDAC as a HEM system offers unlimited possibilities incorporating smart appliances, inverters, advanced metering infrastructures etc. to a home area network (HAN).

References

Amin M., Toward self-healing energy infrastructure systems, IEEE Computer Applications in Power, Vol. 14, Issue 1, 2001, pp. 20-28

Batista, E.A., Gonda, L., Carneiro, A.M., Pereira, M.C., da Silva, A.C.R., Supervisory software development according to IEEE 1451.1 standard, IEEE Sensors Applications Symposium (SAS), 2010, pp. 278 – 281

EPIA, 2011. “Solar photovoltaics competing in the energy sector: On the road to competitiveness”, Brussels, pp.19-26

Mayank A., Bolman C. Carnahan S., Merewitz B., Phipps G., Rogol M., Willhaus S., Xu T., “Solar Annual 2012: The next wave”, Boston, Photon Consulting, pp.19-23

Massoud Amin S., Wollenberg B.F., Toward a smart grid: power delivery for the 21st century, IEEE Power and Energy Magazine, Vol. 3, Issue 5, 2005, pp. 34-41

Brain-Computer Interface: A Bridge between Welfare Technology and Users

Ling Zou, Dr., Vice Dean, Faculty of Information Science & Engineering, Changzhou University & Changzhou Key Laboratory of Biomedical Information Technology

Welfare Technology

In general it can be said that welfare technology is the technology we use to improve the services provided by the welfare society and make them more efficient. The term welfare technology is mainly used in Scandinavia. This is because combining the words welfare and technology makes sense in the welfare society of the Nordic countries (Focus on Welfare Technology).

Welfare technology is used to rationalize and improve the welfare services provided by the society for its citizens. Welfare technology can help to solve a lot of problems. Here, an example is given to show one field welfare technology would solve. As we know, China is one of the largest populated countries, which has a population of more than 1.35 billion at the end of 2013. To slow down the excessive population growth, the Chinese government has adopted the policy of Family Planning since the 1950s. Consequently, the birth rate of China has declined greatly. Contemporary China has entered an aging society; there are 202 million old people, i.e. people above 60, at the end of 2013, which is 14.8% of total population. It leads to a double challenge, the number of young people entering the workforce is declining, at the same time the ageing population now needs more health and care services. In the case at hand, the society is paying more attention to the healthy and happy lives of the old. The remote monitoring system can transmit physiological parameters of the elderly, such as pulse rate, blood pressure, blood glucose, body temperature, into an emergency medical service system through the internet,. With the help of the

remote monitoring system, the doctor can learn the health condition of the aged in real time.

Wearable technology, wearable devices, tech togs, or fashion electronics are clothing and accessories incorporating computer and advanced electronic technologies. The designs often incorporate practical functions and features, but may also have a purely critical or aesthetic agenda (What is a Wearable Device?).

There are all kinds of wearable devices, such as GPS bracelets, oxygen transducers, glucometers, blood pressure sensor instruments, and so on. There is no denying that wearable technology is the future development trend of electronic products. In the near future, the running shoes could record one's running information by embedding acceleration sensor, gyroscopes and Bluetooth; Jackets made of thin film photovoltaic (PV) could transform solar energy into electricity, it will enable electronic products be charged wherever the users go; Cell phones could even be built into gloves, so that they can be worn in the hands. Electronic devices can be worn to serve the users as long as they can imagine, wearable devices will be closely related to the users' everyday lives.

Brain Computer Interface (BCI)

Here, we mainly talk about brain computer interface (BCI) technology, which is the kind of wearable device based on human bioelectrical signals. BCI aims at creating new communication channels without depending on the brain's normal output channels of peripheral nerves and muscles. It is a bridge between welfare technology and users.

In 2003 Steven G. Mason put forward the framework of a brain-computer interaction system (Mason S, Birch G. A general framework for brain-computer interface design.). BCI systems usually consist of four parts: signal acquisition, signal processing, pattern

recognition and external devices control (see Figure 1).

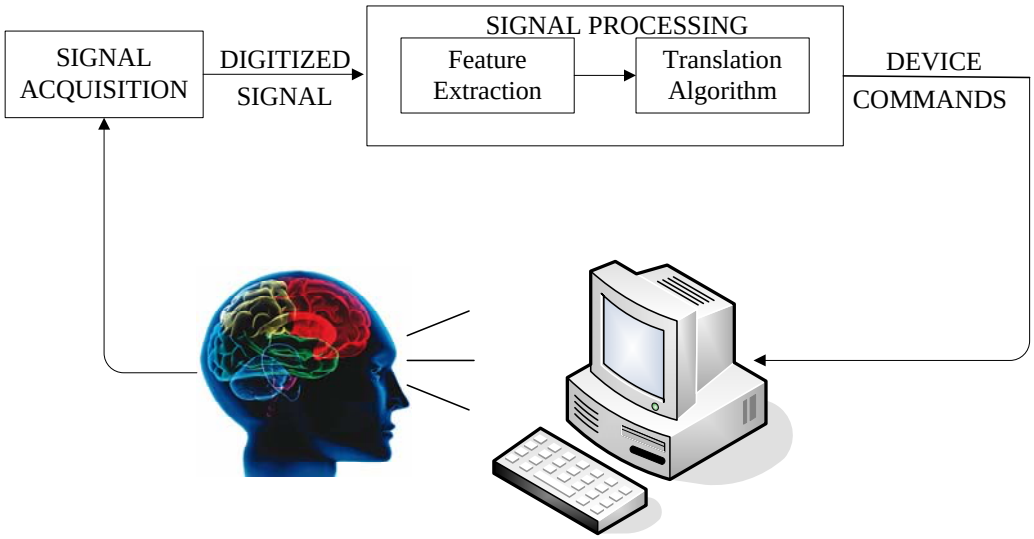


Figure 1. BCI Framework

BCI systems read electrical signals or other manifestations of brain activity and translate them into a digital form that computers can understand, process and convert into actions of some kind, such as moving a cursor or turning on a TV. BCI can help people with inabilities to control computers, wheelchairs, televisions, or other devices with brain activity. It is an interdisciplinary research orientation. With the development of BCI, "animal soldiers" and "insect soldiers" have appeared one after the other. Some assistant BCI diagnosis and treatment systems have been applied more and more in the medical field.

Electroencephalography (EEG) is the most studied non-invasive interface used in BCI, mainly due to its fine temporal resolution, ease of use, portability and low set-up cost.

In order to take the advantage of EEG to design a BCI system, we should carefully research and fully understand the various features of EEG. A variety of features can be extracted from electrical signals. In EEG recordings, either slow cortical potential

shifts, components of visual evoked potentials, amplitudes of steady-state evoked potentials, or dynamic changes of oscillatory activity etc, are of importance and have to be analyzed and classified (Wolpaw J, Birbaumer N, Dennis J., et al. Brain-computer interfaces for communication and control).

Applications of EEG-based BCI mainly include the following aspects: medical rehabilitation (prosthetic control and sports rehabilitation etc.), enhancing physical agility and intelligence of human body (auxiliary driving, military & aerospace applications, neurofeedback etc.) and intelligent human-computer interaction techniques used in the entertainment & games.

Recently, there are lots of EEG-based wearable products on the market, including IBVA, Neurovigil's iBrain, Minicop, Mind Reading Hats, BrainSYNC etc. Our laboratory also developed a Biofeedback system (see Fig. 2). The system is used for attention training.

Figure 2. A Biofeedback system for attention training

A brief Introduction of our lab

Research Center for Biomedical Information Technology was founded by Changzhou University and Changzhou NO.2 People's Hospital cooperatively in October 2011.

Afterwards, approved by Changzhou Science and Technology Bureau, Changzhou Key Laboratory for Biomedical Information Technology was established in April 2012. The aim of our laboratory is to develop and promote original innovation research in the field of biomedical information technology, construct the system of biomedical information analysis, data mining and knowledge discovery which are advanced all over the world and of wide application prospects.

Our laboratory positively promotes academic exchanges and science and technology cooperations. Our laboratory is on the way to become a biomedical information center with worldwide influence and reputation. We extend our warmest welcome to the researchers all over the world to cooperate with us.

References

Focus on Welfare Technology. Nordic Centre for Welfare and Social Issues. www.nordicwelfare.org, December 2010.

What is a Wearable Device? WearableDevices.com. Retrieved 10-29-2013

Mason S, Birch G. A general framework for brain-computer interface design. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 2003, 11(1):70–85.

Wolpaw J, Birbaumer N, Dennis J., et al. Brain-computer interfaces for communication and control. Clinical Neurophysiology, 2002, 113: 767–791.

Independence, Safety and Active Life – Aspects of User-Driven Development of Technology in Elderly Care

Merja Sallinen, PhD, Team Leader in Rehabilitation education, Faculty of Welfare, Satakunta University of Applied Sciences

In Finland, more than 25% of the population is expected to be in the age-group 65+ by year 2030, and at the same time the amount of those over 85 years will double in comparison to current situation (Statistics Finland 2014). The rapid demographic change and increase of life expectancy have forced us to search for new ways of providing care and services for the ever growing elderly population.

Maintaining autonomy, dignity and integrity as well as maintaining social activity, physical functioning and mobility can be seen as the core elements of independent living of the older adults. Accessibility and safety of the environment are equally important. Prevention of falls is one of the main goals of using different kinds of technologies in elderly care; fractures caused by falls may have devastating consequences in regard to independent living. Technological devices, solutions and systems can be used to serve all these purposes. (Fig 1).

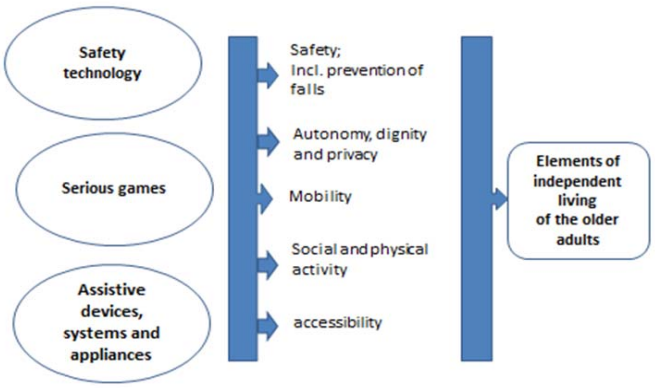


Figure 1. Technology supporting independent living of older adults

According to earlier research, older adults are somewhat reserved in regard to technology and emphasize the perceived usefulness and usability (=user-friendliness) of the devices (Heinz, et al., 2013). This is also linked to acceptance and use of the devices; if the device or solution is perceived user-friendly it is more likely that it is accepted and used by the older adults, whereas in the opposite case the devices remain unused. (Schikhof, Mulder & Choenni, 2010).

A user-driven approach can be described as a collaborative development process between the users and developers of technology. In the first stage the needs, dreams, worries and fears as perceived by the users must be explored. The developers of the technology need to know, which the main problems in the daily activities of the users are, and how technological devices, systems or appliances could help in solving these problems. Any devices or solutions that are developed should be tested by the users in an authentic environment (e.g. at home instead of a technology lab) and users' experiences should be appreciated in the further development or modification of the given solution. The last stage of the user-driven approach is implementation of the technology in the daily environments of the users. In this approach the users are perceived as co-researchers or co-developers, whose contribution is vital to the success of the development of technology. This paper introduces two user-driven projects, KÄKI and WTAL, where the older adults were involved as co-developers of technological devices and appliances.

Developing safety technology in service houses for the older adults

In the R&D project KÄKI, safety technology was developed in three service house units, which provide care and supervision for older people who cannot live alone safely at home any longer. Here safety technology refers to 'low-tech' or 'mid-tech' technologies such as alarm wristbands, activity detectors, safety floors and various communication and monitoring systems.

In the KÄKI- project the data was collected via interviews of elderly service home residents aged 80-92 (n=12) and their proxies (n= 5), as well as via a questionnaire addressed to the nursing staff (n=25). (Sallinen, Kärki, Salo, Teeri & Nurminen, 2013). According to the results, memory problems and difficulties in mobility of the residents were perceived as the main causes for the feeling of insecurity. Moreover, problems in mobility and balance combined with poor vision were often linked to experienced fear of falling. Difficulties in communication and deterioration of hearing were also seen as important causes of insecurity. The technological solutions were expected to decrease the feeling of insecurity and to enhance active functioning of the residents.

The usability of the devices that were used was discussed vividly both by the residents and by the staff. Problems with multiple alarms simultaneously, difficulties in switching off the alarms, false or missing alarms were encountered on a daily basis, especially in the beginning of the try-out of the system. This had caused mistrust towards the safety technology, which in turn, had led to decreased motivation to use the devices. The residents also expressed that they did not want to burden the staff and therefore the false alarms were perceived as embarrassing. The residents criticized the design of some devices; using the devices with small buttons when you have poor sight and trembling hands was found challenging.

The main ethical concern expressed by the residents was related to maintaining privacy despite increasing technical monitoring. The need for monitoring was understood from the perspective of safety but it was discussed whether e.g. cameras (in the corridors or at the front door) could be replaced by other solutions where the privacy of the residents could be better protected. All in all, the homeliness and intimacy of the environment was highly appreciated by the residents. The increased use of safety technology seemed to collide with the core values of the elderly. The elderly and their proxies explicated that the use of technology would be more

acceptable, if you could define yourself what technologies are used and under what circumstances. (Sallinen, Hentonen & Kärki, 2013)

Supporting physical and social functioning through serious games

Serious games (or exergames), combine computer gaming and physical exercising as well as challenge the players' cognition and problem~~s~~ solving skills instead of being merely recreational. In the WTAL-project (Wireless Technologies in Assisting Autonomous Living), serious mobile games were developed together with the users. (Sirkka, Merilampi, Koivisto, Leinonen & Leino, 2012). In this project a visually clear and logically simple point-collecting game was developed in order to practice hand-eye or foot-eye coordination of the older adults. The game was controlled by tilting a cell phone with hand or ankle movements. The equipment required for playing were a cell phone and a computer with a public display such as a screen-TV.

The data was collected through thematic interviews of 34 older adults and 10 staff members after a two weeks "gaming period". Majority of the respondents (88%) found playing a positive experience, describing it as fun, interesting, easy to play, challenging rewarding or entertaining. There were few negative comments and they were mostly related to pain of the joints when tilting the phone or to visibility of the objects on the screen. The game was, however, perceived as suitable for activation and rehabilitation purposes. The comments of the participants varied from "it assists the motor coordination" to "it activates the brain" or "good for social activation". In particular older adults with very limited physical functioning found the gaming to be a suitable method in their rehabilitation, whereas more able-bodied participants, who were still able to walk or do other kind of physical exercises, found it less useful. In addition to those who participated in the gaming experiment, there were many who joined the sessions as spectators and eagerly spurred those who were playing. This confirms the social activation side of the gaming event.

Both the elderly and the staff members gave ideas to improve the game. The future goals to improve the game were set according to the feedback from the users: a) wider variety of controlling the game, b) levels of difficulty, c) developing the game to support different kinds of body movements, d) modifications according to the level of functioning of the player, and e) multiplayer versions to support the social aspects of functioning.

Concluding remarks

Both projects presented here have benefited from the user-driven approach; the older adults gave practical ideas how to develop the technologies. They pointed out weaknesses of the devices in regard to design and usability from the vantage point of a user with decreased functional capacity. Moreover, the elderly users brought ethical dilemmas into discussion, especially concerning safety technology. In our experience, the elderly users – even the oldest of the old and people with mild or moderate memory problems – were willing and able to express their opinions and ideas during the development process. Why not ask them?

References

Heinz, M., Martin, P., Margrett, J. A., Yearns, M., Franke, W., Yang, H.-I., . . . Chang, C. K. (2013). Perceptions of technology among older adults. *Journal of gerontological nursing*, 39 (1) 42-51.

Sallinen, M., Hentonen, O. & Kärki, A. (2013). Technology and active agency of lder adults living in service house environment. *Disability and Rehabilitation, assistive Technology*, DOI: 10.2109/17483107.2013.836685.

Sallinen, M., Kärki, A., Salo, O., Teeri, S. & Nurminen, M. (2013). Nurses' perspectives on implementation of safety technology in elderly care- a mixed method study. *IEEE EMBS Special Topic Conference on Point-of-Care, Heaklth care technologies; 16.-18.1. 2013.* Bangalore, India.

Schikhof, Y., Mulder, I. & Choenni, S. (2010). Who will watch (ove)r me?Humane monitoring in dementia care. *International journal of Huma-Computer studies 68*, 410-422.

Sirkka, A., Merilampi, S., Koivisto, A., Leinonen, M. & Leino, M. (2012). User experiences of mobile controlled games for activation rehabilitation and

recreation of the elderly and physically impaired. *Studies in Health Technology and informatics,* 177: 289-295.

Statistics Finland (2014). Wep page, http://www.tilastokeskus.fi.