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Ongoing research in medical spectral imaging at the University of Eastern

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In my talk, I present ongoing research on spectral based medical imaging. First part of the talk is focused to spectral eye fundus imaging, in which we are moving towards video imaging under spectrally tunable light sources. We aim to do imaging of dynamic phenomena in eye fundus related to retinal blood circulation. For this purpose, new imaging system has been constructed. In the second part of the talk, I present dental spectral imaging, which is ongoing research topic together with the School of Dentistry in the University of Eastern Finland. The dental lesions, especially the calculus and caries, are our targets of research. It can be challenging to detect these lesions by traditional methods e.g., by visual observation, white light transillumination, intraoral X-ray images, or by clinical photographs. Using spectral imaging, we can calculate new type of visualizations for dental experts. Currently, we do imaging under the ethical permission at the dental clinic at the Kuopio Campus of the University of Eastern Finland. In my talk, I show the current status of research and examples of the benefits of spectral imaging. The research done in these topics have been supported financially by the Business Finland and by the Academy of Finland.

Developing Home Monitoring and Care Supporting Systems

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Abstract:
There are rising needs of care supporting for older and disabled persons living at home. Due to lack of care support staffs, robotic solutions have been expected to play a role. So far, no sophisticated home care supporting system has been reported. We aim at developing a home care supporting system synthesizing 1) an at-site monitoring robot, with 2) a remote controlled care support robotic approach, which could provide a cost-effective solution with high safety for care-receivers living in depopulated areas. Results of home monitoring experiments in simulated environments, and remote control experiments will be presented to show the feasibility our approach.

Motivation:
Aging population becomes a serious social problem in many countries. There are rising needs of care supporting for older and disabled persons living at home in those countries. Due to lack of care support staffs, robotic solutions have been expected to play a role.
The most important issue for home care-receivers is how to ensure their safety, especially in the urgent or emergent situations. To deal with the safety issue, focus was put on how to realize cost-effective and spatiotemporally seamless bio-monitoring. A mobile robot following a target person in the home environment while keeping a safe distance with him, could be the right solution: it could provide continuous monitoring with less physical constraints, while involving different types of sensors, compared with the wearable sensor approach; it could avoid blind spots, and occlusion due to furniture and daily commodities in home environment, by actively choosing its observation standpoints, while taking into consideration the effective ranges of sensing of sensors, compared to the smart house approach.
For the home care support function, besides technical details, users' sense of safety, the time & cost for a care-giver to go to the sites shall be considered. Our approach, care support by a remote-controlled robot is a solution balancing the time & cost issue, and sense of safety issue: it could give care receiver more sense of safety than the care support completely given by an at-site autonomous robot, since the operator is a human operator; it needs less time & cost for a care-giver to go to the sites, compared with the power assist approach. Moreover, regarding the time & cost to develop a corresponding technology to a sophisticated level, our remote control approach takes the middle position of the other two approaches.
Another important issue raised by the care givers is that, the care support should be individual dependent: the support should be just adequate for compensating care-receivers' own ability, and in time according to the care-receiver's life rhythm, which could be identified by the bio-monitoring robot approach.

Methods and Results:
Our research efforts include 1) to realize a mobile robot for tracking a target person in the home living environment, measuring and analyzing his activities of daily living (ADL)

for evaluating his life pattern and rhythm; 2) to construct a control algorithm that enables the at-site care support robot to cooperate with the remote operator to realize real-time cooperation between the robot and the operator.
Results of home monitoring experiments in simulated environments, and remote control experiments will be presented to show the feasibility our approach.

Conclusions:
In this study, a home care supporting system synthesizing 1) an at-site monitoring robotic approach, with 2) a remote controlled care support robotic approach, was proposed, and preliminarily tested. Results showed the possibility to provide a cost-effective solution with high safety for care-receivers living in depopulated areas.

Challenges and future requirements:
We are seeking cooperation on non-contact sensing technology for home bio-monitoring, especially sensing for analyzing vital sign, physiological states and mental states. Moreover, testing both bio-monitoring and care support robots in the real environment, needs to clear not only technological difficulties, but also the ethics issue, and social acceptance issue. We have still a long way to go before the commercialization of the robotic system, considering also the health insurance issue.

Elderly Ecological System Design and Services

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The rapid growth of proportion of elderly in the world has increased the needs of geriatric care. In Thailand, the proportion of elderly is projected to rise from 12.2 in 2011 to 14.9 in 2014. This has affected on resources and the cost for supporting elderly care. The elderlies also have a trend of living alone, independent from their family or relatives because of the gradual change of the social structure. It is reported that the percentage of those elderlies are increasing from 3.6 in 1994 to 10.4 in 2014. In addition to the survey, 39% of the elderlies are injured in falling down by stumbling over obstacle, and 7.8% of them are hospitalized. Elderlies in nursing care homes and hospitals also have a high risk of fall down when they attempt to get out of bed in order to go to the bathroom. This accident has high probability of serious injury, such as bone fracture. Hence, the high elderly safety is inevitable required for nursing intervention. To assist in the nursing care duty, we conduct a technological survey on the critical assisting timing for the purpose of the elderly safety and lessen the burden of the nursing care duty. The daily activities of an elderly throughout a day can be observed in each period of time of sleeping, medicine taking, health monitoring, physical activity, social participation, and nutrition. To prevent the bed falling, we propose a set of bed sensors to monitor the position on bed of the elderly. Number of sensors is minimized to decrease the maintenance cost and lessen the operational complexity. As a result, the set of sensors is composed of a pair of pressure sensors and a pair of piezoelectric sensors. Based on the sensing signal pattern, the system estimates the position of the elderly on the bed, and is set to provide a warning message to the caregiver when necessary. The combination of the signals can be modeled to estimate the elderly positions of out of bed, sitting, lying center, lying left, and lying right. In terms of health monitoring, a health logging system is designed and to provide a long-term monitoring to support the health check program. The system supports both hospital information tracking and continuous health information consulting based on the standard data exchangeable design. Medicine identification based on deep learning for image recognition is proposed to assist the elderly of the medicine information. The system provides a large coverage of medical package photos and is trained with a large variation of photos. The project is financially supported by Thammasat University Research Fund under the NRCT, Contract No. 25/2561, for the project of “Digital platform for sustainable digital economy development”, based on the RUN Digital Cluster collaboration scheme.

Imaging of low back pain, potential role for Artificial intelligence

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Few years ago we started to hear about Artificial Intelligence(AI) especially “AI will replace radiologist in the future” and I unclear about that. Lately, this year in the largest radiologist meeting the Radiological Society of North America(RSNA), they state that the AI that will help radiologist work efficiently that I am still wondering. So, with great help of Dr.Chadaporn and Professor Stanislav Makhanov, I am with all of you to learn and share my interests on two common condition/disease: low back pain and thyroid nodule. Those use imaging for diagnostic clues and guidance for a proper treatment. I will speak about the low back pain first and if there is time left, I will also speak about my interest and my work on thyroid nodule.

In my talks regarding low back pain, I will explain how clinician examines and makes diagnosis and how radiologists and their imaging are helpful. Examples, limitations and potential developments of this common study will be described. As a future development is needed, I am looking forward to our future fruitful collaboration.

Diabetic Eye Sentinel

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A Diabetic Eye Sentinel is a self-implemented software for prescreening patients with Diabetic Retinopathy. The software has been awarded the silver medal by the 46th International Invention Exhibition 2018 at Geneva, Switzerland. It utilizes several techniques of image processing to detect two major DR abnormalities: exudates and hemorrhages from retinal images taken from a mobile phone with a special wearable lens. It achieves sensitivity of exudate and hemorrhage detection up to 96% and 88%, respectively.

Image registration between pathological and ultrasonic images

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Relation analysis between physical properties and microstructure of the human tissue has been widely conducted. In particular, the relationships between acoustic parameters and the microstructure of the human brain fall within the scope of our research. In order to analyze the relationship between physical properties and microstructure of the human tissue, accurate image registration is required. To observe the microstructure of the tissue, pathological (PT) image, which is an optical image capturing a thinly sliced specimen has been generally used. However, spatial resolutions and image features of PT image are markedly different from those of other image modalities. This study proposes a modality conversion method from PT image to ultrasonic (US) image including downscale process using convolutional neural network (CNN). Namely, constructed conversion model estimates the US from patch image of PT image. The proposed method was applied to the PT images and we confirmed that the converted PT images were similar to the US images from visual assessment. Image registration was then performed with converted PT and US images measuring the consecutive pathological specimens. Successful registration results were obtained in every pair of the images.

Breast imaging, now and future trends

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Up to now, mammography is widely used as a screening tool for early detection of breast cancer. But this is not the end of the road of medical exploration yet. What are other emerging imaging techniques that have potentials to screen for or diagnose breast cancer? With rapid advances in artificial intelligence (AI) and related technologies, how will these affect the future trends of screening and diagnosis for breast cancer? This presentation will give a brief review of the current practice and future possibilities in breast imaging.