BU-CROCCS updates

2014

BU-CROCCS UPDATES, ISSUE 1, AUGUST 2014

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BU-CROCCS in brief

by Karel Sterckx

The Bangkok University Center of Research in Optoelectronics, Communications and Control Systems (BU-CROCCS) is a new initiative of the School of Engineering at Bangkok University. The center is founded as a unit to carry out both fundamental and applied research work in diverse areas of photonics, optoelectronic devices, optoelectronics, and communication and control systems. Involving several members of Bangkok University and external collaborators, the center utilises the concept of shared facility and expertise within the unit and between affiliates. The center is also intended to serve as an academic and technology hub for a regional, and possibly global, network between different research institutions and industrial firms working in the fields of interest.

Our goals

Locally, one of the main goals is to attract Bangkok University's young faculty members and students to get involved in an international research environment. Such engagement will help enhancing their professional career, and creates additional driving forces for the on-going research work at the university. Towards achieving this goal, the center will provide for technical and academic short courses and workshops. These courses will be public and free of charge for Bangkok University members.

Our facility

The center is located at the sixth floor of the School of Engineering building. It is equipped with three specialist laboratories: electronic & communication lab, smart systems laboratory and micro-photonics. A be-creative area is designated for internship and visiting research students to work and interact.

Our academic achievements

Although our center is newly established, it managed to publish more than 40 journal and conference papers in less than three years. It also managed to gain several research funds, and trained more than 30 undergraduate and graduate internship students from national and international academic institutions. Most of our staff co-supervise graduate students for their masters and Ph.D. degrees with Thai universities such as AIT, Thammasat and Mahidol as well as international universities such as Antwerp University, University of Malaya, and Assam Don Bosco University.

Our team

by Waleed Mohammed

The center comprises of several full time researchers and staff members.

Dr. Tiparatana Wongcharoen (Thailand)
Executive Vice-President for Acad. Affairs.
Ph.D. in Electrical and Computer Engineering, City University, London (UK)

Dr. Natthaphob Nimpitiwan (Thailand)
Dean School of Engineering.
Ph.D. in Electrical Engineering, Arizona State University (USA)

Dr. Karel Sterckx (Belgium)
Director BU-CROCCS.
Ph.D. degree in Electronic and Communication Engineering, Swansea University, (UK)

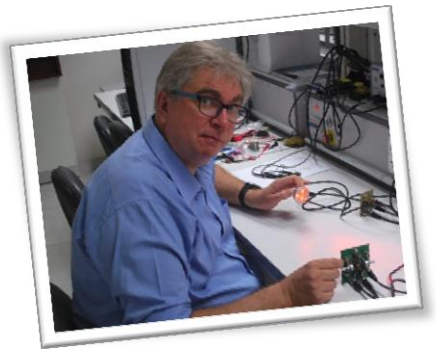
Dr. Poompat Saengudonlert (Thailand)
Research Scholar.
Ph.D. degree in Electrical Engineering and Computer Science, Massachusetts Institute of Technology (USA)

Dr. Waleed Mohammed (Egypt)
Research Scholar.
Ph.D. degree in Optics, University of Central Florida, (USA)

Dr. Wisarn Patchoo (Thailand)
Associate Dean, School of Engineering.
Ph.D. in Electrical and Computer Engineering, Washington State University (USA)

Dr.Pakorn Ubolkosold (Thailand)
Chair of the Electrical and Electronics Engineering Department
D.Eng. degree in Electrical Engineering, Siegen University (Germany)

Dr. Romuald Jolivot (France)
Research Scholar
Ph.D. degree in Instrumentation and Computer Vision, Université de Bourgogne (France)

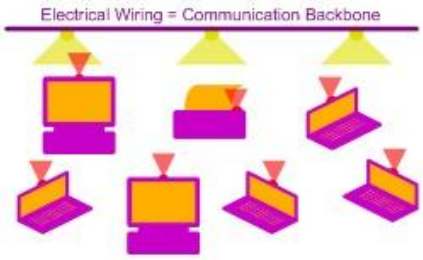


Optical wireless communication

by Karel Sterckx

With the emerging of LED lamps as a green alternative to halogen and gas discharge lamps, the prospect of using lighting infrastructure to provide for indoor broadband communication has attracted interest from researchers and industrialist alike. High Brightness Light Emitting Diodes (HBLEDs), which form LED lamps, are semiconductor devices that can accommodate fast switching times. Hence, the light they emit can be used as a carrier for wireless data. The concept of transmitting data via an illumination source is known as Visible Light Communication (VLC). If illumination is not desired, an optical wireless signal can be provided via an Infrared Emitting Diode (IrED). This concept is known as Infrared Wireless Communication (IrWC). VLC and IrWC are two forms of Optical Wireless Communication (OWC). The other two forms are Free Space Optics (FSO) and Ultraviolet Wireless Communication (UVWC). At BU-CROCCS, however, the focus is on VLC and IrWC only. Work on OWC at BU-CROCCS, thus far, has concentrated mainly on :

- Low cost transceiver design supporting both digital and analogue intensity modulation formats. The transceiver designs accommodate both VLC and IrWC.
- Coding to support VLC over dimmable light



In the near future, work on VLC will concentrate on improving transceiver designs, and the device and implementation of various modulation and coding schemes to improve the quality of VLC communication links. A software defined approach will be used for the implementations of the modulation and coding schemes.

Light at nano-scale

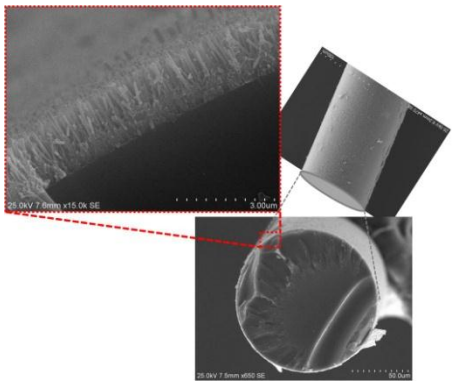
by Waleed Mohammed

Imagine if a body shrinks to a very small scale comparable to few orders of atomic dimensions. Unlike sci-fi movies, where only the human voice seems to get sharper, many laws of physics that govern large bodies do not seem to fit anymore. Hence, light will behave differently when dimensions go to a very small scale or nano-scale — one over thousands of human's hair size.

Nature has provided us with excellent example of nano-structures and how these small features can produce amazing effects. Butterfly wings for example do not have any particular color of their own. The colors we see are solely due to light scattering from nano-features on their wings.

It might be a surprise for many of us to know that using nano-scale feature (or nanotechnology in short) is not new to man-kind. The technology was commonly used to produce the colorful glass works and windows we now see in many historical buildings. What is new is that, nowadays, we gained better control and understanding of how light interacts with such small bodies and features.

In our lab, we investigate how light behaves for different nano-scale structures. These structures are produced in collaboration with Nano-center at Asian Institute of Technology (AIT) and Sultan Qabus University (Oman). The outcome of our investigation is then used for applications that benefit industry and human health.



One of the lab's initiatives is growing nano-scale rods on optical fibers as illustrated in the picture below. The tiny rods play a great role in changing light behavior in traditional optical fiber and opened the door for optical sensing of toxic ions in drinking water as well as optical telecom applications.

Electronic microscope images of Zinc Oxide nano-rods chemically grown on optical fiber. Upper right is a top view of the fiber and lower right is cross section. A zoomed image on the left shows the rods clearly grown on the fiber,

Making telecom systems green

by Poompat Saengudmlert

Our modern lifestyles depend heavily on telecom applications, including making phone calls, chatting on social networks, watching video clips, and so on. With more advanced features on your electronic devices, more and more energy is being consumed to serve such applications. One interesting survey result was revealed in 2007: the ICT industry (of which telecom is a major part) utilizes in each year no less energy than the airline industry. Being aware of this rapid increase in energy use, telecom researchers have begun to seriously investigate how energy is consumed inside telecom systems, and how to decrease their energy consumptions. Such efforts are collectively referred to as "green" communications.

Telecom systems are complex systems that can roughly be divided into core and access networks. Efforts are being made to reduce energy consumption in both parts. At the device level, a direct strategy is to invent new versions of components that consume less energy. At the system level, lower energy consumption can be obtained by various optimization strategies some of which are investigated in BU-CROCCS.

Inside core networks, most energy is consumed by IP routers, which are electronic switching equipment operating under the predominant Internet Protocol (IP). In a traditional setting, data packets are transmitted optically, and are processed (detected, possibly modified, and retransmitted) whenever they travel through a location with an IP router. By allowing some data packets to go through without being processed by an IP router, we can reduce the workload of the IP router and thus reduce its energy consumption.

To let data packets bypass an IP router, another layer of switching, called optical switching, is introduced. The simplest form of optical switching is based on guiding light beams (optical signals) mechanically through reflecting mirrors. While the optical switching technology is not fully mature, it is expected that these optical switches will consume much less energy compared to IP routers since they operate on streams of data packets and do not process the contents of individual packets.

By operating on streams of data packets instead of on individual packets, the use of optical switching has limited functionality. However, by efficient grouping and routing

of data packets, a core network can support the same traffic with much less energy through the use of optical switching in addition to IP routers. Optimization of this grouping and routing of traffic for the sake of energy efficiency is currently under investigation in BU-CROCCS. Preliminary results from computer simulation indicate that as much as 20% of energy consumption could be saved through the use of optical switching.

For access networks, on-going investigations in BU-CROCCS include transmit power optimization for wireless access through visible light communications (VLC). In short, we consider multi-carrier transmissions in which multiple subchannels exist for data transmissions. By optimizing the bit rates assigned to these subchannels, we can reduce the energy consumed for data transmissions. Moreover, the use of pre-equalization (pre-processing of data signals prior to their transmission over physical channels) was demonstrated to further reduce the energy consumption. Preliminary results from computer simulation indicate that as much as 30% of energy consumption could be saved. For VLC, in addition to simulation study, we are also working on VLC system implementation using hardware.

Enhanced Skin Analysis

by Romuald Jolivont

Currently, assessments of skin lesions are mostly performed visually by dermatologists. Well trained dermatologist analyze skin lesion based mostly on its color and interpret clinical pathologies based on their knowledge and experience. However, diagnosis based on color is subjective as color perception is sensed differently among human beings.

There is a growing trend to use optical instruments in dermatology. It aims to increase the amount of complementary information available to the dermatologist for their assessment.

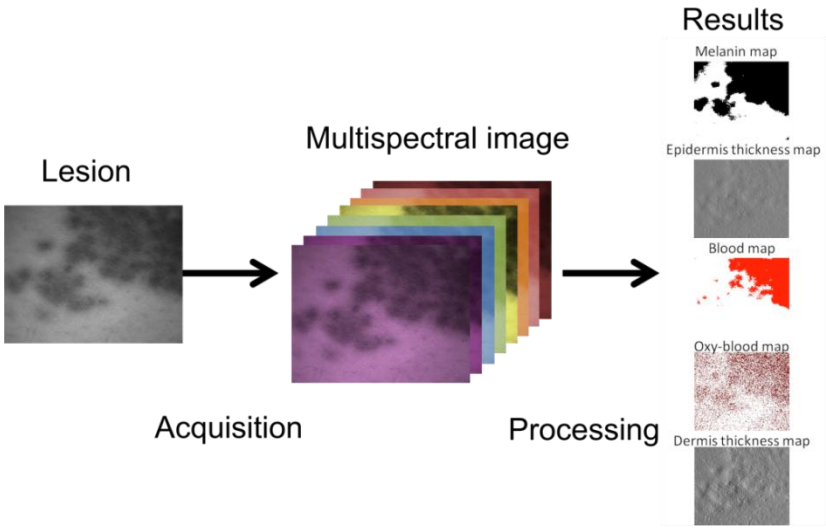
Our project at BU-CROCCS focuses on two main areas. First, we research and develop imaging systems, which combine camera and multicolor light (called multispectral camera). Secondly, we develop algorithms to process the data acquired by the imaging system. Such algorithms deliver objective results about the condition in terms of amount of pigments present in the lesions. The development of new imaging systems takes advantage of the principle of light interaction with skin. Skin chromophores have different optical properties, meaning that light at different wavelength interacts with specific chormophores. By selecting a specific wavelength of light, we illuminate the skin to record information not visible to the human eyes about specific skin components. The acquired images carry important information about the physical and optical tissue parameters. A straightforward application of multispectral imaging is to provide improved skin lesion visualization.

The analysis of the acquired data relies on a mathematical model that simulates the light travelling in the skin. It is a combination of selective absorption and scattering of the physical properties of chromophores composing the skin.

Our research focuses on the development of mathematical models simulating skin models with different complexity. Two categories are currently under investigation. One category is based on statistical analysis. It assumes that skin is a combination of multiple quantities of different chromophores. Another category is based on the development of a physical model of light transportation based on the optical skin properties. It retrieves skin parameters by inversing the model to match the acquired images.

The algorithms deliver a concentration map of skin chromophores. Our research concentrates on the retrieval of specific parameters, especially the concentration of melanin and hemoglobin though it can be extended to other parameters depending on the pathology studied.

The overall target is to provide additional objective and quantitative information to the dermatologist to enhance their diagnosis, especially for the follow-up and assessment of treatment. It can notice the difference of skin composition not yet visible to the human eye potentially saving time to modify treatment.



Schematic of multispectral imaging system: acquisition + processing yielding concentration maps

Research and applications of microcontrollers/FPGA electric power systems

by Natthaphob Nimpitiwan

In our laboratory, nano-fiber has been used in sensor applications for detecting chemical agents in polluted water. These sensors were developed in collaboration with the national research institute for biotechnology or BIOTEC. To produce this nano-fiber, BIOTEC has to import an electrospinning machine. Electrospinning is a part of a nanofiber weaving technique, which is currently used in research and the industry. BU-CROCCS receives funding from BIOTEC to develop an electrospinning machine and high voltage module to replace imported nano-sensors.

Applications of microcontroller in digital feedback control such as the balancing robot,

which is a senior project that allows students to study and implement digital control in real hardware. An Inertial Measurement Unit (IMU) is used as a tilt sensor and a simple PID controller is applied to regulate the target.

Data compression and signal processing

BY Wisarn Patchoo

My background is mainly in the area of data compression and signal processing. Generally speaking, "data compression" relates to ways to efficiently represent data in compact form. This can be achieved by identifying and using structures that exists in the data to eliminate redundant or irrelevant data. "Data" is piece of information that we are interested in, i.e., the quality of rain fall in Bangkok in May 2014 or the amount of stock market each day. In an electrical and computer engineering sense, data can be room temperature obtained from sensors, human speech from microphones, or images captured by a camera. The variation of data is referred to as "signal". "Signal processing" refers to methods to analyze, modify, or extract interesting features from the signal. The variation of color of each pixel in image is also considered a signal. At BU-CROCCS, we focus on the implementation of image

Smart strip reader

and video processing based on embedded system implemented on FPGA. One particular work, in which we collaborate with Chulalongkorn University and the Thai national research center for biotechnology (BIOTEC), is the development of a "Smart Multiple-Strip Reader". This is a device to test a target chemical compound in a liquid solution. The reader approximates the concentration of the target compound by detecting color change in the solution by means of a high-sensitive CMOS camera. Currently, we are trying to find an efficient way to classify the color change.

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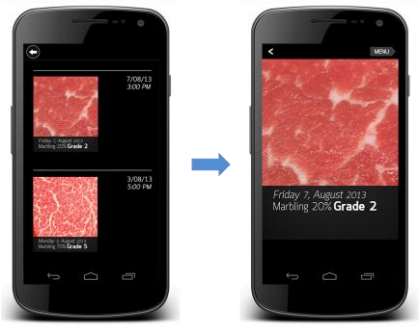
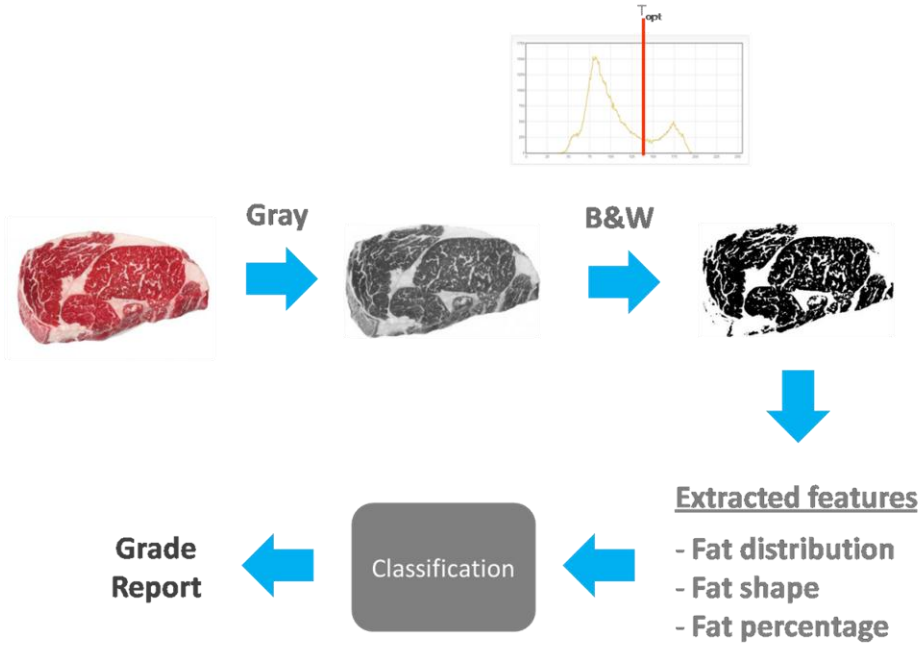
Development of Automatic Meat Grading Platform

by Pakorn Ubolkosold

Meat (beef/pork) marbling is a crucial index to quantify meat quality. The marbling score or grade is usually determined by the measurement of fat geometry and fat distribution over the area of interest. In practice, meat grading is carried out manually by meat experts using their visual senses or comparing the meat slice with the standard cards. This manual grading procedure demands not only great labor though also is unreliable. At BU-CROCCS, we design and develop practical meat grading systems employing image processing techniques in order to determine the grade of meat. The system consists of a series of different levels of image processing such as background extraction, color calibration, feature extraction, and classification.





To support various usages, we develop the systems based on different technologies such as smart-phone/tablet based, FPGA based, Web-based, PC-Based, as well as Micro-controller based platforms.

Student opportunities

by Karel Sterckx

BU-CROCCS welcomes qualified undergraduate and graduate internship students, both Thai and international, to execute projects that are part of the center's ongoing research. The center is able to receive students throughout the year. The applicant must be motivated, self-disciplined and possess proficiency to communicate and write technical reports in English. The internship program does not provide financial support. However, the center assists in arranging affordable accommodation prior to arrival in Thailand, and does not charge any tuition fee. Transportation from the airport at the start the internship is provided free of charge.

FOR MORE INFORMATION

For detailed information regarding the internship please visit the web-site:
http://eng.bu.ac.th/bucroccs
or email the director of the center.

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