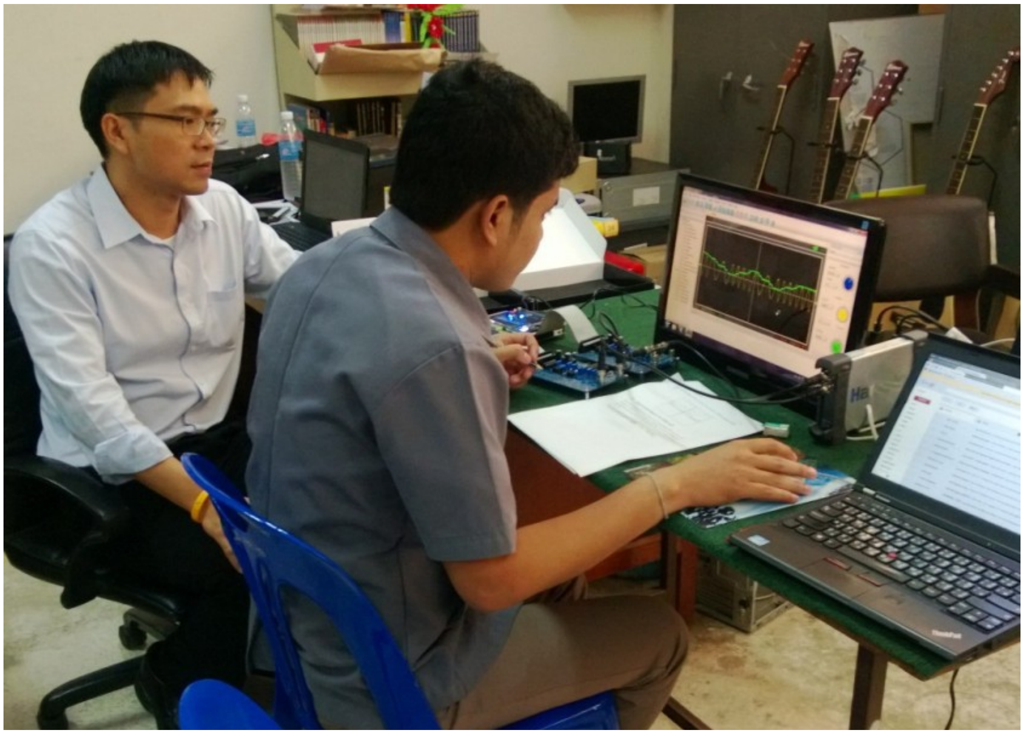


BU-CROCCS updates

2014

BU-CROCCS UPDATES, ISSUE 2, DECEMBER 2014

Training and Exchange at BU-CROCCS

by Karel Sterckx

Welcome to the second edition of BU-CROCCS Updates. In the first edition we introduced our research center as well as its members and their respective research involvement. We also mentioned that BU-CROCCS offers internships to qualified undergraduate and postgraduate students. For this second issue, we asked our current postgraduate internship students to introduce their work. Students presenting their work are

Ms. Charusluk Viphavakit (Thailand) – Ph.D. candidate at Frederick University, Cyprus.

Ms Hoorieh Fallah (Iran) – PhD candidate at the University of Malaya, Malaysia.

Ms Wern Kam and Mr. Yong Sheng Ong (Malaysia) – Master students at the University of Malaya, Malaysia.

Ms Kakoli Nath, Ms Dhritishri Das, Mr. Mridul Pathak and Mr. Abhijit Kakati (India) – Master students at the Assam Don Bosco University (ADBU), India.

Through the Erasmus Mundus INTACT mobility scheme, BU-CROCCS also had the pleasure of welcoming Dr. Ian Grout, faculty member of the University of Limerick, Ireland. Dr. Grout conducted a month's research in collaboration with Dr. Karel Sterckx from BU-CROCCS.

Several BU-CROCCS members are involved with the development of a low-cost telecommunications trainer, for which a grant of the Thai Research Fund (TRF) was obtained. Low cost is achieved by implementing various (de)modulating and de(coding) schemes on a low cost Field Programmable Gate Array (FPGA) development board employing Software Defined radio (SDR) techniques. Further details of this project are provided by Dr. Poompat Saengudomlert of BU-CROCCS, who is in charge of the project.

IN THIS ISSUE

Students' talk

by Internship Students

Edited by Karel Sterckx

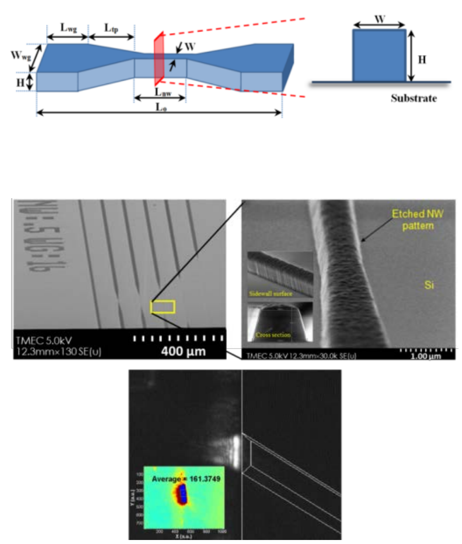
The center welcomes on average 15 to 20 students a year for internship training. They come from different universities in Asia and Europe to perform undergraduate or graduate research projects under the guidance of the center members. Here, we gave our students an opportunity to share their technical experiences and achievements

Polymer Nanowire for Optical Sensing Applications

Ms. Charusluk Viphavakit – *Thai national pursuing a PhD at Frederick University, Cyprus. Through Bangkok University, she obtained an Erasmus Mundus STRoNGTIES grant to finance her studies. She is supervised by Dr. Christos Themistos of Frederick University and Dr. Waleed Mohammed of BU-CROCCS.*

Polymer nanowires are used as alternative optical waveguides in sensing applications due to their attractive features. Polymer nanowires have better mechanical flexibility compared to semiconductor nanowires and they are biocompatible materials that can have different functional dopants. There are several possible techniques to fabricate polymer nanowires. However, none of these bottom-up techniques enable a reliable and high throughput for large-scale patterned nanowires. Top-down fabrication techniques, such as laser interference patterning (LIP), combined with inductively coupled plasma (ICP) and nano-imprint provide a uniform and oriented nanowire structure at large-scale.

For our work at BU-CROCCS, polymer nanowires are fabricated using a nano-imprint technique which promises a simpler, less time consuming, and lower cost process with high-throughput. With this nano-imprint technique, the dimension and uniformity of the polymer nanowire can be better controlled. Polymer based nanowires are intended to be used as an integrated optics transducer to detect the index difference when there is a change in refractive index of the cladding material. The sensing region of this polymer nanowire is located at the interface between the guiding area and the cladding region where an evanescent field exists. In order to achieve a highly sensitive polymer nanowire the width and height of the structure, need to be optimized in order to enhance the evanescent field in the sensing area. The characteristic of the nanowire is investigated by evaluating the absorption coefficient or the attenuation loss.



The structure and electron microscopic images for the nano-wires used in this study.

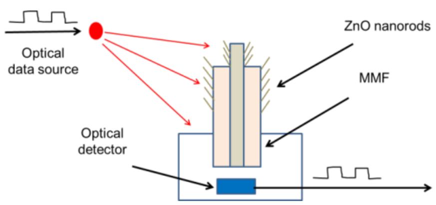
In the future, the sensitivity of this polymer nanowire will be improved by coating the surface with a metal layer to enhance the surface plasmon resonance (SPR).

Wide Field of View Optical Reception

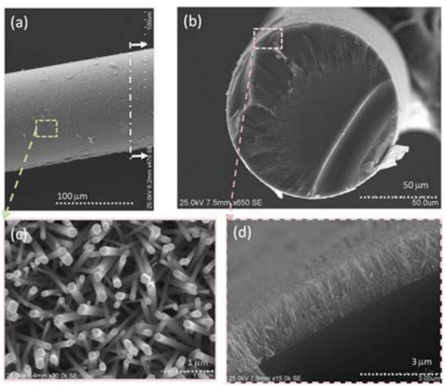
Ms Hoorieh Fallah – *Iranian national pursuing a PhD at the University of Malaya, Malaysia, and received a scholarship from this university to finance her studies. She is supervised by Dr. Sulaiman Harun of the University of Malaya and Dr. Waleed Mohammed of BU-CROCCS.*

To broaden the field of view of optical wireless reception, an optical fiber on which Zinc Oxide (ZnO) nanorods are grown is placed in front of the photo detector. Via the ZnO nanorods, the incident light is scattered into the optical fiber, which guides the light to the photodetector. The principle is dd in figure (1) below.

ZnO nanorods are grown uniformly on the fiber, using a hydrothermal process which is a simple and low cost method. The process compromises of two parts, namely seeding nanoparticles and the growth of the nanrods. ZnO nanorods scatter the light at an angle larger than the critical angle inside the fiber. When scattering light inside the fiber, the nanorods length and density are found to be the most crucial parameters for optimum side coupling. These two parameters are controlled through the seeding and growth time. Maximum excitation of the cladding mode by side coupling of light was obtained with ZnO nanorods of length ~2.2 µm, demonstrating average coupling efficiency of ~2.65%. To increase coupling efficiency through core modes excitation, the fiber cladding is removed to allow light to reach the core region. A 50 % pure Hydrofluoric acid is used to remove the cladding region of fiber. Light coupling efficiency is extracted by de-convolving the finite beam extinction from the measured power. Figure (2) shows Scanning Electron Microscopy (SEM) images of ZnO nanorods on the optical fiber.



(1) Schematic view of the proposed optical antenna configuration



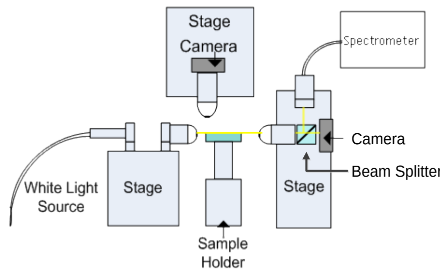
(2) SEM images of (a) Uniform growth of ZnO nanorods on the optical fibers (b) Cross sectional view of the optical fiber showing the growth thickness (c) High magnification top view and (d) Side view of the rods on the optical fiber showing the growth directionality

Surface Plasmon Resonance Based Fiber Sensors

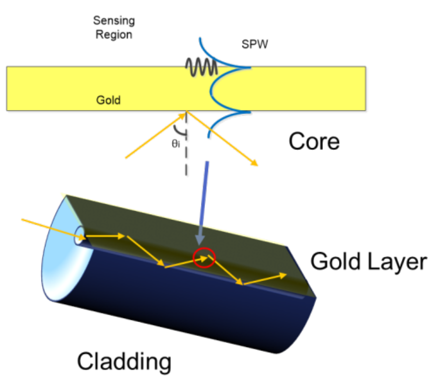
Ms Wern Kam – *Malaysian national pursuing a Master of Physics at the University of Malaya, Malaysia. She is supervised by Dr. Rozalina Zakaria of the University of Malaya and Dr. Waleed Mohammed of BU-CROCCS.*

The use of sensors in our daily life has been expanding since modern life relies heavily on such devices. Developing a much more sensitive, fast and accurate sensor comes at a cost, and to seek solutions to reduce this cost, researchers have been seriously investigating numerous new techniques for sensing applications.

At BU-CROCCS, our project focuses on Surface Plasmon Resonance (SPR) sensor, which turns out to be an indispensable part of photonics devices that cut across conventional disciplinary boundaries. It offers a promising route towards better quality of life, disease treatment and allows for high performance efficiency in harsh environments. The technique was reported in 1983, hence it is no longer a groundbreaking technology though there is still much to improve for sensing application purposes.

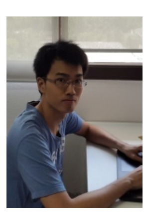


Characterization setup



SPR D-Shaped fiber sensor

Sensing with Light Scattering

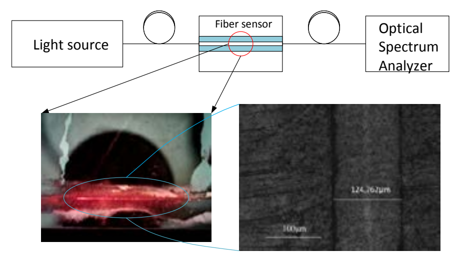


Mr. Yong Sheng Ong – *Malaysian national pursuing a Master of Physics at the University of Malaya, Malaysia. He is supervised by Dr. Rozalina Zakaria of the University of Malaya and Dr. Waleed Mohammed of BU-CROCCS*

Light just used to illuminate the earth and make matters visible to us. Now, after the invention of optical fiber, light carries more role in human daily life. It made our world shrink in an amazing way as we are able to reach information from around the world almost instantly. We are also able to reach persons we care about the most when we are at different parts of the world.

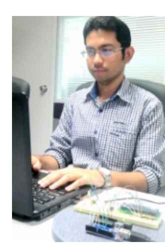
Optical fibers are also able to protect us and give us specific environment information by converting them into sensors. This is done by tailoring optical fiber into specific shape or applying coating to it. The protection comes from early warnings by detecting a change of dangerous substance concentration. This is helpful for coal mining and oil industries as well as other fields that are hazardous. It is able to act as transmission line and transducer, which makes installation easier.

Our project focuses on sensing by using scattering due to surface roughness. A change of concentration will yield a change in signal and we can extract the data we need. In the first part of our project, we study how light behaves in different dimension of fiber optic through computer simulation and try to optimize. Next, we fabricate a device and characterize it using the setup of the figure below.



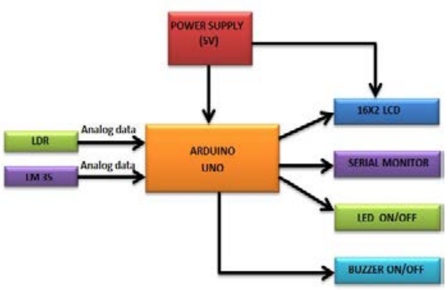
Experiment setup with microscopic image of fiber sensor surface (lower right)

Energy Monitoring Using Distributed Sensor



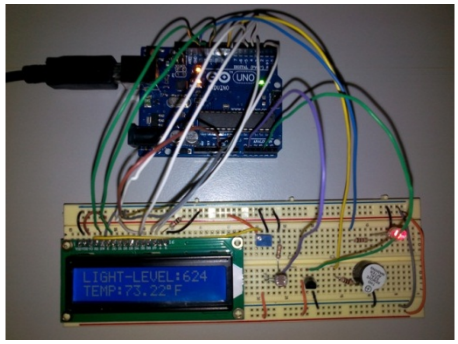
Mr. Abhijit Kakati – *Indian national pursuing a Master of Technology at the Assam Don Bosco University (ADBU), India. He is supervised by Dr. Sunandan Baruah of ADBU as well as Dr. Pakorn Yubolkosol and Dr. Romuald Jolivot of BU-CROCCS.*

Energy saving has become a trend now-a-days. Almost everyone tries to save energy, whether it is for household purpose or for industrial purpose. In order to save, we must first know the present usage. Only after knowing and monitoring, one can control energy consumption and save as per desired. It is of utmost importance in many industrial as well as experimental setups to monitor as well as to control parameters such as light and temperature. Monitoring factors such as light level, temperature etc. are not only important for industrial purposes; they are also a cause of growing concern in our everyday life. Industries always depend on a comfortable environment as it is assumed to be directly linked with the rate of production. The friendlier the environment, the better the rate of production will be. Hence, it is important that the environment variables, such as temperature, relative humidity, dew point, light intensity etc., are continuously monitored and corresponding systems adjusted to maintain a comfortable working environment.



Block diagram of the system

My project at BU-CROCCS is concerned with the development and functioning of a simple, easy to use and cost-effective monitoring system using distributed sensors. Distributed in the sense that, individual sensor nodes are integrated or distributed into the system for monitoring purpose. Light level as well as temperature of an environment can be monitored efficiently, using the proposed system. The main objective of this project is to construct a simple yet effective device for monitoring energy as well as controlling certain parameters which can be of use industrially as well as of private use. The system is highly concerned with automation. A simple and cheap sensor LDR is used for monitoring light and an LM 35 temperature sensor, which is calibrated directly on the Celsius scale, is used for measuring temperature. The heart of the system is based on Arduino. It is a cost effective and simple design as it employs cheap components that provide reliable data. The system is highly portable and compact. It can be of tremendous use in monitoring river water temperature, for automatic control of street lights, automation of home lighting system, egg industry, green house and many more. Moreover the system is so adjusted, that many other sensors can be integrated into it according to ones requirement at ease.



Experimental setup

Testing Scattering Properties Of Zinc Oxide Nanorods Under Changes In Environment

Ms Dhritishri Das – *Indian national pursuing a Master of Technology at the Assam Don Bosco University (ADBU), India. She is supervised by Dr. Sunandan Baruah of ADBU and Dr. Waleed Mohammed of BU-CROCCS.*

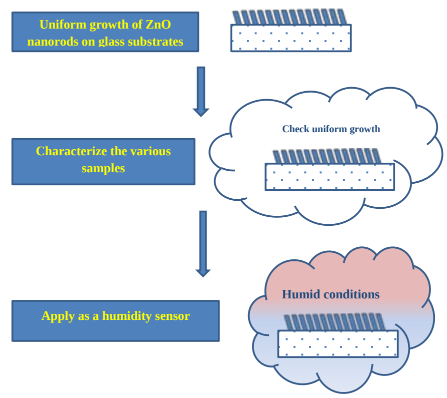
Nanorods are small structures at the nanoscale range, which is not visible to the human eye. These rods can behave in a variety of ways when subjected to light. A scattering effect is observed in a substrate that has nanorods on it. Scattering is defined as the change in propagation of light when it encounters a small object or particle.

An example of light scattering is when the short wavelengths of sunlight i.e, its blue components are deviated by particles in the atmosphere making the sky blue.

The scattering effect of light can be engineered for sensing purposes. One such sensor is based on Zinc Oxide (ZnO) nanorods that are grown on glass substrates. They are grown using hydrothermal process, which is a simple, low temperature and environmental friendly process that does not require complex conditions.

One of the important parameters of growing ZnO nanorods over glass substrates is uniformity, which results in even scattering throughout the sample and yields more absorption. More distinct visibility in the fringes gives information about the uniformity which is monitored with a spectrometer.

ZnO nanorods grown substrates are utilized in sensing humidity. For this purpose, the glass samples are kept under various humid conditions and their changes are observed comparing with the normal conditions.



System flow chart

Characterization of Zinc Oxide Thin Film Growth Using Optical Fiber Based Sensor

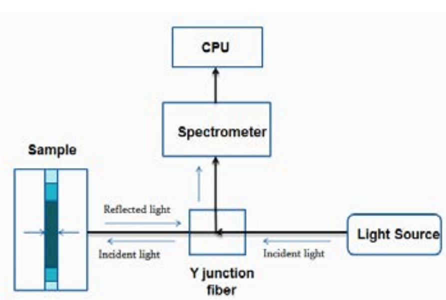
Mr. Mridul Pathak – *Indian national pursuing a Master of Technology at the Assam Don Bosco University (ADBU), India. He is supervised by Dr. Sunandan Baruah of ADBU and Dr. Waleed Mohammed of BU-CROCCS.*

Optical sensors are widely used in different fields of engineering technology. Over the past decades many product revolutions have taken place due to the growth of the optoelectronics and fiber optic communication industries. Optical fiber based sensor systems have attractive advantages due to reasons like small size, light weight, immunity to electromagnetic interference, passive composition, high sensitivity and the ability of distributed sensing. In fiber optics, optical characterization schemes have an advantage for remote application, reduction of system complexity and cost efficiency.

In this project a fiber based sensing system will be developed employing the Fabry Perot interferometry technique which has been established for in situ growth of thin films. This will be applied for determining the optical characterization of Zinc Oxide (ZnO) thin films during growth. Generally, a

Scanning Electron Microscope and a Transmission Electron Microscope are the core devices, which give us the appropriate value of the film thickness and the film growth. These offline processes have some limitations at the time of fabrications, such as time delay and high cost. This work aims to develop an optical fiber based sensor for a convenient simulated optical signal processing based system for characterization of thin films. This simple and inexpensive technique would be useful for the fabrication of advanced optoelectronics and semiconductors devices.

The synthesis of ZnO nanoparticles has advantages due to their unique properties and potential applications in optoelectronic devices. Semiconductor compounds have drawn important attention during the past few years since their novel optical and transparent properties have great potential for many optoelectronics applications. ZnO is a wide band gap semiconductor that shows high optical transparency and luminescent properties in the near ultra violet and the visible regions. Due to these properties ZnO is one of the most important materials for electronics and optoelectronics applications such as solar cells, liquid crystal displays, gas sensors, heat mirrors, and surface acoustic wave devices. ZnO nanoparticles were prepared by hydrothermal method. The properties of ZnO to adopt it for different applications, such as, the band gap of ZnO is modified to use as UV detectors and emitters. ZnO nanoparticles are widely used in fundamental research and potential applications, such as hydrogen- storage, field emitters, ultraviolet lasers and diodes, piezoelectric devices and photo crystal fluorescence labels in medicine and biology, controlling units as UV photo detectors and as high flame detectors in cosmetic industry and as a component of sun screens.



Schematic diagram of the measurement setup

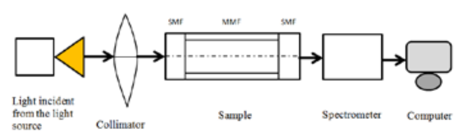
Optical Sensor Based On Fiber Multimode Interference

Ms Kakoli Nath – *Indian national pursuing a Master of Technology at the Assam Don Bosco University (ADBU), India. She is supervised by Dr. Sunandan Baruah of ADBU and Dr. Waleed Mohammed of BU-CROCCS.*

Currently, there are many sensors used for the measurement of numerous variables, some of which are expensive due to the components used, level of precision, etc. However, nowadays, optoelectronics and fiber optic communications have reached a level of technological maturity, quality and cost effectiveness, which makes them an attractive alternative to other sensors. Fiber optic sensors have good durability against harsh environments, high resolution, stability, high sensitivity, fast response and immunity to electromagnetic interference. The development of fiber optic sensors based on multimode interference (MMI) effects is relatively new. Moreover, since they exhibit a band-pass filter response they can be used in other applications as well.

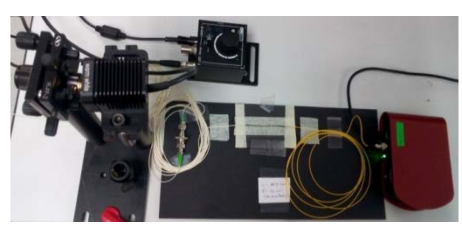
The MMI concept has been investigated during the past few years in order to develop new optical devices. Typically, the MMI based fiber device consists of a step index multimode fiber (MMF) section spliced between two single mode fibers (SMFs), forming an SMF-MMF-SMF (SMS) structure. In recent years, the multimode interference occurring in SMS fiber structure has been utilized in the design and fabrication of devices such as bandpass filter, temperature sensor, displacement sensor and wavelength tunable fiber lens. The MMI technique is based on the phenomenon of self-imaging which can be defined as the property of multimode waveguides by which an input field profile is replicated to form single or multiple images of the single-mode input field at periodic intervals along the direction of propagation of the waveguide. The image reproduction is due to both, constructive and destructive interference which is present all along the waveguide.

My project at BU-CROCCS is to investigate the changes in the transmission spectrum by varying the environmental conditions of a fiber optic sensor based on multimode interference. The principle of this sensor lies on the change of the refractive indices of the cladding modes. The corresponding resonant wavelengths will shift in the transmission spectrum when the external refractive index around the MMF section is changed. The operating mechanism of this sensor is based on the self-imaging phenomenon that occurs in MMFs, which is related to the interference of the propagating modes and their accumulated phase. The sensor is very simple and cost effective since the sample used in the sensor has been prepared by splicing a segment of step index coreless multimode fiber between two standard single mode fibers. Thus, it becomes a conventional single-mode multimode single-mode (SMS) fiber structure. The multimode section of the fiber is capable of carrying many guided modes. As a result, the light at the input of the MMF section is replicated for a specific wavelength in both amplitude and phase at its output, providing a band pass spectral peak. Hence, to obtain a single image, the phase difference between the guided modes should be a multiple of 2π. The peak wavelength of the output spectra recorded by the spectrometer shifts with the changes in the surrounding refractive index owing to the direct exposure of the coreless fiber. The change in output spectrum on the application of de-ionized water was observed and studied using the spectrometer.



Schematic diagram of the system

MMI based fiber devices which rely on the re-imaging concept, which has several advantages namely fixed wavelength and tunable wavelength band pass filtering, temperature, liquid level, refractive index and displacement measurement.

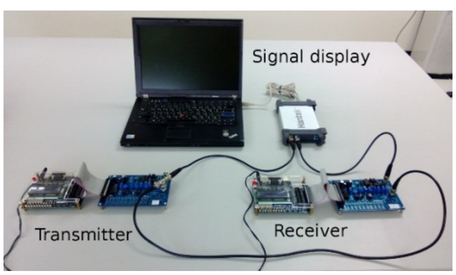


Experimental setup

Helping Vocational Colleges Teach Digital Communication Labs

by Poompat Saengudomlert

To help address the shortage of lab equipment in teaching the basics of digital communications in Thailand, BU-CROCCS researchers have developed low-cost lab kits to be used in vocational colleges. The lab kits are created based on the software defined radio (SDR) concept, where field programmable gate arrays (FPGAs) are used as digital signal processing (DSP) devices. While FPGA development boards were purchased from Altera, digital-to-analog converters (DACs) and analog-to-digital converters (ADCs) were designed and implemented by BU-CROCCS researchers. In addition, the associated FPGA configuration software was written by BU-CROCCS researchers. No licensed software is required for the users of our lab kits.



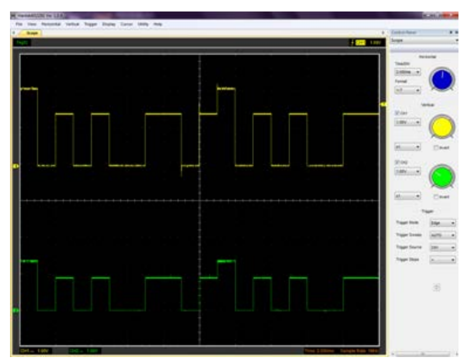
Ten lab sessions have been prepared with the following topics: (1) Basic signals in digital communications, (2) Basic signal filtering, (3) Pulse amplitude modulation, (4) Pulse width modulation and pulse position modulation, (5) Amplitude shift keying, (6) Frequency shift keying, (7) Phase shift keying, (8) Quadrature amplitude modulation, (9) Time, frequency, and code division multiplexing, (10) Error detection and error correction. An accompanying lab manual has been written, where each lab session starts with some preliminary questions that prepare students to sketch the signals that they would be observing.

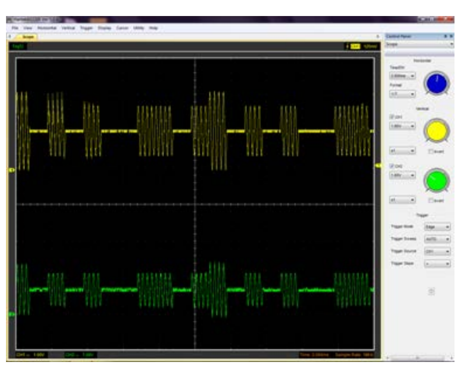
Up to now, BU-CROCCS has provided on-site training to a few vocational college instructors. In the near future, these instructors will utilize BU-CROCCS lab kits in their courses to supplement their lectures.

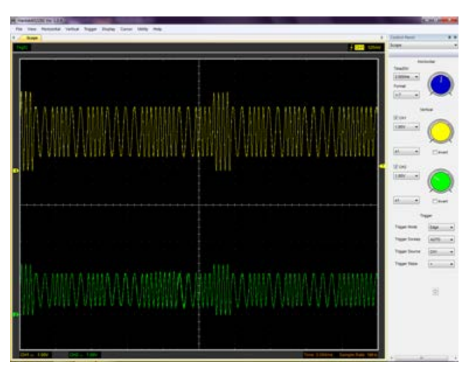
While the developed lab kits cannot be compared with commercial graded equipment in terms of sampling frequency, carrier frequency, and transmission bit rate, the underlying basic principles of digital transmissions are kept the same as those systems with higher performances. Up to now, as many as four different vocational colleges around Thailand have expressed their interest in using our lab kits for actual teaching.

In the future, BU-CROCCS plans to continue developing such lab kits to cover more advanced communication topics such as multi-carrier transmissions, including the widely used orthogonal frequency division multiplexing (OFDM). In addition, the developed digital transmission systems can be used to support other research areas, including visible light communications (VLC).

While the developed lab kits cannot be compared with commercial graded equipment in terms of sampling frequency, carrier frequency, and transmission bit rate, the underlying basic principles of digital transmissions are kept the same as those systems with higher performances.







Signals generated by our own lab kits. The top part of each figure is the transmitted signal, while the bottom is the received signal. The three modulation schemes are Pulse Amplitude Modulation (PAM), Amplitude Shift Keying (ASK), and Frequency Shift Keying (FSK).

Erasmus Mundus "INTACT" Programme Staff Mobility to BU-CROCCS

by Ian Grout

In July 2014, I had the opportunity to undertake a one month staff mobility to Bangkok University supported by the Erasmus Mundus (EM) INTACT programme (INTACT – It's time for collaboration towards close cooperation - http://www.em-intact.eu). The visit was hosted by BU-CROCCS. The research centre within the University of Limerick associated with the INTACT programme is the Optical Fibre Sensors Research Centre (OFSRC - http://www.ofsrc.ul.ie).

EM INTACT is a scholarship programme for students and researchers/professionals at the Bachelor, Masters, Doctoral and Post-Doctoral levels as well as Academic and Administrative Staff members from Asia to the European Union and vice versa. Bangkok University is one of the Asian university partners. EM INTACT, started in October 2013, is a four year programme which supports over 170 scholarships/fellowships. The main areas of interest are the STEM disciplines (Science, Technology, Engineering and Mathematics) though with specific priorities for researchers in Electrical & Electronic Engineering; Information and Communication Technology; Photonics; Biomedical Engineering; Computer Engineering; Energy and Power Systems; Informatics; Telecommunications; Mathematics; Physics; Civil Engineering; Soil and Water Sciences. The twenty INTACT partners come from Europe (seven partners) and Asia (thirteen partners).

Both BU-CROCCS and the OFSRC are actively involved in research activities using fibre optic sensors and embedded electronic systems design. The mobility undertaken here allowed for the development of co-operation in the area of electronic sensor systems design using programmable logic (FPGAs and CPLDs), with a common interest area between the co-operating partners in

With Dr. Karel Sterckx within the research laboratory at BU-CROCCS

1. Embedded system and sensor interfacing design using programmable logic (in particular field programmable gate arrays (FPGAs)

2. Embedded sensor systems design

3. Optical fibre sensors

The visit also allowed for discussions with staff and students within the group to understand the work undertaken and also to exchange ideas and information on how activities are undertaken in both institutions. Specifically, the visit provided the opportunity to:

1. Understand more of how the academic activities are undertaken within Bangkok University

2. Compare how academic activities are performed in both institutions

3. Discuss how collaboration in research and teaching could be supported through EM INTACT

4. Develop ideas for research collaboration

5. Experience the rich culture, life and history of Thailand

BU-CROCCS updates

Center's Highlight

by Waleed Mohammed

Thai Research Fund Grant

Dr. Poompat Saengudomlert, Dr. Natthaphob Nimpitiwan and Dr. Pakorn Ubolkosold were awarded a research grant for the development of educational telecommunication kit for vocational schools training.

Erasmus Mundus Opportunities

Bangkok University is currently involved in two Erasmus Mundus (EM) consortia, namely EM INTACT (www.em-intact.eu) which is coordinated by Frederick University in Cyprus, and EM LEADERS (http://www.emleaders.eu/index.asp) which is coordinated by City University London in the UK.

Through these EM programmes, both undergraduate and postgraduate students from any recognised Higher Education Institute (HEI) within the European Union can apply for a mobility grant to carry out a research-based internship at BU-CROCCS. For more information, please contact Director BU-CROCCS, Dr. Karel L Sterckx (karel.s@bu.ac.th).

Visit of the French Attaché

On July 2nd, Stéphane Roy, Attaché for Scientific and Higher Education Cooperation, visited our facilities at BU-CROCCS.

Visit of the Belgian Ambassador

On August 14th, the Center welcomed H.E. Ambassador of Belgium Marc Michielsen. The team demonstrated the on-going research and educational activities at the center.

Visit of Dr. Sunandan Baruah from Assam Don Bosco University

On November 7th, Dr. Sunandan Baruah, head of the electronics and communications engineering department, Assam Don Bosco University, visited the center and discussed with the center members the current collaboration between the two institutions.

Internship from BKBIET

During the months of August-September the center welcomed seven internship students from the BK Birla Institute of Engineering and Technology (BKBIET), India, to perform their undergraduate training under the supervision of the center members.

Internship from ADBU

During the months of August-November the center welcomed four internship master students from Assam Don Bosco University (ASDBU), India, to perform their graduate work under the supervision of the center members.

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http://eng.bu.ac.th/bucroccs