RESEARCH REPORT

1. Name: **Muhammad Arsalan** (ID No.: **SP04401**)

2. Current affiliation:
Department of Electronics, Carleton University, Ottawa, Canada.

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ■ **Engineering Sciences** ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution:

Department of Physical Electronics,
Tokyo Institute of Technology,
2-12-1-S3-25 Ookayama, Meguro-ku,
Tokyo 152-8552, Japan

5. Host researcher:

Dr. Nobuo Fujii
Email: fuj@ec.ss.titech.ac.jp

6. Description of your current research:

My main field of research is in the area of asynchronous adiabatic logic circuits. An adiabatic circuit achieves its power savings by operating dynamically with exchanging ideally no energy with its surrounding. The adiabatic asynchronous circuits that have so far designed are special primitive cells communicating through well-defined handshaking protocols. The research involves the design of basic logic gates, and a modular application, like a 16 bit Full adder, in this logic style. Through my research work I plan to test and prove the strengths of adiabatic asynchronous logic for future extremely low power applications. I believe that my research will be invaluable as asynchronous adiabatic circuits have tremendous potential in many diverse applications including, but not limited to, implantable biomedical devices, deep space probes, mobile computing devices and others.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of the research plan:

Exploring the opportunities to pursue my research in the field of low power electronics and its applications in the fields such as biomedical engineering and space research. To work towards a full functional multidisciplinary application,

gathering the knowledge of the useful tools and research going on in the relevant fields.

Description of the research activities:

Development of a practical and useful electronic design requires ample amount of time and resources. Due to the time constraint, to start a new project and get some presentable and useful results in less than two months was not very pragmatic. To get most out of the available time and resources my supervisor has advised me to participate in the ongoing research work at Fujii-Takagi laboratory and have some visits to observe the research direction, facilities, and resources available at Japanese high-tech microelectronics research laboratories. A brief description of the activities during my stay at Fujii-Takagi lab is as follows.

a) Seminars at Fujii-Takagi lab

There were two seminars per week held at Fujii-Takagi lab to present the current state of research and discuss any potential problems and solutions. Everyone has to present his work on a pre-decided date. Not only I attended all the seminars regularly, I also presented my own research activities in a seminar. Abstract of some of the seminar presentation I attended is given as follows,

1) In mixed signal (digital + analog) designs, noise generated in digital parts adversely effect the performance of analog part of the design. *Nicodimus Retdian* is conducting research on the reduction of digital substrate noise using the active cancellation technique. The proposed system is designed to be fully implemented on-chip using a DC bias technique.

2) *Miku Ueki* is studying about Operational Trans-conductance Amplifiers (OTA). The purpose of her study is to improve linearity of OTA with low supply voltage. She is using MOSFETs in both saturation region and sub-threshold region. Drain current characteristics of MOSFET is approximated by third-order Chebyshev polynomial independently of its working region. She is trying to cancel the third-order term of the polynomial by using another MOSFET.

3) *Sirichai Bannasarn's* research topic is the design of fast-locking PLL-based frequency synthesizer using first-order loop technique. Conventionally, for a good phase noise performance and a fast-locking process, two second-order loops, one with narrow loop bandwidth and the other with wide loop bandwidth, are applied as a dual-loop structure. As it is known that first-order system has a faster response than the second-order one; therefore, he is trying to replace one of the second-order loop with wide loop bandwidth by the first-order loop in order to achieve a faster locking process. The possibility of the dual-loop structure with 1st-order and 2nd-order loops is proved by equations and simulations and the making of the 1st-order loop is currently under investigation.

b) External Laboratory Visits

In addition to these seminars, Dr. Fujii has specially arranged a number of visits to the laboratories of world's leading microelectronics research and manufacturing organizations. Through these visits, I get the chance to observe the working of many research, development, and fabrication facilities and obtained invaluable experience in many relevant fields. A brief description of my visits, along with other group members, to those facilities is as follows.

Renesas® Technologies, Takasaki.

Renesas® is a merger of Hitachi® and Mitsubishi® semiconductor divisions. It was the world's 3rd largest semiconductor manufacturer in the year 2003 after Intel® and Samsung®. We attended several presentations on the organizational structure, current products, market share, and new product design and development at Renesas®. We also get the chance to observe the design, production and testing facilities at Renesas® Technologies, Takasaki.

Sony® Atsugi Technology Centre

At Sony Atsugi Technology Centre we attended the presentations about the production facilities at Atsugi Technology Centre. Most exciting part of that visit was the visit of the clean room production facility and to observe the in-production CCD sensors for Sony's optical products such as Camcorders and Digital Cameras. We were also privileged to operate state-of-the-art electron microscopes to observe silicon wafers at different stage of productions.

Sony® Showroom at Shinagawa

Engineering research not leading to the useful applications and products is not very captivating. We get a chance to observe Sony's future and latest high-tech products in the consumer and commercial market. This showroom facility is not for the general public and requires special invitation. There were a number of exciting products on display such as *QRIO®* robot, portable audio, handheld computers and grating light valve (*GLV®*) projectors, among the others.

Quantum Nanoelectronics Research Center (QNERC)

The Quantum Nanoelectronics Research Center (QNERC) was established by Tokyo Institute of Technology in April 2004 and the inauguration ceremony was held on 17th June, 2004.QNERC conducts research to support the goals of Japan's national strategic 'nanotechnology project' as well as functioning to support Tokyo Institute of Technology staff involved in academic, industrial and international collaborative research. I get a chance to observe the facilities and ongoing research through Oda - Mizuta lab. Single electron transistors and single electron memory devices are promising for ultimately low power electronics, which are essential for the

application of future ultra-large-scale integrated circuits and portable computers. Researchers at QNERC have developed a unique method for the fabrication of nano-crystalline silicon (nc-Si) particles with diameter less than 10nm using very-high-frequency plasma-enhanced decomposition of silane. They are also involved in building the new generation of tiny devices called Nano Electromechanical Structures (NEMS).

RESEARCH REPORT

1. Name: Joy Jie Cheng （ID No.: SP04402 ）

2. Current affiliation:

University of Waterloo
Waterloo, Ontario, Canada

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

☐ Chemistry ☒ Engineering Sciences ☐ Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution:

Osaka University

5. Host researcher:

Prof. Takahashi Yasuhiro

6. Description of your current research

A better understanding of molecule structure of polymer can lead to better application and production of the material. For studying of polymer structure the primarily used methods are X-ray diffraction and neutron diffraction. Both are scattering method. Neutron scattering offers better resolution because it has minimum interaction with the electron cloud of the atom.

Poly-p-phenylene sulphide is a semi-crystalline polymer with good thermal stability and tensile property. In our project we are trying to calculate the structure factor of the poly-p-phenylene sulphide crystal. The analysis method is an iterative one. Scattered intensity calculated on basis of estimated structure factor is compared to observed scattered intensity. On the basis of the difference between the calculated and the observed value, calculations are made. This process continues until the difference between observed and calculated values is within acceptable range.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Analysis of Crystal Structure of Poly-p-Phenylene Sulphide Using Neutron Scattering Techniques

Description of the research activities:

My research project is conducted in Osaka University under the supervision of Prof. Takahashi Yasuhiro. Prof. Takahashi is an expert in the area of neutron diffraction study of structure of polymer. In our project, the neutron scattering data of poly-p-phenylene sulphide has already been obtained prior to my arrival in the university. Another group has already done calculation about the structures of poly-p-phenylene sulphide based on one type of crystal confirmation. Thus far we are working on unit cell constants (a, b, c) and the reciprocal values (a*, b*, c*) from the raw data. The work is on going.

In addition to Osaka University, I had the opportunity to visit several other laboratories in other universities and the Sumitomo Corporation. I had very interesting discussions with the researchers there. I have gained fresh insights that offer new directions in my own research project. I was honored to be asked to give a presentation on my own research at the Hashimoto laboratory in Kyoto University. The followed discussion was most interesting.

8. Please add your comments (if any):

My experience in Japan gave me an insight into both the academic structure and the type of work being carried out here. There are many interesting areas of polymer research in Japan. For example, the living free radical polymerization study in Prof. Fukuda's laboratory in Kyoto university. I think Japan offers many exciting possibilities in the area of polymer research. In my stay, I have formed friendships with Japanese researcher I hope will continue after I leave here.

I would like to express my gratitude for JSPS and the Canadian Embassy for given me this opportunity to be here. In addition, I would like to thank Prof. Takahashi for hosting me for the last two month. I have learned many things here.

9. (If any) Advisor's remarks:

Ms. Cheng visits many laboratories, met many researchers, and discusses with many people in Japan. This experience should give many advantages in her research and her future

RESEARCH REPORT

1. Name: Maxime Descoteaux (ID No.: SP04403)

2. Current affiliation:

Centre for Intelligent Machines &
School Of Computer Science
McGill University

3. Research fields and specialties

Computer Science, Mathematics & Engineering Sciences

4. Host Institution:

National Institute of Advanced Industrial Sciences & Technology (AIST)

5. Host Researcher:

Chinzei Kiyoyuki

Description of current research

I am currently in between Master's and PhD graduate studies. My current research is the development of computer vision algorithms for medical image analysis problems. I focus on differential operators to extract shape information from medical image data sets. Before this summer, my main focus was on tubular structures. In particular, I designed an automatic method for blood vessel segmentation on Magnetic Resonance Images (MRI).

Title of your JSPS research plan

Shape Operators for Bone Detection

Description of the JSPS research activities

My host researcher and his students are working on a surgical simulator for pituitary gland operation. Their goal is to produce a virtual reality environment on which students can experiment and practice before operating

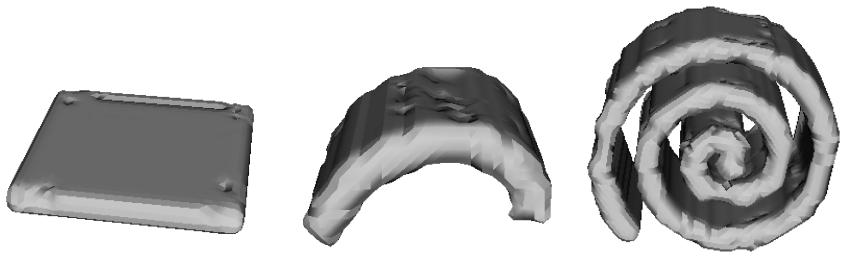


plate rib spiral

Figure 1: Segmentation of synthetic plate, rib and spiral example.

on human patients. Typically, in pituitary gland interventions, the neurosurgeon makes his way to the pituitary gland through the nose. In doing so, he must brake several paranasal sinus bones, cut soft tissues and avoid puncturing blood vessels and veins nearby. Hence, the surgical simulator must have a precise 3-dimensional representation of soft tissues, bones and vessels in order to simulate the intervention.

The goal of my JSPS summer program with the AIST Surgical Assist Technology group was to use my Master's work for blood vessel segmentation and extend it for bone segmentation from CT data sets. This involved defining a new shape operator able to capture plate-like structures and the modificaiton od the flow to reconstruct bones. This was done in the first few weeks of the program. We tested our new segmentation algorithm on simple synthetic objects before applying it to real data. See Figure 1 for illustration on a plate, rib and sheet-like spiral examples. We show a surface rendering of the final segmentation output of our method.

Then, we segmented bones from real CT data in the paranasal sinus area. Figure 2 demonstrates the original data and the corresponding segmentation. In itself, the definition of a *sheetness* measure based on the underlying shape present in the data is an important contribution to the field.

The other major contribution of my work this summer was to perform a careful comparison with other existing techniques. There are two other methods for bone segmentation in the literature. The first is the naive approach of thresholding the input data and the other is a method based on the local orientation detection of the variation of intensity. The latter is essentially a "smarter" thresholding method based on a structure tensor. Hence, I had to read a few articles and implement this algorithm to perform some qualitative comparison against our segmentation. We managed to clearly show that our segmentation is more robust for low contrast and thin bone structures. We also demonstrated theoretically the strengths and weaknesses of both the structure tensor operator and our shape operator based on the Hessian matrix.

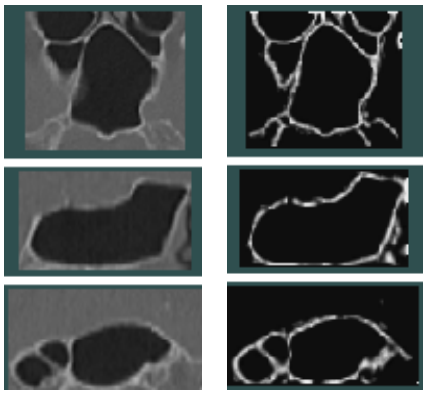


Figure 2: Segmentation of the paranasal sinuses

We believe we have the necessary to write a high-quality paper for the next Medical Image Computing and Computer-Assisted Intervention conference. Moreover, I will surely continue to collaborate with the group to incorporate this bone detection and vessel extraction in the tissue classifier for the surgical simulator.

My comments

This JSPS summer program was a great experience for me. It was a perfect combination of research, International collaboration and Japanese culture discovery. I believe coming here with clear and realistic objectives at a time in between my Master's and PhD studies greatly helped. I would like to thank the JSPS and SOKENDAI staff for organizing such a well-run program and acknowledge the AIST Surgical Assist Technology group for all their help and support.

Advisor's remarks

Mr. Descoteaux was very successful during (only) the seven weeks stay at AIST Tsukuba. Max already obtained significant and publishable results in the short period. We agreed to continue this work more at least for a publication. Dr. Michel Audette, leader of Surgical Simulator Project in the Surgical Assist Technology Group, think of implement Max's algorithm into his simulator. Max was also helpful to work together with our French student Alex Thinnes. To conclude, I believe the fellowship was quite effective, because we could establish these tangible and future-expandable outcomes. I would thank to JSPS for giving the opportunity.

RESEARCH REPORT

1. Name: Jason Etele (龍 杰 生) (ID No.: SP04404)

2. Current affiliation: Carleton University

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry x Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

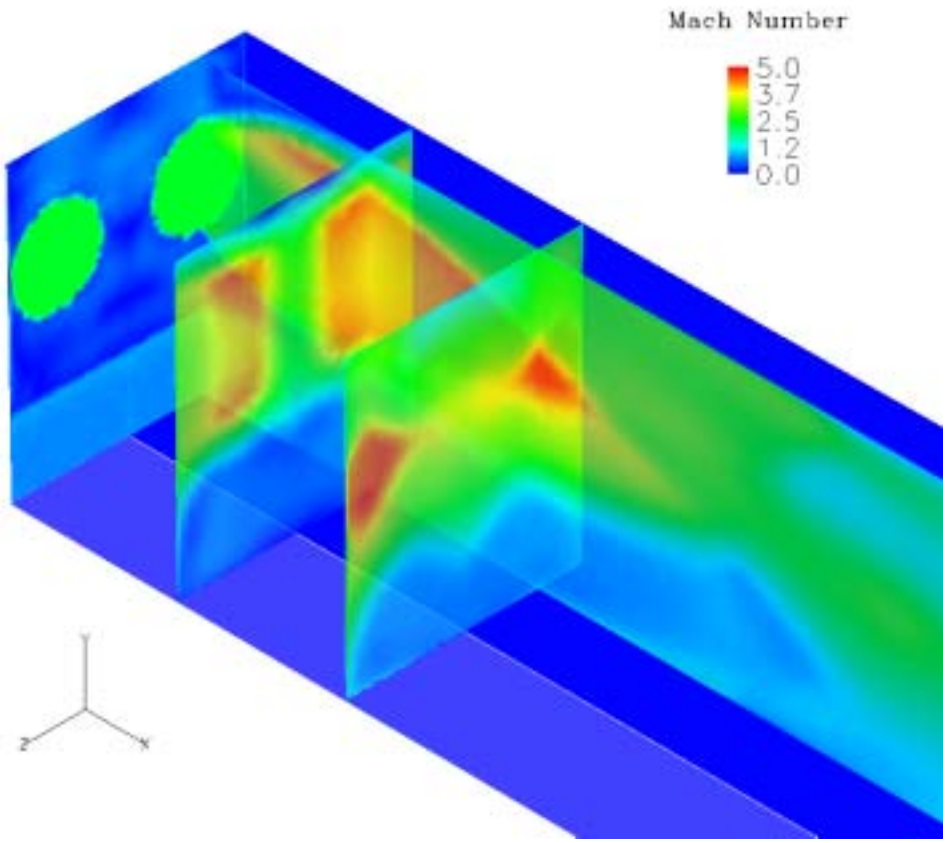
4. Host institution: Kakuda Space Propulsion Laboratory (JAXA)

5. Host researcher: Takeshi Kanda

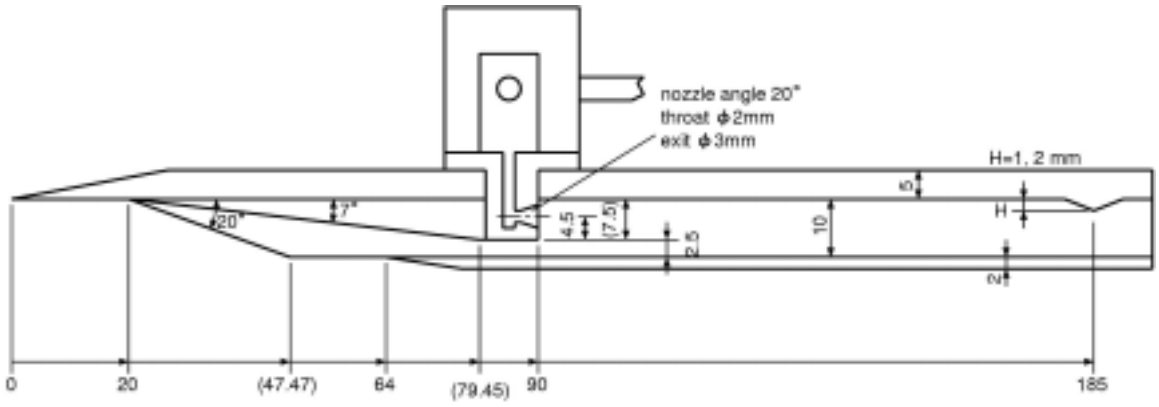
6. Description of your current research

In 1997 NASA released their Highly Reusable Space Transportation Study which stated that they would like to see the cost of launching 9,000-18,000 kg of payload into Low Earth Orbit (. 270 km) be reduced from the then price of approximately $22,000/kg to under $450/kg by 2025. One of the main candidates for achieving this aggressive goal was identified as air-breathing rocket technologies, collectively known under the acronym RBCC (Rocket Based Combined Cycle) engines. In addition to North American research, the Japan Aerospace Exploration Agency (JAXA) is currently involved in RBCC research with their own RBCC engine, based on previous experience with their E1 and E2 scramjet engine designs.

JAXA's main combined cycle engine research group, located at the Kakuda Space Propulsion Laboratory, has focused most of its efforts at the experimental validation of their model. However, recently interest has grown into using computational techniques to investigate various design options. The study undertaken under this program represents the initiation of a program to use Computational Fluid Dynamics (CFD) to study the mixed subsonic/supersonic flowfield within the RBCC engine. Given the lack of a previously established computational research program in this area, much of the time was spent defining the problem and determining the most efficient means of obtaining relevant data. After selecting an appropriate solution algorithm (also developed at the Kakuda center but used primarily for very high speed flows) a suitable domain of study was chosen.



This figure shows the initial stages of the flow development by means of the Mach number (the ratio of the flow velocity to the speed of sound) within the ejector section of the engine. Two high speed rockets (green circles at the leftmost y-z plane) exhaust into the duct above a rectangular area through which atmospheric air enters (this area is light blue, located below the green rocket circles). The initial y-z plane corresponds to the 90 mm position in the figure below, where the region between 90 and 185 mm represents the ejector section of the RBCC engine.



Using data similar to this from the CFD calculations, validation of the numerical results can be done through comparison with experimental data previously obtained on this model. With the CFD algorithm suitably validated, the research plan is to use CFD techniques to investigate the properties of the flowfield using various geometries at the point where the rocket exhaust is injected into the engine. By varying parameters such as the angle at which the air enters the ejector section (x = 90 mm), it may be possible to improve the overall performance of the engine. The research done under this program is the first step towards establishing this research objective.

RESEARCH REPORT

1. Name: **Irfan Kadri** (ID No.: **SP04405**)

2. Current affiliation:

Department of Electronics, Carleton University, Ottawa, Canada.

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ **Engineering Sciences** ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution:

National Institute of Information and Communications Technology
Yokosuka Radio Communications Research Center – Ultra Wide Band Group
3-4, Hikarino-oka, Yokosuka-shi, Kanagawa
239-0847, Japan

5. Host researcher:

Dr. Ryuji Kohno
Email: kohno@nict.go.jp

6. Description of your current research:

My area of interest is in the exciting up and coming field of Ultra Wide Band (UWB) communications and radar systems. The main focus of my research is on integrated ultra wide band antennas.

There is ever increasing interest in UWB transceivers, especially in the field of wireless communications, as they represent a potential solution to the growing problem of spectrum scarcity. UWB systems are novel in that they propose to allow new services to be offered on spectrum already allocated without significantly interfering with the incumbent users. By overlaying a UWB system on existing wireless bandwidth it will be possible to wrest additional capacity from a already heavily utilized portion of spectrum. UWB technology could also be used for radar systems due to their superiority over conventional radar systems. UWB radars have excellent distance resolution and low propagation losses and can be co-located for use as a multiple radar complex. They especially show promise in the field of automotive radar for collision avoidance and parking assistance, ground penetrating radar for mine

detection, imaging systems for military, security or rescue applications and finally for non-invasive medical applications.

As potential research I am investigating not only the design of UWB antennas but also exploring on chip integration of the antennas, through the utilization of fabrication technologies such as Low Temperature Co-Fired Ceramics (LTCC) or even direct integration onto silicon. This should lead to a low power, low cost solution for a UWB transceiver, making it commercially attractive.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of the research plan:

Distortion of Ultra Wide Band pulses in transmission lines

Description of research activities:

The most interesting aspect of impulse radio-UWB is that it converts a received RF signal directly into a baseband signal. This greatly simplifies the transceiver architecture in that all the necessary components can be located on a single chip. However a major stumbling block that remains in this approach is not only the design of a wideband antenna but as well the integration of a UWB antenna with the rest of the transceiver. While there exist methods of designing wide band antennas, none of these antennas are suitable for circuit integration.

My research at the NICT was devoted to studying transmission line structures with the future intent of being able to better design UWB antenna structures. Antenna's such as printed dipoles can be considered in their simplest form as transmission lines. The physics of a transmission line can be described through the wave equation. My research at NICT involved the modeling of the basic wave equation in MATLAB while using different UWB pulse shapes as stimulus to the system. The basic model for the transmission line was further enhanced by incorporating additional second order effects such as nonlinearities. The addition of nonlinear elements to the model was especially useful since it allows one to observe how a transmission line disperses or smears the shape of the UWB pulse.

The end goal of the research at NICT was to characterize the dispersion and then possibly design a pre-distorted version of the pulse. Such a pulse when applied to the

transmission line would then undergo a transformation due to the effect of the transmission line. At the output the pulse would then be recovered in the form that was desired in the first place. Although this end goal was not achieved the nonlinear model that was developed is a good starting step into gaining a deeper insight into the problem of pulse distortion.

The research at NICT tied in very well with my intended goal of designing future UWB antenna's. By stepping back and analyzing the problem at a more basic level, better understanding of the fundamental physics of the problem could be seen.

External Laboratory Visits

In addition to the research work carried out at NICT Yokosuka, I had an opportunity to visit the headquarters of NICT at Koganae. Here I had a chance to tour the microwave devices fabrication facility and the super conductive electronics group. I had a chance to see working UWB chipsets and antenna's. This was quite exciting as the technology is still very much in infancy and not yet available for commercial development.

8. Please add your comments (if any):

Working with the NICT-UWB group was a very rewarding opportunity. I got a chance to meet the world's leading researchers in the field. From the positive feed back I have had from the NICT-UWB group, some form of collaboration may be setup in the future in order to jointly continue work on UWB antennas, which would further enrich my Ph.D work.

9. (If any) Advisor's remarks:

My hosted researcher Mr. Irfan Kadri achieved an excellent research on a timely and very important subject on which my supervising UWB group has focused in order to make a UWB technology more feasible satisfying a radio regulation. Although a transmitted UWB impulse radio signal should have so an appropriate pulse shape as to satisfy regulated spectral mask, a transmission antenna is used to distort a pulse shape. Therefore, we need a design scheme of a UWB antenna which can transmit an appropriate pulse shape with a good ultra wideband characteristics. Mr. Irfan Kadri could derive a theoretical scheme of such a performance antenna based on a traditional transmission line theory. I hope we will start collaborating with him and his institute for further progress. Finally, I appreciate JSPS on giving us this opportunity of our fruitful collaboration.

RESEARCH REPORT

1. Name: Sumit Kundu （ID No.: SP04406）

2. Current Affiliation: University of Waterloo

3. Research Fields and Specialties: Chemical Engineering

4. Host Institution: Yamaguchi University, Ube campus

5. Host Researcher: Dr. Masayuki Morita

6. Description of your current research project:

My current research project examines the durability and reliability of fuel cell materials including how the processing of the different materials impacts the final property of the material. As part of this work I am interested in the mechanical strength and durability of proton conductors such as Nafion and other electrolytes.

7. Research implementation and results under the program (as much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of Research Plan: Mechanical Stability and Conductivity of PEO-PMA Gel Electrolytes.

Description of research activities:

I evaluated the impact of silicon dioxide on the mechanical strength and conductive properties of gel electrolyte membranes used in lithium ion batteries and capacitors. The work consisted of mixing the monomer components with phosphoric acid and silicon dioxide (SiO_2) in a glove box under an argon atmosphere and then mixing. The mixture was then poured into an aluminum pan and cured using ultra-violet light. This turned the liquid mixture into a gel that could be easily manipulated. A sample of the material was cut out and its conductivity was tested. Different amounts of SiO_2 were added to the mixture to determine the effect on the conductivity and mechanical properties. Samples could then be taken to the University of Waterloo and the mechanical properties tested there. The percentage of added SiO_2 was to be varied from 0 to 25 percent.

Part of my time was also spent learning about the work of other students. In particular I helped one such student with experiements involving a new method of catalyst preparation for use in direct methanol membrane fuel cells. I also spent

time in a fuel cell lab on the Ube campus learning about different testing techniques and fuel cell material preparation techniques.

8. Please add your comment (if any):

I also spent the last week of the program visiting different laboratories, institutes, and companies involved in my broad field of research (hydrogen and fuel cells). With the help of Noriko Abe at the Canadian Embassy (who set up the meetings) I was able to meet with professors and students at Yokohama National University, NIMS, and Tokyo Institute of Technology as well as researchers at JARI and the leader for hydrogen business R&D at Tokyo Gas. Finally I was able to visit three hydrogen retail stations in the Kanto area. These meetings allowed me to make contacts with professionals in my field as well as learn more about current research.

RESEARCH REPORT

1. Name: **Dion Leung** (ID No.: **SP04407**)

2. Current affiliation: **University of Alberta, Edmonton, Alberta, CANADA**

3. Research fields and specialties: **Electrical Engineering (in Telecommunications)**

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry **Engineering Sciences** ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: **Osaka University (Graduate School of Information Science and Technology)**

5. Host researcher: **Professor Masayuki Murata**

6. Description of your current research

The objective of my current doctoral research topic, "Capacity Planning and Operational Strategies for Mesh Survivable Networks under Demand Uncertainty," is to design cost-effective transport networks that can survive physical failures and adapt to unpredictable demands. During my research work at the University of Alberta and TRLabs, Canada, I have been trained to use optimization techniques for formulating problems to address fundamental questions about capacity planning and to investigate effective strategies for operating future networks. In the past four years, under the supervision of Professor Wayne Grover, our solutions to these problems have led to several journal and conference publications and a patent filed in Canada.

One of the recent highlights of my work has been a proposal for a capital investment strategy for dimensioning survivable transport networks where traffic uncertainty is present. While virtually all existing strategies for designing survivable networks are completely based on a specific demand forecast and are optimized for a single moment in time, our idea is to consider capacity-planning as a two-stage decision process, where corrective action or 'recourse' is incorporated into a current plan to adapt to real demand situations. To facilities-based network operators, recourse might refer to lighting up new fiber in multi-conduit networks, or leasing additional capacity from third party network operators. An optimization model is formulated to create the capacity plan, where the total cost of current outlays and expected future costs to adapt to demand uncertainty is minimized. A case study on a pan-European network using this approach shows that significant long-term cost savings over traditional capacity planning methods can be achieved. The two-stage capacity planning method also provides new strategic insight into how to obtain the best trade-off between present and future capacity investments, as well as when to exploit the benefits derived from modularity and economies-of-scale of network capacities.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Re-optimization Strategies for Improving Capacity Utilization of Survivable Mesh-based Transport Networks

Description of the research activities:

The constantly changing of demand services, manual-intensive demand provisioning process, and ad-hoc capacity link upgrades have all contributed to a large amount of uncoordinated or "stranded" capacity in today's backbone carrier networks. Such stranded capacity is undesirable to network carriers since new services cannot be effectively provisioned and additional revenue cannot be generated unless the capacity is properly managed. Global network re-optimization provides a means to re-arrange existing services so that more new bandwidth services can be accommodated. In this project, our goals are: (1) to develop a re-optimization model so that we can quantify the benefit or performance gained from this process; (2) to determine how existing services should be re-arranged for improving the overall capacity utilization. Additionally, since a single fiber cable failure can bring down a large number of high-bandwidth service paths, network survivability (e.g. service recovery from a cable cut) is also an essential part of this study. Another goal of this project is (3) to consider and integrate network survivability in the re-optimization model.

This collaborative project mainly consists of two phases. In phase one, I have formulated an integer linear program using AMPL (Modeling Language for Mathematical Programming) to characterize the re-optimization problem. Given a network with some pre-connected services, the objective of the formulation is to re-arrange the existing service paths such that the total number of potential demand flows over the network is maximized. In phase two, my host research associate, Dr. Shin'ichi Arakawa, has written a program to evaluate the capacity performance and hence the benefit of re-optimization can be quantified.

From an initial study based on a small size network, we found that the use of re-optimization has slightly improved the capacity utilization over the non-optimized approach. These preliminary results hence motivate us to investigate further and to fully test the model against networks of larger size and under different traffic scenarios.

At the point of writing this report, we are in the process of preparing a manuscript to be submitted to the Optical Fiber Communication Conference / the National Fiber Optic Engineers Conference (OFC/NFOEC 2005), which will be held in March next year in Anaheim, California, USA. Final results from this study will also become a part of my doctoral thesis, which is expected to be completed at the end of 2004.

Besides the research activities conducted at Osaka University, presenting my work at the 9th OptoElectronics and Communications Conference / 3rd International Conference on Optical Internet (COIN/OECC 2004) at Pacifico Yokohama, Yokohama, Kanagawa during the 2nd week of the program was also a great experience for me to meet other professionals in Japan, both in academic and

from the industry, and to share technical ideas.

8. Please add your comments (if any):

I would like to take this opportunity to thank JSPS and NSERC for giving me such a valuable opportunity to spend my summer in Japan, to experience research life at Osaka University, and to interact with other knowledgeable people in the same field but with different research and culture backgrounds. I would also like to thank Professor Masayuki Murata and Dr. Shin'ichi Arakawa for their valuable inputs on my summer project, as well as for the fruitful discussions during the group meetings. Although the two-month term in Japan seems to be a short period of time, every moment I spent here is unforgettable and I treasure the true and honest friendship with my colleagues. Besides plenty of nice sceneries and various interesting local activities, I believe it is the people that make Japan an enjoyable and unique place to live and for conducting research.

RESEARCH REPORT

1. Name:Cheryl Nelms (ID No.: SP04409)

2. Current affiliation: M.A.Sc. Candidate, University of British Columbia, Department of Civil Engineering

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences
☐ Chemistry ☐ X Engineering Sciences ☐ Biological Sciences
☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences
☐ Interdisciplinary and Frontier Sciences

4. Host institution: The University of Kitakyushu, Hibikino 1-1, Wakamatsu, Kitakyushu, Fukuoka

5. Host researcher: Akihito Ozaki, Assoc. Professor, Ph.D

6. Description of your current research:

The construction, operation and the maintenance of buildings have a significant impact on the environment. Natural Resources Canada estimates the building industry consumes more than 50% of primary resources, is currently responsible for 35-40% of total national energy consumption and generates 25% of Canada's solid waste. One method the building industry can contribute to the environmental goals of the Government of Canada is through the application of sustainable development principles in the design, construction and operation of buildings. In particular, the replacement of traditional technologies with technologies with a reduced ecological, health and environmental life cycle impact: sustainable technologies such as green roofs, high volume fly ash concrete, photovoltaic or grey water recycling systems.

At present, the performance of sustainable technologies in buildings is generally not assessed holistically, but rather from a primarily single-issue perspective (e.g. only financial or only environmental). Such an approach is limited in that it ignores the interaction of the technologies within the physical facility itself as expressed through life cycle costs, the impact on the surrounding environment, and the interaction in context with the project and the spectrum of stakeholders (e.g. developer, owner or public) whose value systems may conflict. The focus of this research is to identify the primary cause and effect relationships of selected sustainable building technologies, and to develop a framework for the systematic assessment of sustainable technologies. Application of the framework is intended to contribute to improved decision making and the rationale selection of sustainable technologies and techniques, by addressing project performance

from environmental, social, economic and technical perspectives. Its use is illustrated by way of the assessment of green roof technology using industry case studies to validate the framework developed. A green roof can be defined as a contained green space on the roof of a structure. This technology has been selected because it demonstrates the multiple dimensions of a technology and the potential impacts on other building systems.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: The effects of the change in roof top garden design parameters on energy consumption of a commercial building.

Description of the research activities:

The primary objective of my research in Canada has been to develop a framework to assess sustainable technologies using a holistic approach (technical, environmental, social and financial performance criteria). Green roof technology has been used to validate the framework developed in industry case study projects. As one element of this research it was of interest to investigate the technical performance of green roof technology with respect to energy conservation. There are many proposed environmental benefits of green roof technology including energy conservation, improved roof membrane life cycle performance, stormwater management and aesthetics among others. However, research (primarily in Asia and Europe) on the contribution of green roofs to energy conservation to date has been performed with respect to particular climatic conditions and the results are not applicable on a global basis. Therefore, when policies are created or incentives are offered to implement this sustainable technology it is not understood how to develop optimal design criteria (soil depth, soil or plant type etc) specific to building climatic conditions to meet environmental performance targets such as energy conservation.

The research I performed in Japan included developing an understanding of heat and moisture transfer theory, the use of a building simulation program, THERB, and the application of this program to determine the contribution of a green roof to building energy conservation with varying soil depths, moisture content and climatic conditions. THERB is dynamic energy simulation software developed in Japan, which can estimate heat and moisture transfer in buildings and wall assemblies using a more detailed approach than other available simulation software. Unique to this program is the approach to account for moisture transfer in building wall assemblies and which is of particular importance in the understanding of the performance of green roof technology. Initial results indicate that in the Vancouver,

Canada climatic conditions an increase in soil depth results in the potential for energy conservation but the amount is very small and is particularly dependant on the moisture content of the soil.

A secondary goal of my research has been to review how innovative technologies are evaluated in Japan and their inherent risks managed in the project and amongst project stakeholders. The Japanese environmental building assessment method, CASBEE, was studied and compared with LEED™ the North American approach to environmental building assessment. This aspect of my research was been performed through document reviews, site visits and meetings with industry professionals to elicit their approach in technology evaluation.

8. Please add your comments (if any): In addition to carrying out the above research at the host institution I was given the opportunity to make a number of site visits and meetings with public and private sector organizations. I met with the following Japanese professionals:

- General Manager, Environmental Engineering Group, Nikken Sekkei Ltd. and visited a highly innovative Japanese office building at Shonan Village;
- Marketing manager of Mori Building company to discuss client and company interest in the implementation of innovative technology and tour of the Roppongi development including the green roof landscaping;
- Deputy Director Architecture and Building Engineering Division, Ministry of Land Infrastructure & Transport Manager for presentations on the procurement of innovative technology, risk allocation and a new financing approach (private finance initiative) planned for a government building development in Tokyo;
- Director of Research at Shimizu Corporation to discuss risk management in projects, innovative technology including the SMART system (robotized construction approach to highrise buildings) & site visit to construction of Tokyo horse racing facility;
- Site visit to the construction of a mixed use highrise building in Kokura;
- Site visit to view the construction of a traditional Japanese house and discuss difference of methods applied in comparison to the Canadian residential housing construction approach.