NSERC Summer 2016
Digital Camera Sensors & Micro-optic Fabrication

With Prof. Glenn Chapman (ENSC)
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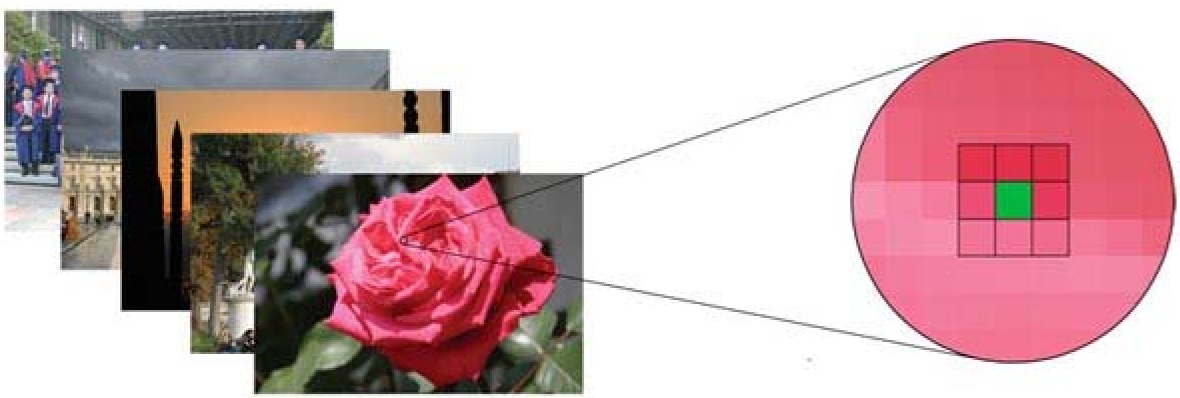
Interested in digital camera research, biomedical imaging through tissue using optics, or getting a hands introduction to how micro-chips and micro-optical sensors are made? Then get some real lab experience from NSERC summer positions which are available in three areas.. Depending on the students' there may be more than one student per project. Students selected for these projects will receive a NSERC funding of $5625. The descriptions are below or download this page for a description of all 4 projects.

NSERC Summer Project 1
Helping Improve Digital Camera Sensors

With Prof. Glenn Chapman (ENSC)



Are you interested in digital photography or optical sensors? We are exploring ways of ways of improving the digital sensors used in these systems, called CMOS Sensors or Active Pixel Sensors. There three areas we are working on: the identification of defects as cameras age, the creating new ways to recover the missing pixel information, and the testing of new sensor designs.. As the sizes digital camera sensors become larger both in pixel count and area, the possibility of pixel defects increases during manufacturing, and over the lifetime of the sensor. People do not want to throw away expensive cameras just because they have dead pixels in it, but find such dead spots annoying in pictures. We are exploring ways of correcting this using fault tolerant pixels and pixel defect identification using from the pictures camera users take. In addition we have developed several new pixel designs that offer new characteristics e.g. higher sensitivity or larger dynamic range. Student can help us test, analyze and simulate the response of this design. Previous students have also been part of published conference papers on these results and part of it has resulted in a patent application. Want to learn more about defects in cameras – for a more complete introduction go to
http://deneb.ensc.sfu.ca/papers/EI11_defects.pdf

Depending on the student's background this project would range from:
(1) Experimental testing of digital cameras to identify and evaluate defects. This can include hardware development for the testing, and software development to run the tests (controlling the cameras).
(2) Developing software programs to analyze the image data to locate the defects, and extract their parameters.
(3) Developing algorithms and software for recovering the true image hidden by the defect.

(4) Experimental testing of already fabricated chips with new Active Pixel Sensor designs. This includes both optical, and electronic measurements
(5) The design of new pixel cells (if they have a taken ENSC 450 VLSI design)

Previous summer students have also been part of published conference papers on these results (including one that is part of a patent application), and the project can be expanded into a BASc thesis. 40% of the students working on NSERC summer projects in this group have gone on to win NSERC graduate scholarships, in part aided by their research.

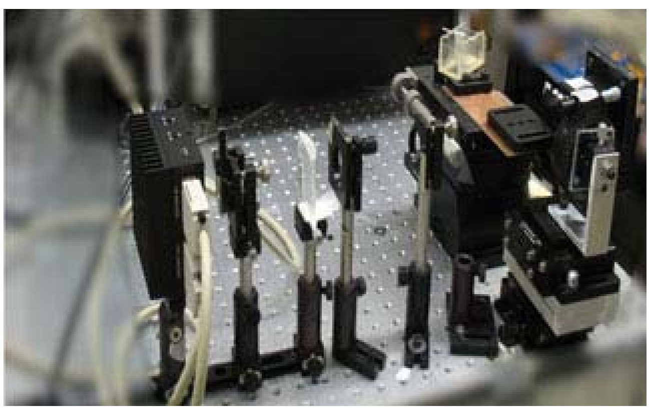
Skills Needed:

Student should be in third year or above. Some combination of the following skills are needed, but not all are required (i.e. if you have all but 470 that is fine). The skill set will determine the type of project. If you at taking these courses below in fall 2013 or spring 2014 that is fine.

(1) A background in digital photography is very helpful, and a general liking of experimental work.
(2) Experience with adobe photoshop, or digital raw files valuable
(3) Good computer skills, Spreadsheets & Matlab and/or C programming very helpful.
(4) Taken an Optics courses: Optical and Laser Engineering Applications (ENSC 470), or an advanced optics from physics (for students making and designing more complicated optical systems.)
(5) Eng. Physics or Electronics background (for the micro-optics).
(6) ENSC 450 VLSI design important for the device design/simulation project area.

NSERC Summer Project 2
Using a Micromachined Optical device designed to see through Tissue

With Prof. Glenn Chapman (ENSC)



Are you interested in biomedical, micromachining, or optics/lasers and looking for a NSERC summer project that will give you practical experience in research? Then consider a project with which combines a micromachined device with an optical system and a CMOS camera to build a system that can see through tissue (eg. skin). Light can penetrate quite deeply into tissue but much of it becomes heavily scattered. To illustrate this effect place a flash light behind your hands in the dark and see the resulting red glow which penetrates, but the very poor definition of the bones within the hand. The key to successful optical imaging is the separation of the slightly scattered light, which carries information about the structure of the tissue through which it passes, from the scattered component that is billions of times greater. We have built some micromachined optical devices that are already seeing though the equivalent of 10 mm of tissue. Where would this be used? Since light does not damage tissue like X-rays do it can be used to replace X-ray screening in such areas as mammograms, brain scans etc. Our target is to test the micromachined/optical systems we have built on simulated tissue and see if we can reach the needed sensitivity for such applications (do not worry – we do not use real tissue). As part of this we are building stable scattering phantoms (test structures that act like tissue but are more stable) in our clean room that allows us to characterize our imaging systems. Previous summer students have helped measure the test structures in scattering media and analysis of the results. These students were part of published conference papers. This summer project will extend this to observation of more complex investigation of imaging through scattering materials at different wavelengths and object structures, plus help build improved experimental setups. As part of this you will learn how to do complex statistical curve fitting analysis to extract important experimental values.

Want to learn more about seeing through tissue – go to this web link for a paper on the topic: http://deneb.ensc.sfu.ca/papers/jstqe03.pdf

Depending on the student's background this project would range from:

(1) Laser measurements on test phantom structures simulating tissue
(2) Building new micromachined devices with some measurements on them
(3) Experiments on fabricating and testing new test structures that simulate tissue.
(4) Experimental analysis of scattering materials using statistical curve fitting

Previous summer students have also been part of published conference papers on these results (including one that won a best paper award at the SPIE Electronic Imaging conference), and the project can be expanded into a BASc thesis. 40% of the students working on NSERC summer projects in this group have gone on to win NSERC graduate scholarships, in part aided by their research.

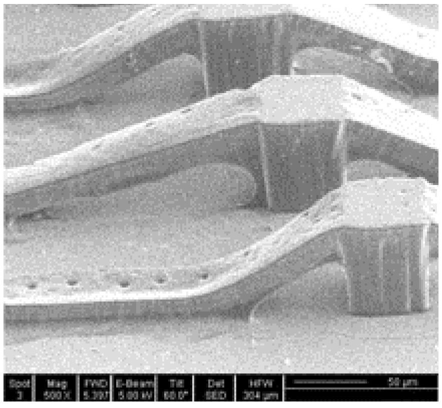
Skills Needed:

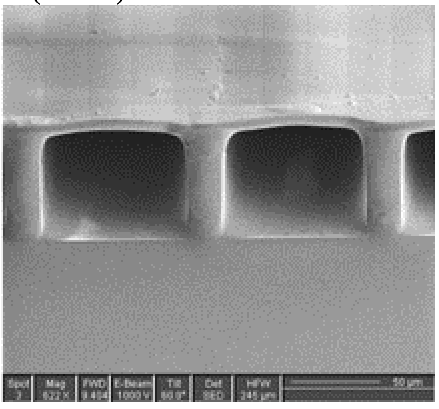
Student need to be in third year or above. Some combination of the following skills are needed, but not all are required (i.e. if you have all but the courses that is fine). The skill set will determine the type of project. If you are taking the 470 or 495 courses in the fall 2011 or spring 2012 that is fine.

(1) Good computer skills, Spreadsheets & Matlab (Adobe Photoshop an advantage but not necessary as you can learn that).
(2) Taken an Optics courses: Optical and Laser Engineering Applications (ENSC 470), or Photonics & Laser Applications in Engineering (ENSC 460) or an advanced optics from physics (for students making and designing more complicated optical systems.)
(3) Good computer skills, Spreadsheets & Matlab and/or C programming very helpful for
(4) Biomedical option programs.
(5) Taken ENSC 495/851 (for students wanting to help build devices)

NSERC Summer Project 3
New Ways of Micro-optics Fabrication

With Prof. Glenn Chapman (ENSC)





Interested getting hands on experience in the areas how computer chips, micro-sensors are made and at the same time working with lasers? Our group, on a CREO sponsored project at enable the creation of 3D micro-devices, such as micro-lens arrays. We have developed a new process where we can write with a laser on a special metal layer and turn it transparent. This is used to make photomasks, which create the patterns used in integrated circuits (think of them are really big film negatives). Furthermore the amount transparency depends on the laser power allowing us to create gray-scale masks (mask where we can create patterns of varying transparency just like a film negative). These are used to create 3 dimensional micromachined structures, for example microlenses. These masks are already the best direct write photomasks currently ever created. Our goal is to bring them to the commercial levels that CREO needs. This project will be done in with the help of graduate students already working in this area.

Want to learn more about these masks – go to this web link for papers on the topic:

http://deneb.ensc.sfu.ca/papers/bacus03.pdf

http://deneb.ensc.sfu.ca/papers/photonw07mems.pdf

Depending on the student's background project would range from: build microstructures with the masks, learning how to make the material more transparent, improving our mask writing system.

(1) Build 3D microstructures with the masks

(2) Experiments on how to make the grayscale materials more transparent and better controlled.

(3) Improving our laser mask writing system (this would be more software orientated).

Previous summer students have also been part of published conference papers on these results (including one that won a second best paper award at the SPIE Electronic photomask conference), and the project can be expanded into a BASc thesis. 40% of the students working on NSERC summer projects in this group have gone on to win NSERC graduate scholarships, in part aided by their research.

Skills Needed:

Student should be in third year or above. Some combination of the following skills are needed but not all areas are required. The skill set will determine the type of project. If you at taking the courses below in fall 2011 or spring 2012 that is fine.

(1) Have taken ENSC 495/851 (for students wanting to build devices in the cleanroom)

(2) Taken an Optics courses: Optical and Laser Engineering Applications (ENSC 470), or an advanced optics from physics. (for students making and designing more complicated optical systems.)

(3) Good computer skills, Spreadsheets & Matlab and/or C programming very helpful.(for the laser mask system work)

(4) Eng. Physics or Electronics (for helping with the material improvement).

(5) Good computer skills, Spreadsheets & Matlab very helpful.

(6) Experience with FPGA programming (we use that in controlling the laser writing system)

NSERC Summer Project 4
Creating a Low Computational Cost Magnetic Field Equation

With Prof. Glenn Chapman (ENSC)

This is project is for students with a Physics and Math interest, who like manipulating equations, and are good at programming. Back in second year you learned about how a magnetic field is created by current in a coil, and were shown the simple equations for the field along the axis of the coil. However most real engineering needs to calculate the magnetic field at points outside the axis. Those equations involve complex mathematical physics functions and are very computationally intensive. We are creating a series of approximations equations to the off axis magnetic field which have the potential to be both accurate and easy to compute. Each order of approximation is much more accurate than the previous with a modest increase in computational complexity. In this project the student would develop programs to create the optimize the approximations to minimize the deviation from the true values. If successful these equations would tremendously enhance calculations in many electrical areas, magnetic coil design, inductance calculations, and plotting magnetic fields effects. Students can participate in a journal publication on this topic (NSERC project students have generated 25 papers within my group). It certainly can be extended to a BSc thesis.

Depending on the student's background they will
(1) Developing parameter optimization programs to create the most accurate approximations over all space.
(2) Extending the approximations to higher orders for greater accurac and more complex coil designs.
(3) Developing new approximation solutions.

Skills Needed:
Student should be in third year or above. Some combination of the following skills are needed but not all areas are required. The skill set will determine the outline of project

(1) Taken a basic Electricity and Magnetism course like Physic 321 (advanced EMag courses are a plus but not required).
(2) Knowledgeable of Excel spreadsheets and programming them
(3) Good in C programming
(4) Experimented in Maple.
(5) Experienced in Matlab.
(6) Interested in solving tough mathematical problems to extend the approximations.