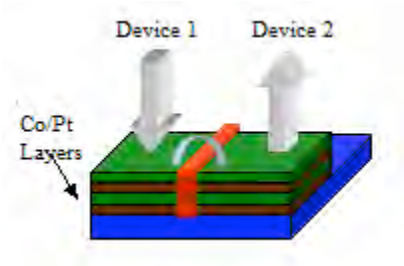
ND*nano* Undergraduate Research Fellowship (NURF)
2012 Project Summary

1) Student name: Oisin Brogan
2) Faculty mentor name: Michael Niemier
3) Project title: Application-level hardware with magnetic logic

4) Briefly describe any new skills you acquired during your summer research: I've become comfortable working with a Linux machine, learned how to use the terminal proficiently and write bash scripts. I've also improved my Python coding skills. Finally, I learned how to put together a scientific poster.

5) Please briefly share a practical application/end use of your research: My research is still in its infancy, just past the proof of concept stage. However, eventually, if all goes to plan, my research could culminate in a workable magnetic logic based chip that could use parallel processing to perform image processing at a much higher rate then currently possible. This chip could also interface with the existing electrical based logic we have today.

Project summary:
The semiconductor industry is reaching the limits of performance improvements predicted by Moore's law. A different approach is needed process information in a more energy efficient manner. One such approach is via the control of fringing fields of nano-scale magnets. Stacks of layers Co/Pt or Co/Ni can be realized such that their magnetization state is only perpendicularly up or down, and can be used to represent binary 1s and 0s. Problems involved with magnetic based logic are relatively low switching speeds and interference from nearest neighbor magnets. Our research tries to take advantage of these possible negatives and take use the inherent parallel processing of the magnets, and develop Non-Boolean, CNN based architecture.



Picture of two nano-magnets showing a binary 0 and 1

Using image edge detection as a case study, previous research had found promising architectures. Our research involved conducting a comprehensive design space exploration (different magnet sizes, spacings etc.) and adding thermal noise to the simulations. Both of these required many different simulations to be run, to gain statistical data. I was involved in developing a python based tool to quickly test proposed designs. This was to avoid submitting

bad designs to the physics based simulator, which can take days to get results. I was also involved in automating the process to submit simulations, making it easier to run dozens of simulations at once, necessary to gain the statistical data we needed.

Publications (papers/posters/presentations):