

NDnano Undergraduate Research Fellowship (NURF) 2011 Project Summary

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Project title: Design of nanomagnet logic devices

My goal for the summer was to create a design tool to simplify interactions with the Oommf magnetic solver.

Computation using electronic signals has several disadvantages that nanomagnet logic devices can overcome. Electronic computation requires current so as computer chips decrease in size the heat that they generate increases. Magnetic logic only requires small amounts of current to generate the necessary magnetic fields, so magnetic devices offer a low power alternative to electronic devices. Electronic devices also have the disadvantage of volatile memory. Because magnets hold their position in the absence of a magnetic field, nanomagnet logic devices offer non-volatile memory storage. In order to investigate the possibilities of nanomagnet logic, a design tool is needed for the simulation of more complex circuits.

My tasks for the summer included learning about micromagnetics and magnetic logic, running simulations using existing code, creating a netlist language for defining circuits, and producing a graphical user interface for the simulation of magnetic circuits. I began by familiarizing myself with the magnetic solver program Oommf. This program is the main tool for simulating magnetic interactions. This program has a wide variety of uses outside of nanotechnology, so one of my goals was to simplify the use of Oommf for the design of nanomagnetic circuits. I first came up with a system for defining magnetic circuits using the width, height, x-position, and y-position of each magnet. The next step was to create an image of the circuit using a list of these variables. I then needed to figure out how to start a simulation with this image using system commands so that the Oommf interface didn't need to be opened. I also needed to create a simplified format for input files so that running simulations would be easier. Once the basic operations of the program were created, I built a graphical user interface for displaying the circuit images and simulation controls. I next wrote functions to parse through the output files and graph the average magnetic fields of each magnet. This allows users to easily see how the direction of each magnet changes over time. Once this was complete additional functionality was added for creating fixed magnetic fields, creating multiple fields, or creating subcircuit files. The result of my research is a design tool for the simulation of nanomagnet circuits.

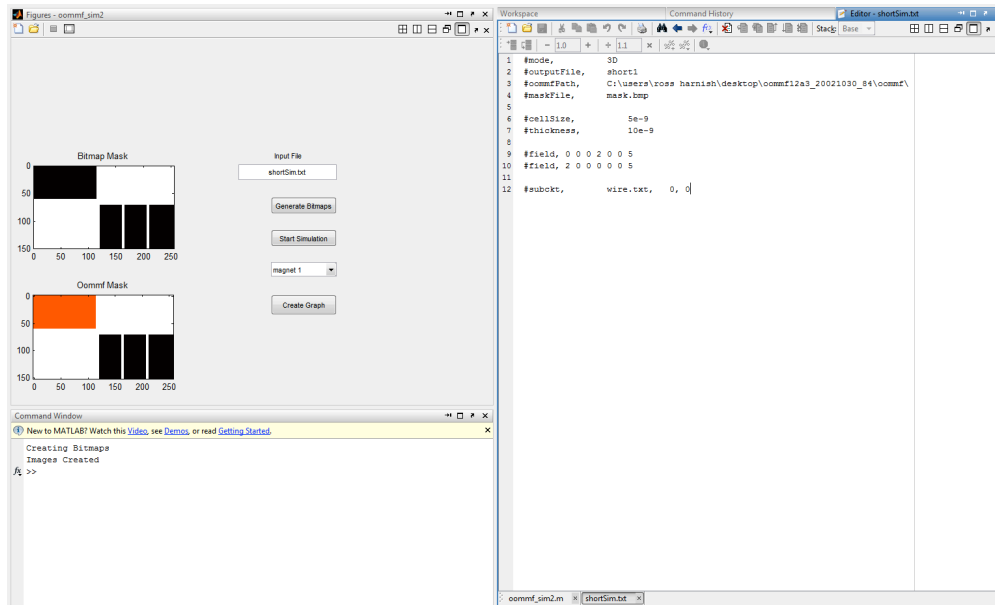


Figure 1: Interface with example input file