The focus of my research project has been to create an imaging system that can computationally create a scaled topographical map of any real-life object by taking a series of images overhead the object

And determine its limits

. This has a wide variety of applications. In general, it’s extremely difficult to measure irregularly shaped objects without examining the object close-up or attaching sensors; this and future research could change that. A user would be able to calculate gradients of the surface of the object among other interesting computations. Imagine a space shuttle descending onto an unknown planetary body; it could produce a topographical map of the surface in order to land appropriately and prevent catastrophic damage.

The project began as an idea rooted in basic optical principles. Because of the physics behind the thin-lens equation, we know that at a certain distance from a lens (i.e. the focal length), whatever is at that distance is in focus. If we can tell when a pixel is in focus, we already have a distance associated with it: the focal length; therefore, we can vary the camera's height at a measureable rate and record the distances for which a pixel is in focus. In the end, these distances and their corresponding physical location coordinates can be stitched together to produce a scaled topographical map of the object.

Key elements include: how to determine when a pixel is in focus, resolving discrepancies between the changing fields of view

My research attempted to better understand the limits of such a technique. In the end, my results discovered that no apparent physical limit exists to prevent such a technique from working proficiently. My technology was able to recover shape and approximate depth properly, but more work is needed. It is hoped that this study will encourage investment in future research—specifically in terms of the camera technology used and to better account for the lens curvature.

Future Research:

* better camera—less “fish eye”
* account for the curvature of the lens to more accurately determine location coordinates

The problem is far more complex than the classic textbook problem due to irregularities in the surface of the object we're looking at and the fact that images are 2-dimensional structures. Nonetheless, the physics still functions in a similar manner. The idea is simple enough, but the implementation has been enormously complex. For instance, consider the issue of changing the camera's field of view as we raise or lower it.

But these are the types of challenges which I thoroughly enjoy solving. Furthermore, it has been an amazing experience to be able to work on a project from start-to-finish. Software engineers commonly only work on one portion of the software development life cycle. I've been fortunate enough to see this project through from beginning to end. I've also enjoyed learning new technologies like Arduino and Python. Lastly, I've done this project almost entirely independently. No one is supervising me on a day-to-day basis. I simply have to make decisions and execute them, and I'm proud of that. Scraps: The challenge of this project has b I've been attempting to solve this issue for a while. I've built a translational stage, programmed an Arduino to rotate a stepper motor, and wired a breadboard with the stepper motor, a stepper driver, and the Arduino. I've explored many imaging techniques in order to solve the problem of determining when a pixel is in focus. I will continue to look for the 'best' method once this project is complete. For now, I'm using my own twist on a common method called the "variance of the laplacian." Once the system is fully functioning, I will create a virtual environment so my colleagues can easily run the program for whatever future imaging tasks they may have.