Project Title:

Efficient and Accurate 3D Modeling (*working title*)

Authors:

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Synopsis of Program:

This proposed project is an extension of a pre-existing “human-in-the-loop” application utilizing two robots and a turntable to image and grasp objects within a predetermined region.

This project focuses on advancement of the applications of the optical robotic arm. The end goal is to add functionality of the controlling GUI to easily move the arm and obtain images from other perspectives to build a refined 3D model of the object being imaged. Ideally this process can be automated through machine learning and analyzing an image stream to determine where another image is required.

The next stage of the project includes taking a series of images of this object over time and connecting the 3D models to create a 4D model where one can see the changes over time (the 4th dimension). An ideal object to model in three dimensional space over time is a plant, specifically a flower. By taking images of the flower over time, and applying topological models to the images, a 4D plant model can be represented in a three dimensional environment sequenced over time.

Intellectual Merit:

There are are a variety of technical challenges associated with the success of this project. The challenges can be broken down into two main areas: (1) the movement and location of the imaging arm, and (2) determining where new images are needed to make an accurate model and meshing models together to create a ‘4D movie’.

Before one can satisfy the first, an efficient way of calibrating the optical arm with respect to the virtual origin so that what it sees can be accurately modeled with their respect to their place in the real world. Once that is achieved reverse kinematics can be used to easily move the arm from one point in space to another to get a new image. Ideally this process intelligently avoids all other obstacles in the space and finds alternative paths where necessary.

The second task involves understanding the images taken by the camera so that an overall 3D model of a given object can be scanned, with all its concavities and other intricate curvatures captured. Using a plant as a model, the camera can scan and take all the important shots necessary to create an accurate mesh. Additionally, by representing the structural characteristics of a plant (e.g. branches, leaves) to code, an additional model will be created to project a plant in 3D space. This model will help improve any gaps from the camera’s mesh, arising from low-quality photos due to shadows and filling those holes with what *should* be there.

Broader Impact:

There are two potential impacts of the project. The first relating to the 3D modeling technology alone. Like we mentioned previously, through this project one will be able to obtain an accurate 3D model of an object and model over time. One potential application of this technology includes monitoring plant

growth in a lab setting. This technology will minimize the monitoring and meticulous notes required lab personnel when observing growth or changes on a daily, or even hourly, basis.

The second incorporates the grasping arm technology in a few ways. The 3D models created by this project can be further analyzed to grasp the object and even move it (i.e. helping a disabled person drink a glass of water). Additionally the algorithms created to control the movements of the camera arm can be modified to enhance the functionality of the grasping arm.