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.

Keywords: Kinect, Computer Vision, Modeling, Reverse-Kinematics, Robotics

Intellectual Merit:

This Small Business Innovation Research Phase I project has a variety of technical challenges that 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’.

To achieve these goals, the optical arm must have the ability to orient itself, so that what it sees can be accurately modeled. 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.

Broader Impact:

The first significant impact that this project relates to the 3D modeling technology alone. 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 by lab personnel when observing growth or changes on a daily, or even hourly, basis.

The second significant impact that this project will provide 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 (e.g. 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.

Elevator Pitch:

Good Morning, everyone! Who here made themselves breakfast or a cup of coffee this morning? Probably most of us, right? I know I might not be up here talking to you guys without my morning cup of Joe. There are over a quarter million people in the United States that weren't able to due to spinal cord injuries.

My is Tom Magnan. And I am Tarek Hatata. And we are here to talk to you about a technology that would make these simple tasks possible - tasks that we able-bodied people take for granted everyday. This technology focuses on creating efficient and accurate 3D models of real world objects.

To conduct our research we are working with a two-armed robotic setup. One centrally located grasping arm and a second optical arm on the perimeter of the turntable setup. This is a laboratory setup that can be easily converted to a breakfast table for the aforementioned example.

Emphasis on the efficient modeling. We know a lot of you are probably thinking that technology already exists to create models of real world objects. That is true, but none of those technologies are currently efficient enough to use our intended applications. The burden associated with a spinal cord injury is bad enough, they should not have to wait two hours to accurately model their coffee mug before taking a sip. Our technology uses a "human-in-the-loop" methodology to significantly reduce the time needed to model.

Through our GUI, a user will be able to select a pre-existing shape (i.e. coffee mug, bowl, spoon) and apply that mesh to the image stream and have it adjust to the real world object. We are focusing on an efficient algorithm so that given the first image, we only need to take pictures from obstructed angles rather than continually looping around the object like current technologies.

Because of the nature of the setup, the optical arm will understand its location relative to other objects in the "world" through reverse kinematics, so it can readjust its path and avoid obstacles. It will also have the ability to take its image stream and reorient itself with landmarks or tags in its view to ensure accurate data in the event that the arm went too far or too short.

In addition to assistance for the disabled that we already talked to you about, the modular technology can also be extended to a variety of laboratory settings. One that we are simulating in our current research is using the technology to replace the need for additional laboratory assistants in doing daily measurements of plant growth. This could all be done by our software.

We hope that you, too, see the desperate need for technology like ours. We can only make it possible with your help.