DEPARTMENT OF
Engineering

TCU COLLEGE OF SCIENCE & ENGINEERING

Object Detection and Retrieval Using Low-Cost Autonomous Robotic Vehicle

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SciCom Let's Talk Science

In our project, a control-theory based algorithm would be employed to develop a small electric vehicle that can self-navigate through an unknown course to arrive at the desired location while avoiding obstacles and walls. This project is an extension of our successful project funded last year, in which we were able to operate a partially autonomous car to run around a location and generate a virtual map. Our team expects to grant the car full autonomy like a self-driving car and let it travel through a relative abundance of places to create computer models of critical infrastructures without the help of humans. The success of this project will have a broad impact on society. First, this capability would be useful in self-driving cars, which allow drivers to spend their time more productively instead of driving to work or assist disabled people. Second, the car can generate a simulated model of places that help to analyze unknown locations. Finally, the project can surely create a platform for future TCU engineering students to learn about self-driving car technology and machine learning. This project is expected to succeed due to the achievements we gained from the previous project.

The algorithm will be written in Python/ROS, controlled by Raspberry Pi 3, and tested on a walled course constructed by us. It should be able to navigate a course without having already driven through it. Another special feature is that the car will also precisely arrive at a pre-determined location.

Introduction: In our project, we aimed to design an autonomous rover similar to that of the popular Mars rovers such as Curiosity. Our rover employs a differential drive system with two continuous rotation servo motors that are controlled with the popular ROS robotic programming library in C++ and Python. A navigation algorithm employs the known position of the robot gathered from a magnetic encoder on the motors and the multiple optical range finders placed around the vehicle to avoid obstacles on route to its destination. A camera is employed to detect target objects for simple pick-and-place tasks using its DC motorized gripper placed at the front of the vehicle. We have successfully built this vehicle and have demonstrated its capabilities at the 2019 IEEE R5 robotics competition in Lafayette, Louisiana as well as at the SRS presentation day.

Inspiration:

- We were inspired to compete in the annual IEEE R5 Robotics Competition, where the task was to make an autonomous robotic vehicle to pick and place blocks into a “mothership”.

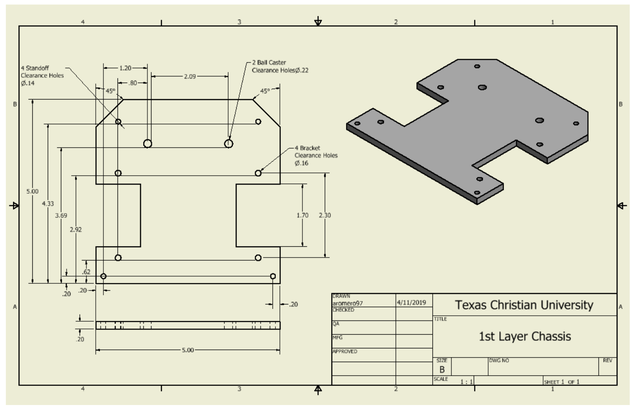
- The Mars Curiosity Rover served as inspiration for our design mechanically.

Mechanical Design:

The structure was designed with Autodesk Inventor to assemble and stabilize all components while simultaneously considering their dimensions and functions. This was achieved by laser cutting and 3D printing fabrication.

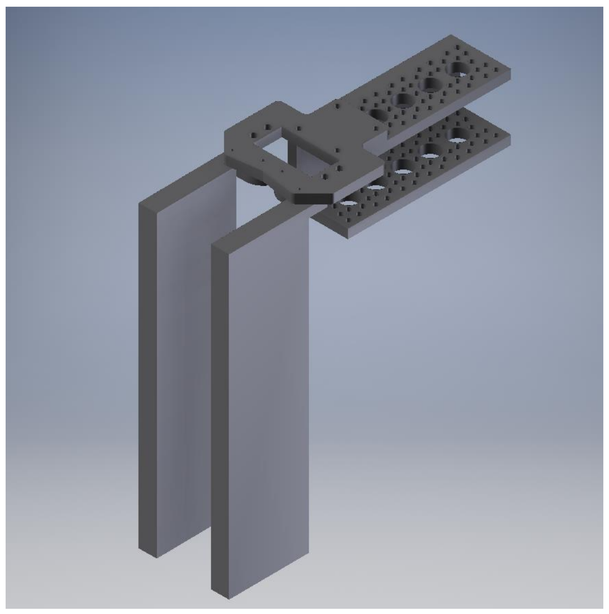
3-Layer Chassis

- Front of the 1st layer was designed with corner edges at 45 degrees to fit an optical range finders mount
- 2nd and 3rd layers designed to house battery components, an Open CR, ODROID, a camera, and gripper

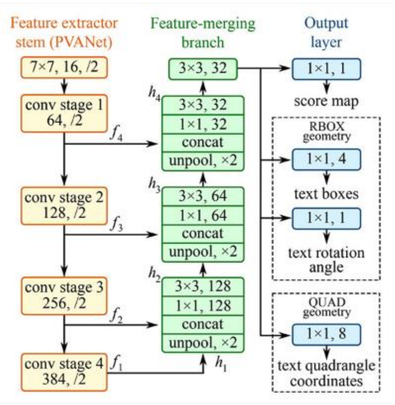


DOF Gripper with Servo Motor

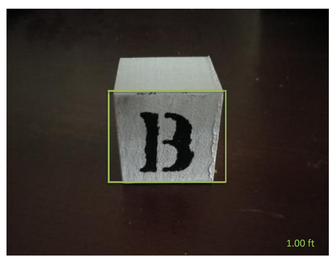
- 180 degree Servo Gearbox was implemented to rotate the Gripper to a clearance state
- Length of the extension arm was calculated to grab a 1.5” cube midway from the ground
- Servo motor varied the distance between Gripper arms accordingly



Object Detection and Retrieval:



- OpenCV was used to detect text in natural scene images using the EAST text detector. OpenCV’s EAST text detector is a deep learning model, based on a novel architecture and training pattern.

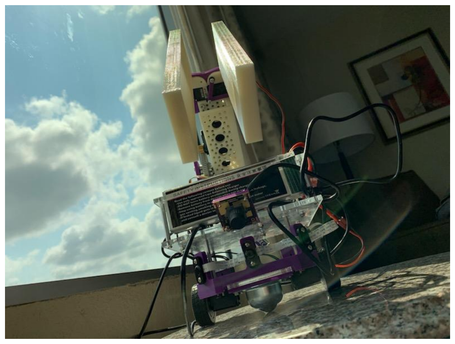


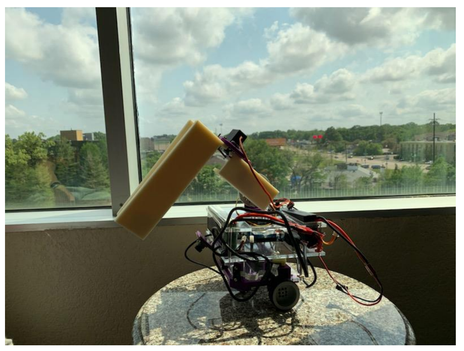
- The text is decoded with a Optical Character Recognition (OCR) algorithm using the Tesseract binary with python.
- The distance to the object is found with a triangle similarity algorithm in OpenCV.

Acknowledgements:

- TCU IEEE, RAIC, IEEE R5 and Dr. Morgan Kiani for advising, inspiring and assisting with this research.

Final Design:





- Participated in the competition (knocked out in first rounds)
- Was able to pick up a few blocks

Summary:

- Made autonomous robotic vehicle capable of detecting, picking up, and placing marked objects.
- Plan to compete in competition again next year.