Planar Positioning System for 3D Scanning

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Abstract

3D scanning is a key tool, especially for researchers and students. Unfortunately, there aren't any cost-effective options out in the market for these groups of people. Currently the market for a 3D scanning system is either on the low end with pricing under $300 but limited capabilities in terms of the size of objects able to be scanned, or on the high end with pricing above $1000. Our project intends to bridge that gap and provide a cheap, efficient, DIY (do-it-yourself) version of a 3D scanner. Using planar positioning and LIDAR (Light Imaging and Ranging) measurements combined with computer algorithms on systems such as MATLAB we intend to create a 3D scan of an object with the goal of eventually 3D printing it. We hope to reach an accuracy of 80%, knowing that through iterative design process we can continue to increase accuracy up to the physical limitations of the LIDAR sensor. Our project also supports the idea of DIY systems for education and curiosity among students, but also provides a framework for researchers to develop low cost platforms in the study of tomography. Overall, we hope that this system will allow students, researchers and amateur enthusiasts a way to use, modify and understand 3D scanning and apply it to projects, research, or any other needs they might have.

Project Overview

The goal of this project is to develop a 3D scanner that uses a planar positioning system to map objects using a laser and computer algorithms. The direct focus will be the positioning system which can also be used for a variety of mapping projects such as RF tomography, optical imaging/scanning, and scanning of objects to be 3D printed. The positioning system will mirror that construction of builds like CNC (computer numerical control) machines, 3D printers and other linear motion devices. This project supports the idea of DIY (do-it-yourself) systems for education and curiosity among students, but also provides a framework for researchers to develop low cost platforms in the study of tomography

Scan one side of the object with the LIDAR.

Rotate the object 90 degrees using the turntable.

Scan another side and repeat until the object has turned 360 degrees and all sides are scanned.

Data from the LIDAR is saved along with coordinate points and mapped in MATLAB to get a 3D image.

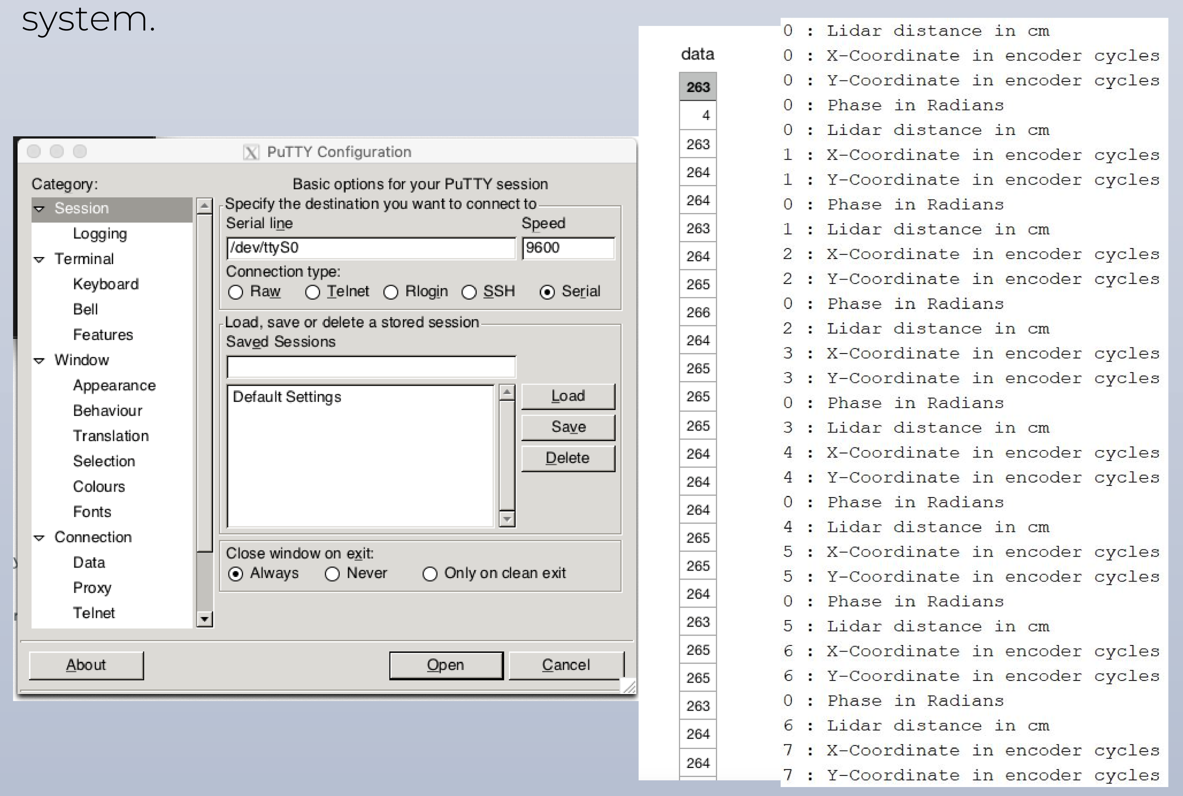
Engineering Requirements

- The system should be able to reproduce an accurate image of the object within 80% accuracy.
- The system should be able to process the image in the same time it takes to run a trial.
- The total cost of our system should not exceed $1000.
- The system should have an average power consumption of 36 Watts.
- The system will have modular design that will allow end users to replace and troubleshoot the system without the need for a technician.
- Users of the system should be able to learn 80% of functionality within 100 hours of operation.
- The system will have a reliability of 95%.

Testing and Results

Testing:

-Step 1: We checked to see if we were able to read data points from the lidar and match them with a planar coordinate system.



-Step 2: We took those data points and put them into MATLAB to try to get a 3D image of the object.

Design Alternatives

Sensor: LIDAR : Light Imaging and Ranging sensor that sends a laser to map distances from an object.

Sensor: Ultrasonic: Non-contact distance measurement module which works at 40KHz.

Coding: C/C++: Language compatible with Arduino boards.

Coding: Python: Language compatible with Raspberry Pi.

MCU: Arduino: LIDAR works well with Arduino and also compatible with the motors.

MCU: Raspberry Pi: Can use Raspberry Pi technology to scan a 3D image, also could be used with the LIDAR

Simulation: MATLAB: Used by researchers and a commonly used tool in labs. Also able to plot multiple points to show a 3D image.

Simulation: Unity 3D: 3D simulation software.

Conclusion

Overall our design is a proof of concept for a low budget DIY 3D Scanner using Planar Positioning and LIDAR. We succeeded in keeping our cost mid-level and below $1000 with the total coming in to be $994.94. We were also able to use the planar positioning method along with the LIDAR to get our data points. We then were able to plot the points into MATLAB to get our final image. Our final image is not exact to the object but that is to be expected given the limitations of the design and that this is a proof of concept.

-Step 3: We compared the scan and the object to see if the image was within the 80% accuracy that we set in the engineering requirements.

Final Design

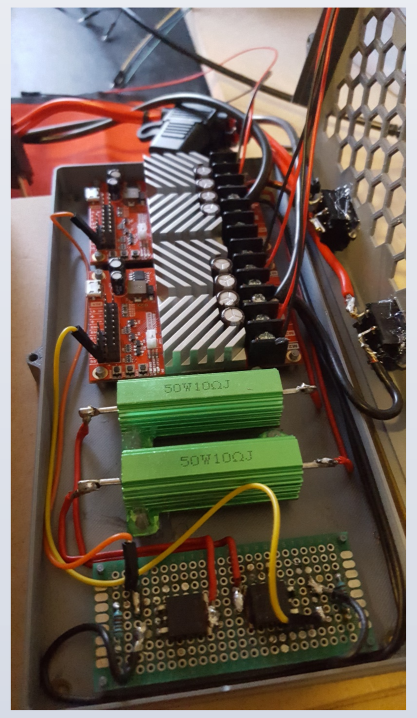
Sensor: LIDAR:
Range: 40m
Accuracy: +/- 2.5 cm
Update Rate: > 1kHz
Current Consumption: 65mA

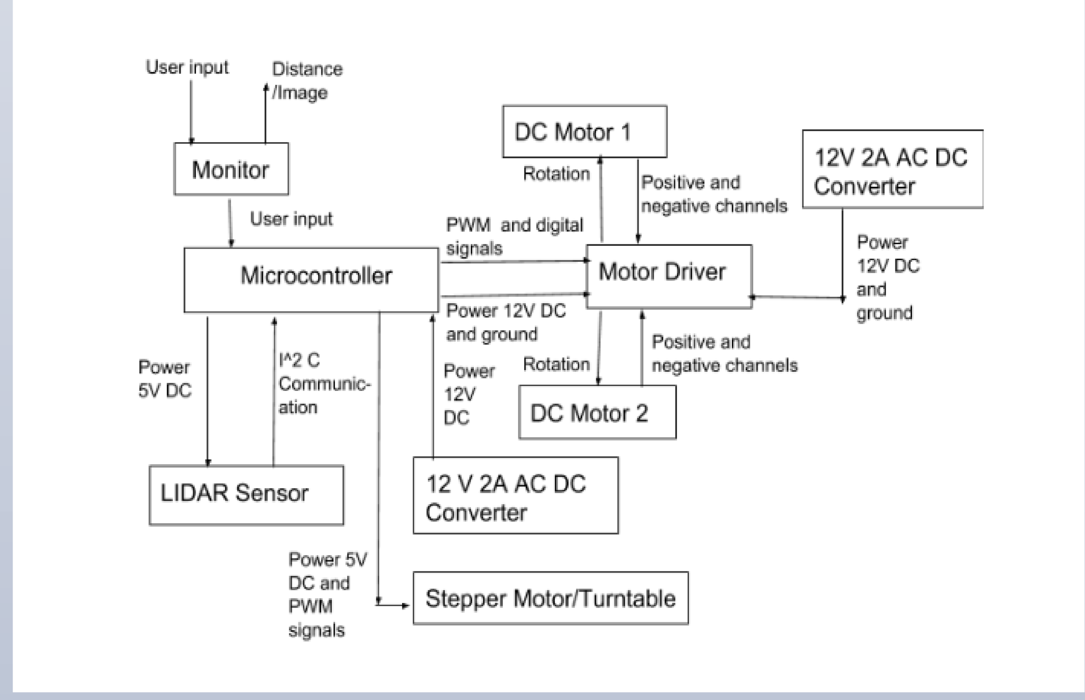
Coding: C/C++

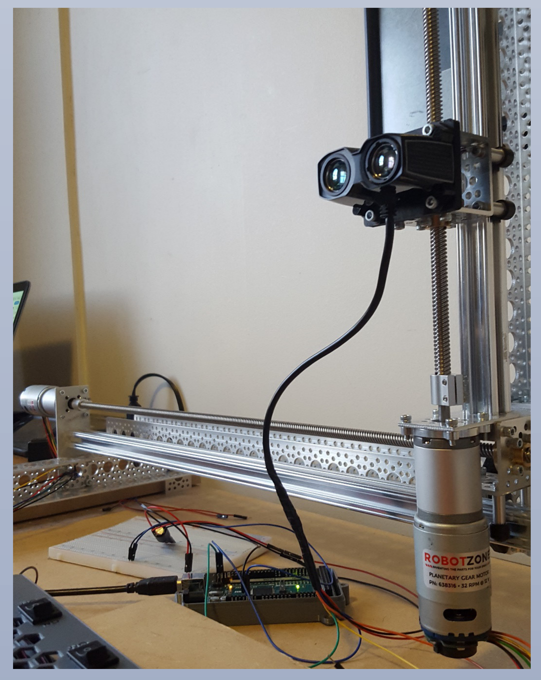
MCU: Arduino Mega:

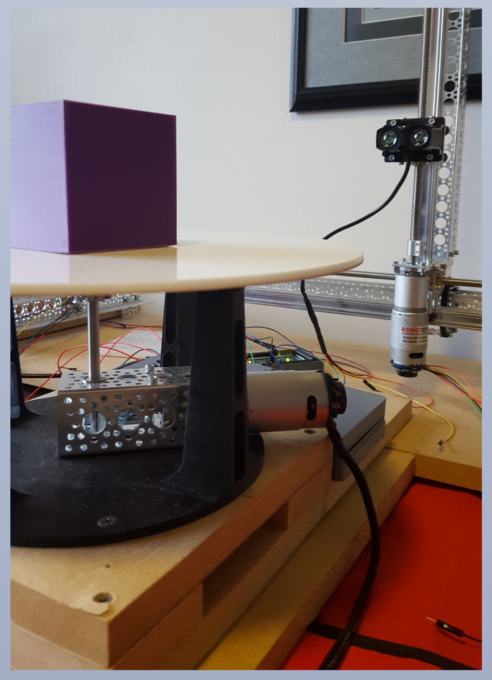
Motors:
RPM: 32
Power Consumption: 120 W
Motor Type: DC Brushed Motor

Motor Driver: RoboClaw
Power: 720 W max
Channels: 2 at 30 A
Encoder: Quadrature









Acknowledgements

We would like to acknowledge the US Army Research laboratory for the initial funding of the planar positioning system. We would also like to thank Danilo Erricolo and Yangquing Liu as well as the UIC Makerspace for all the resources.