3D LiDAR-Based Object Scanner

Zach Jaromin, Jack Rourke, Garrett Schaefer, Robert Xu
EE Senior Design | 2022-2023

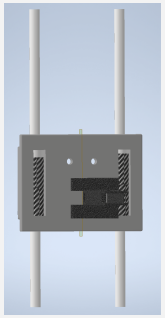
Project Overview

Corporations spend millions of dollars designing products and then ensuring that manufactured results are up to the original design specifications. Using CAD software, nearly any part or product can be digitally modeled. However, this can often be a time consuming process and there is no guarantee that the engineer doing the modeling will complete his task perfectly. If even one dimension is off, the model will need to be updated, and any parts already sent to the printer will need to be scrapped. Thus, if there is already a prototype of a part and a company or individual would simply like to replicate it in CAD, they must undergo a time consuming and error prone process to model it in software. Additionally, there are currently incredibly costly systems in place to ensure parts meet the standards that they were designed with. Having an individual take measurements or employing a computer vision system can be unreliable and incredibly costly. If a cost effective, simple solution to this problem could be implemented, it could increase the efficiency and accuracy of designing and manufacturing all manner of products.

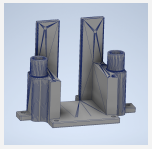
System Requirements

1. Precise stepper motor control to rotate objects and raise sensors.
2. Functional LiDAR sensors to obtain distance measurements.
3. Stable frame to prevent excessive shaking and sliding.
4. STL file creation to allow for future replication of objects.
5. Data storage on a micro SD card.
6. Wireless communication to allow the user to enable scans and select scan quality.

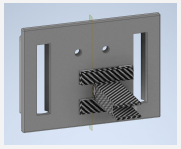
CAD



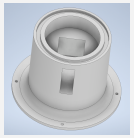
Assembly, Sensor Mount with Linear Shafts



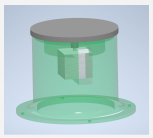
Motor Mount



Sensor Mount

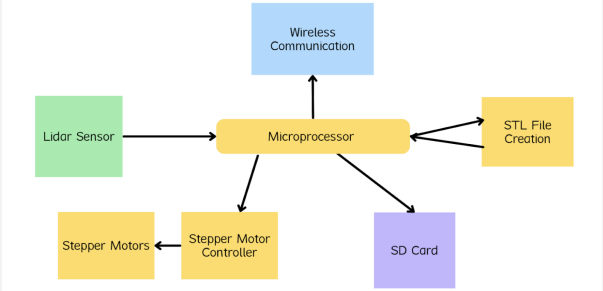


Rotating Platform (View 1)



Rotating Platform (View 2)

Subsystems



- Three sensors provide measurements for our objects – the JRT U8XX, SparkFun V153 Sensor, and the Sharp GP2Y0A21YK SF00242. Each sensor has different precision, accuracy, resolution, and sampling rate parameters.
- The SD card system stores measurement data from the LiDAR sensors. It interfaces with the microcontroller via the SPI communication protocol.
- The stepper motor controllers interface with the microcontroller and the stepper motors. They provide the 24V to the motors, which receive command pulses from the microcontroller serially.
- The stepper motors provide slow, precise mechanical motion for the system. One motor will be used to rotate the platform supporting the object being mapped. Other motors will raise and lower the LiDAR sensors to incrementally capture the entire object.
- Wireless communication allows customers to remotely interact with the system through a website. Users can select between three different scan qualities and remotely enable/disable the system.
- The data from the scan is processed in a Python program that creates a 3D point cloud, generates a mesh, and converts the mesh into an STL file on the user's PC.
- The power supply provides 5, 12, and 24 V to our board and devices. For devices that require 3.3V, a voltage regulator on our board steps a 5V connection down.

Future Enhancements

The largest future enhancement would be the use of an extremely high quality LiDAR sensor, preferably one with an accuracy of ± 1mm. However, the cost is in the neighborhood of tens of thousands of dollars. Other future enhancements include the implementation of higher quality stepper motors. Motors with the ability to control movements in smaller increments, which could increase the resolution of the image map generated by the LiDAR sensor. More powerful motors would also allow for larger, heavier objects to be scanned.

Control Board

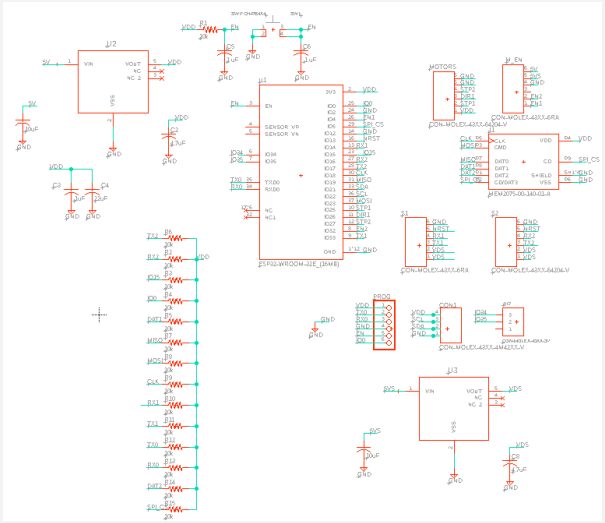


Figure 1. Board Schematic

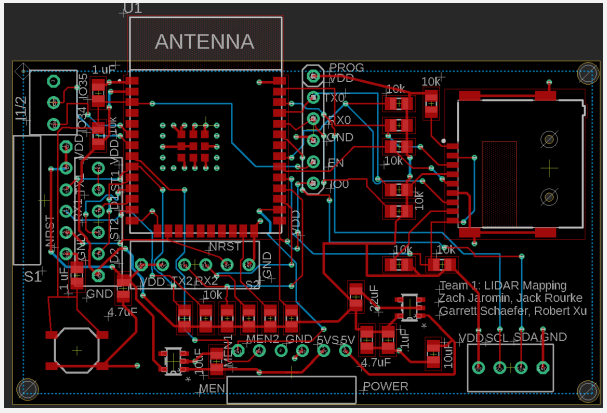


Figure 2. PCB Layout