An Affordable 3D Laser Camera

Overview

Currently, 3D LIDAR technology is too expensive to meet the needs of small scale robotics researchers. 2D LIDAR is cheaper but doesn't provide enough data for navigation.

Our goal was to generate a 3D point cloud using only a 2D LIDAR.

To accomplish this, we designed an apparatus and accompanying software to "nod" a 2D LIDAR and organize the data in a 3D visualization.

Requirements

Functional

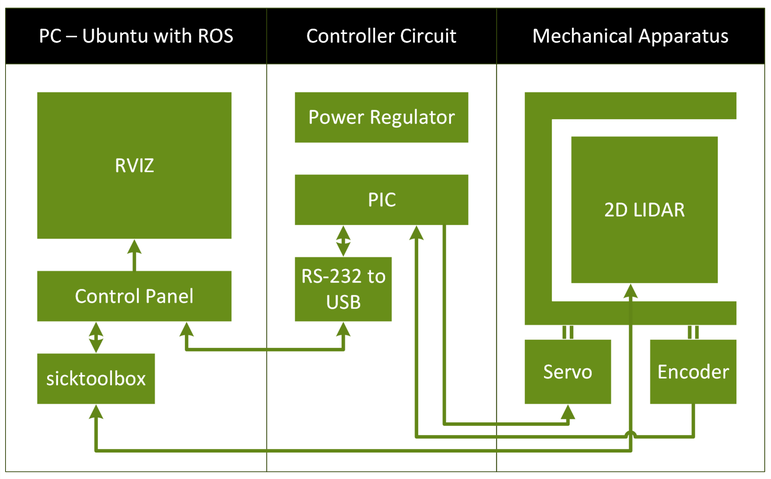
- Scan time should be less than 1 second
- Servo controller must provide positional feedback
- Results should be displayed in a human-readable format

Non-Functional

- Design should incorporate the provided SICK LMS-291 LIDAR
- All software should be open-source
- Cost of prototype must be significantly less than a commercial 3D LIDAR

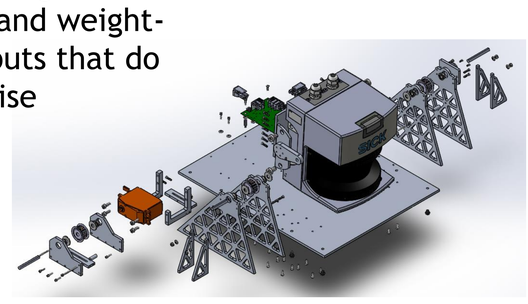
Technical Design

Block Diagram



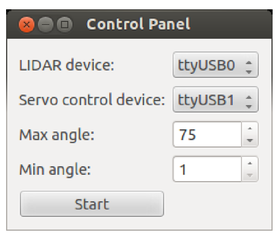
Mechanical Apparatus

The apparatus was designed to provide the highest resolution without needing to utilize a brushed DB9 connection. It also optimizes the horizontal field of view since the sensor will be primarily used for navigation. Features include a sliding servo mount for belt adjustments, high precision bearings for smooth rotation under heavy loads, and weight-reducing cutouts that do not compromise structural integrity.



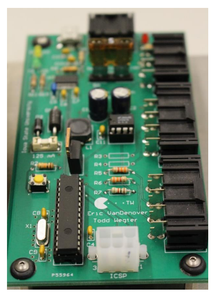
Software

In order to maintain an open-source platform, we developed the software for Linux PCs and used Robot Operating System (ROS) to run our application. The application is written in C++ so that we could easily utilize several different tools in ROS. These tools include RVIZ, a toolbox in ROS that creates 3D visualizations, and the sicktoolbox library which interfaces with SICK LIDARs. The GUI is a simple control panel that makes it easy for users control the entire system.



Controller

Our custom PCB receives commands from the PC via USB. The controller moves the servo motor to the desired position and makes adjustments if necessary. These adjustments are based upon feedback from the optical encoder mounted directly to the LIDAR. The controller was programmed with C and is designed to utilize interrupts to maximize efficiency.



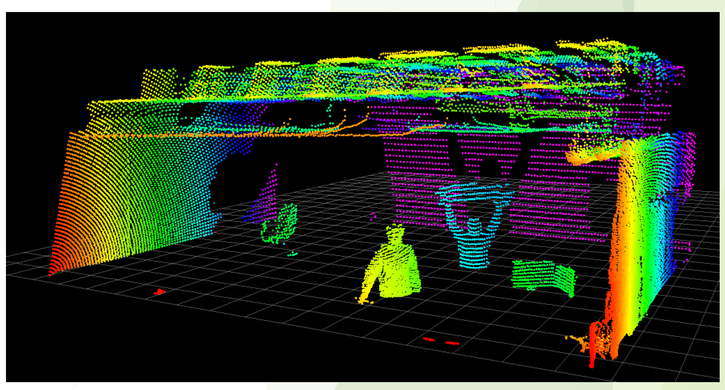
Servo: Savox SV0236MG
Encoder: Avago HEDM-5500
Microcontroller: PIC18F2580
USB to UART: FT232RL
Power Regulator: LM2675

Testing

- Mechanical Stress Testing
- Manufacturability Testing
- Breadboarding
- Functional Testing
- Integration Testing
- Usability Testing

Results

- Custom aluminum apparatus
- Scan time: ~1 second
- Closed-loop feedback for position control
- Easy-to-use GUI
- 3D data visualization



May14-08

Team Members:
Nicolas Cabeen
Eric VanDenover
Xiang Wang
Todd Wegter

Advisor:
Dr. Koray Celik

Clients:
Lunabotics
Vermeer

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering