LiDAR Proximity Detection as Sensory Substitution for the Blind

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Abstract

This project is a first step in a larger goal of developing a neural prosthetic. With the goal of aiding blind individuals, this device would bestow spatial awareness to individuals by translating visual information into somatosensory cues. This prototype would involve LiDAR detection of objects within 8 meters of the device. As objects enter this detection range and move closer, the device's eccentric rotating mass (ERM) vibration motor will increase in intensity using the pulse width modulation (PWM) functionality built into the Arduino.

1 Introduction

Previous research has demonstrated the effectiveness and applicability of sensory substitution devices. Individuals who have lost their vision due ocular complications still have a largely functional visual system, despite lacking the proper sensory input. Tactile stimulation of functioning mechanoreceptors in the skin can over time be interpreted by these remaining visual systems. Patients report experiences adjacent to sight after training and repeated use of these devices (Bach-y-Rita & Kercel, 2003). This device interprets distances using a LiDAR sensor and translates them to a gradated intensity of vibration. As objects approach the sensor, the motors deliver a more intense vibration. The LiDAR sensor is mounted on the subject's glasses to allow them to scan their surroundings using the intuitive motion of turning their head, while the vibration motors are attached to a bracelet allowing for ease of use and maneuverability. Additional safety features added include an LED to indicate if the LiDAR has reached a temperature above its operating range as well as a RGB LED to indicate the signal strength. While these are not directly useful to the patient, in clinical trial settings these data are extremely useful to those conducting training sessions.

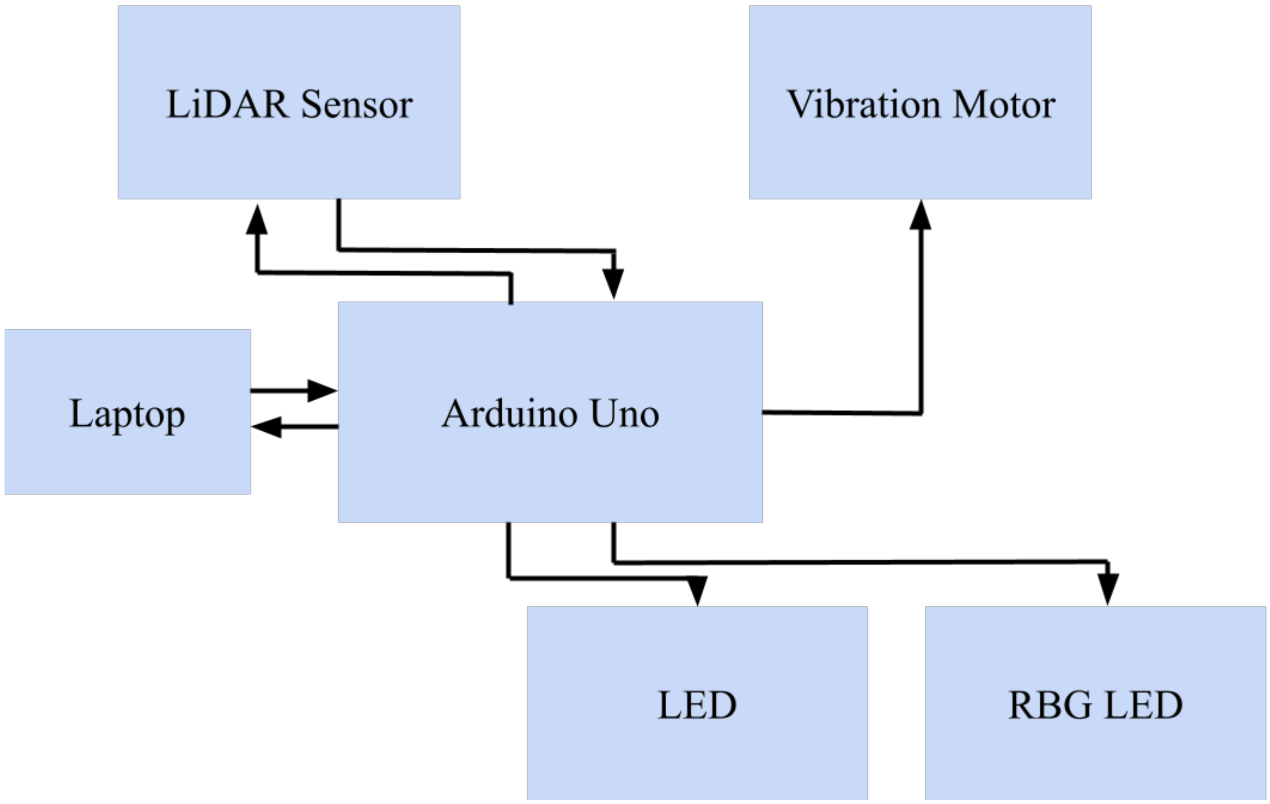
2 List of Parts

1. Arduino Uno
2. Breadboard
3. LiDAR Sensor (TFLuna)
4. Vibration Motor (Eccentric Rotating Mass)
5. Red LED
6. RGB LED
7. 100Ω Resistors
8. Wire

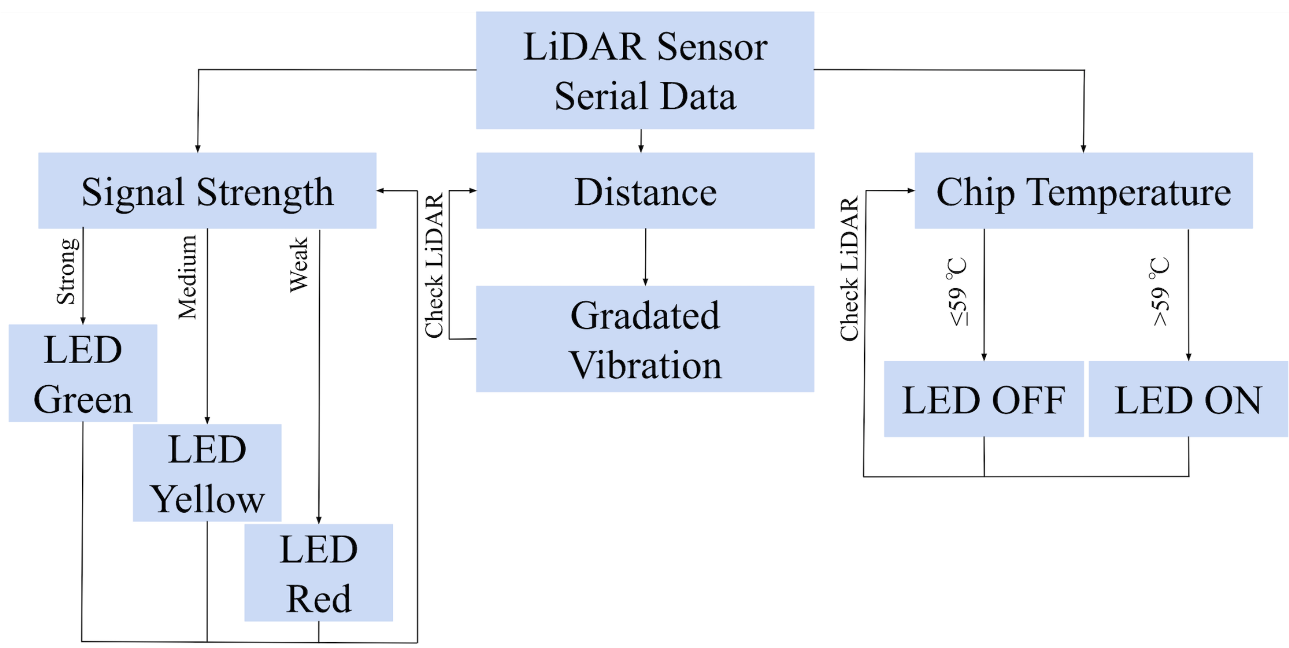
3 Plan of Implementation

- **Week of March 27th:** write code to interpret LiDAR sensor data & connect vibration motor to Arduino
- **Week of April 3rd:** set up LiDAR sensor to report distance
- **Week of April 10th:** finalize code to modulate vibration motor intensity & code for LiDAR sensor
- **Week of April 19th:** first attempt to modulate intensity of vibration based on distance of objects via the LiDAR sensor
- **Week of April 24th:** finalize project and fix remaining issues

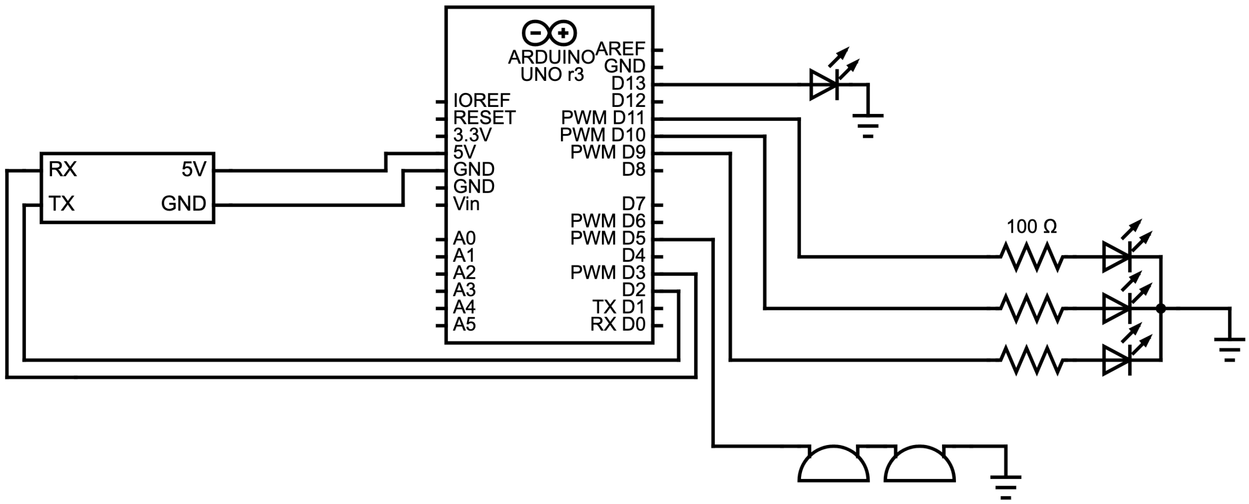
4 Block Diagram



5 Software Flowchart



6 Schematic



7 References

Bach-y-Rita, P., &; W. Kercel, S. (2003). Sensory substitution and the Human–Machine Interface. Trends in Cognitive Sciences, 7(12), 541–546. https://doi.org/10.1016/j.tics.2003.10.013