

ECE4011/ECE 4012 Project Summary

Project Title	Light Emitting Navigation System (LENS) – Headgear for the Visually Impaired
Team Members (names and majors)	Malavika Bindhi, EE
	David Clyde, EE
	Anushri Dixit, EE
	Daniel Fulford, EE/BME minor
	James Fulford, EE
	Muhammad Islam, BME
Advisor / Section	Dr. James Hamblen / L5B
Semester	Year/Semester: Spring 2017 Final (ECE4012)
Project Abstract (250-300 words)	<p>The Light Emitting Navigation System(LENS), is so named for its critical use of LIDAR sensing technology. The project was sponsored by Dr. Brian Gay who originally approached brothers James and Daniel Fulford with the idea. Essentially, he envisioned a head gear that can be comfortably worn by a visually impaired user that uses object detection and alerting to allow the user to safely navigate their environment. Currently, there are no major and commercially practical accessory devices such as this being produced. There are major advancements in the area of Ophthalmology, including neuroprosthetics, but not all can afford or are willing to use this as an option.</p> <p>The project’s aim was to design and develop a device that is non-invasive and affordable outside of health insurance. Estimated at \$487 per unit, the device is to be worn around the head resembling a virtual reality headset construction. Low hanging obstacles are a huge concern for the blind population and the performance of our final prototype is capable of this and more. Furthermore, we followed the design specifications of Dr. Gay, and implemented an array of 7 sensors, 1 LIDAR and 6 mini LIDAR time of flight sensors (TOF).</p> <p>Obstacle detection occurs using audio feedback. Each sensor is independently tied to each note with the three left and three right TOF sensors mirroring each other as low C, E and G notes. The middle sensor is a high C. The intensity or volume of each note changes with distance to object detection. The closer the object the louder the note. One final 3D printed prototype was produced for Dr. Brian Gay. Considering the prototype’s great success and fulfillment of Dr. Gay’s requests, he plans to pursue commercialization by verifying several possible avenues such as federal grants and third party organizations to make it possible.</p>

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List codes and standards that significantly affect your project. Briefly describe how they influenced your design.	<ol style="list-style-type: none"> 1. LIDAR sensor standards: LIDAR sensor is used to gather data for real-time navigation and audio feedback. These sensors have data exchange format standards which are relevant to determine how the data is used in the system. 2. Inter-IC Sound (I²S) : Serial bus interface standard used for communication with VS1053. This interface is used to only handle external DAC. 3. Musical Instrument Digital Interface (MIDI): Standard that describes protocol for communication between electronic musical instruments and computers [10]. MIDI sounds were utilized to provide feedback to user. 4. I2C bus specification: To integrate all seven sensors with the microcontroller, I2C interface is utilized. I2C bus specification details the connections, protocols, formats, addresses, and procedures that define the rules on the bus. 5. USB: To interface the microcontroller with a PC 6. Serial Peripheral Interface (SPI): Serial bus interface standard used for communication between mbed and vs1053 codec.
List at least two significant realistic design constraints that applied to your project. Briefly describe how they affected your design.	<ol style="list-style-type: none"> 1. Durability: Must be able to handle slight abuse, such as being dropped from a height of at least four to six feet, being stepped on or hopefully much less likely being hit against a wall. 2. Simplistic and ergonomic design: Must be simple to use, the user must remember where each button is and what they do since the user won't be able to see or read them. Must also be very comfortable for long periods of use. 3. For the design to be comfortable to wear it must also be very light which will also affect its durability. The two constraints work against each other. The design was to find a balance between the two constraints.
Briefly explain two significant trade-offs considered in your design, including options considered and the solution chosen.	<ol style="list-style-type: none"> 1. LIDAR vs. Ultrasonic/Infrared Sensors: LIDARs are far more expensive than ultrasonic/IR sensors. However, they are also more accurate. The need for accuracy is more important than the price because the LIDAR still fell within our budget. Therefore, the LIDAR was chosen. 2. TOF vs. Ultrasonic: TOFs are cheaper than adequate ultrasonic sensors but have less range (about 4 feet max). They are still more reliable than ultrasonic. 3. Weight and convenience: It is crucial that the weight of the headgear be minimized in order to improve usability and convenience. However, the weight tends to increase as soon as we have to increase functionality by adding more sensors. Usability was more important so we opted for the seven sensors in order to maintain this and meet our client's requests.

<p>Briefly describe the computing aspects of your projects, specifically identifying hardware-software tradeoffs, interfaces, and/or interactions.</p>	<ul style="list-style-type: none"> - Inputs: <ul style="list-style-type: none"> » Light detection from LIDAR aperture » Distance measurements from LIDAR processed by mcu for MIDI sound production - Outputs: <ul style="list-style-type: none"> » Codec uses distances measurements from microcontroller to vary the volume audio feedback and produce the harmonious and continuously playing musical notes » Environmental awareness for the user - Mbed Vs Arduino: Mbed has a quicker processing speed but Arduino is cheaper and more user friendly. Also, some versions of Mbed lack USB 3.3 volts which is useful for various circuit modules. We selected the Mbed for its robust processing capabilities and our greater familiarity with the device.
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