ECE 445 - Project Proposal

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Vehicle Detector for Hearing-Impaired Cyclists

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I. Introduction:

With gas prices continuously rising, the bicycle is become a more popular alternative to the car. The bicycle, much like any form of transportation that shares the road, has safety concerns that must be addressed, mainly the potential danger of bad and inattentive drivers. For hearing-impaired cyclists, this danger is increased tenfold, as their ability to sense encroaching vehicles is greatly diminished on a bicycle.

Our product, a vehicle-detector, while specifically intended for hear-impaired cyclists, could very well be of use to any cyclist who wishes a safer trip. The device will consist of three main components: a rearview camera, a front display unit, and a proximity sensor. The display will replicate the camera's view, allowing the rider to have a direct understanding of exactly what's behind them. If a vehicle comes within at least 30 ft., the sensor will further ensure the rider's safety by indicating the presence of a vehicle. This will permit the cyclist to keep their eyes on the road in front of them as often as possible.

Benefits:

- Extrasensory safety from other vehicles sharing the road
- Safer, more comfortable riding (do not have to turn around, can keep eyes in front)
- Use of an alternative, "green" transportation, powered by alternative energy
- Provides the hear-impaired with the ability to ride anywhere

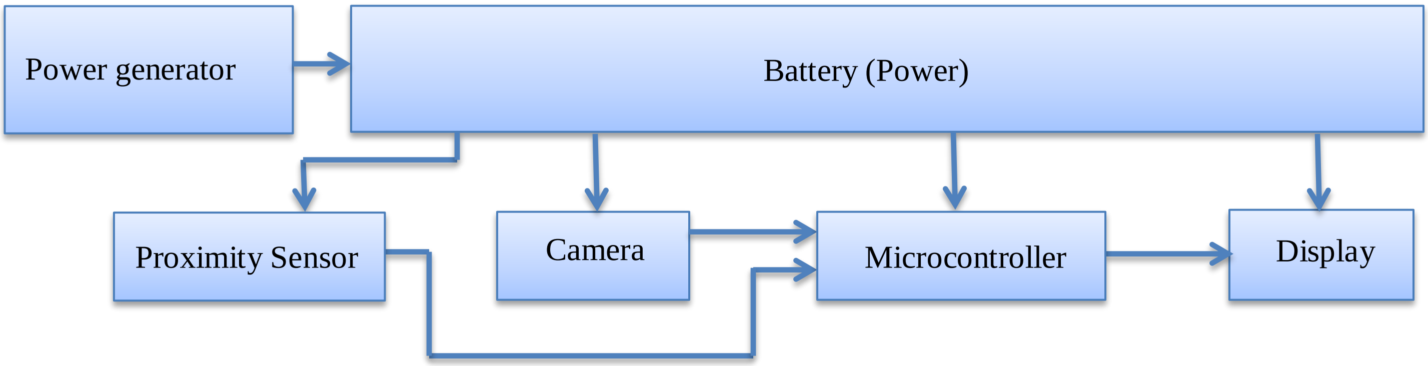
Features:

- Proximity Sensor, alerting the rider of vehicles within a 30 foot radius
- Rearview display, providing the ability to see beyond the sensor's scope
- Statistics on display (e.g. vehicle distance, battery power, spedometer, etc.)

We decided on this project from a number of ideas, because this device will be more than a commodity, it will be able to help people. Upon doing personal research, we found that the hearing-impaired are severely disabled when riding bikes, as they can't hear vehicles approaching behind them. Our aim is to provide all riders the ability to have a safer, more comfortable ride. This will hopefully encourage even more people to ride bicycles and become more engaged with alternative transportation.

II. Design

Block Diagram:



Block Descriptions:

- *Proximity Sensor:*
  The Proximity Sensor consists of the antenna (which is responsible for transmitting and receiving the signals for detection), the oscillator that generates the signal, and additional circuitry needed to interface with the microcontroller. It will be responsible for transmitting and receiving signals for detecting cars and other vehicles that are within range. The signal will travel from the antenna to the object that is somewhere in its path, bounce off the object and return to the antenna. The received signal would then be sent to the microcontroller where it will undergo DSP interpretting the data. The oscillator will be a crystal that generates a frequency for the antenna.

- *Power generator:*
  We wish to make our system powered by green energy. The power generator will convert mechanical power (from the motion of the wheels of the bike) to electrical energy and charge the battery. Mechanical power will be harvested from the wheel and converted to electrical energy by the generator. The power generated from the generator will be sent to the battery. The battery should charge the battery whenever the bicycle is in use for transportation or sport.

- *Battery*:
  The Battery is where the generated energy will be stored. It will output power to all components (that consume power) on the block diagram, including the microcontroller, display, and camera. We will be using voltage regulators to output different voltages for the different devices. The type of battery and its specs are to be decided after thorough research is done. Additional circuitry will be necessary due to the use of the voltage regulators.

- *Camera:*
  The camera will be directed towards the back side of the bicycle. It is used to give cyclists a picture of what is happening behind them in addition to the alerting signals on the display. The signal from the camera will be sent to the microcontroller generate signals compatible for the display. The signal type and how it will interface with the microcontroller will be determined after research is done in this field.

- *Display:*
  The LCD Display displays the following things:
  - Images from the camera. The camera will be watching towards the back of the bike, allowing the bike rider to observe things happening behind them when desired. The signals will be generated from the camera and sent to the microcontroller where it interfaces the camera with the display. The "translated" signals are then sent to the display.
  - Battery status. It should show the battery level and if it is in charging status.
  - Alert signal of cars or other objects approaching. The alert signal should catch the bike rider's attention.

  The LCD display would have a size of around 3.5". The things to be displayed will be sent from the microcontroller.

- *Microcontroller:*
  The Microcontroller deals the following:
  - Performing A/D and DSP functions for signals coming from the Proximity sensor and battery (for detecting power level).
  - Calculating and analyzing data coming from the Proximity sensor and the battery.
  - Displaying the camera video on the LCD display. This includes displaying the image from the camera mounted on the back of the bike, displaying the calculated and analyzed results from the proximity sensor, and displaying the battery status.

  The signals from the sensor will be analog. The microcontroller will perform its A/D function so that we can process the data. The power level of the battery will be sampled as well to inform users of the status of the battery on the display. The data type for the LCD display has yet to be determined after research.

Performance Requirement:

- Sensor can detect approaching cars within range of 50 ft.
- Transmitted and received signal for the proximity sensor should have time difference below 1s.
- Camera and display should have refresh rate no lower than 25 frames per second.
- Full battery can power entire system for at least 3 hours.
- Power generator generates 30-60 Watts of power.
- Microcontroller must have at least 32 MB RAM and be able to carry a video signal.

III. Verification

Testing Procedures:

- Test the sensor with different distance measures, and plot the distance and beam width.
- Test the voltage/signal coming from the senor when an object is detected at a certain distance.
- Test the display and make sure the frame rate being displayed on the screen is sufficient enough for the user to view what's behind them.
- Test the speedometer and battery on a 7-segment display to guarantee the data is being read correctly.
- Test battery in terms of total charge and rate of charging/discharging.
- Test generator efficiency at different pedalling speeds.

Tolerance Analysis:

The tolerance of the proximity sensor will be one of the most important components of our device. If the sensor is poorly callibrated, half of the device's sensing abilities will be null. The sensor must be able to detect vehicles but ignore other "noise" (e.g. trees, birds, pedestrians). This will require us to callibrate both the distance and beam width of the output signal.

To test this, we will have to try out multiple frequencies to determine which is the most efficient and locating specifically encroaching vehicles. We'll need to analyze data from the network analyzer (smith chart) and determine the appropriate beam width for maximum efficiency and returning strength. We'll incorporate time-scale plots to analyze the sending and receiving times to guarantee that total time falls within our range of less than a second.

IV. Cost and Schedule

Labor:

3 (partners) x $35/hour x 2.5 x 15 hours/week x 10 weeks = $39,375

Parts:

Part name	**Part Price**
Arduino Microcontroller Board	$40
Battery Pack	$40
Mechanical Power generation system	$30
LCD Display	$60
Camera	$100
Antenna for Proximity Sensor	$200
PCB and components	$30
Cables and components used for testing	$30
Total	$530

GRAND TOTAL = 39,905

Schedule:

WEEK	TASK	PERSON *(in charge)*
2/6	Discuss project and finish Proposal Review competitions Research display options Research Proximity Sensor algorithm and options Research Power system (Battery and generator), camera options Research Microcontroller options	Ian Ian Ian Nate Nate Parth
2/13	Research antennaes and transmitting/receiving algorithm Sign up for and start working on Design Review Research Microcontroller options Research displaying system, camera, and power System Finalize component parts and order	Ian Ian Parth Nate Nate
2/20	Finish Design Review Review programming language for microcontroller Research DSP and alerting system Decide/Design circuit schematic for Power system	Ian Parth Parth Nate
2/27	Figure displaying data from camera to LCD Display Decide/Design circuit schematic for Power system Test power generator efficiency	Parth Nate Ian
3/5	Build and test antenna/proximity sensor system Incorporate display, camera, microcontroller with power system	Ian Nate
3/12	Finish Individual Report Testing for efficiency and range for antenna Finalize camera refresh rate to match display and microcontroller	Ian Nate Parth
3/19	*Spring break*	All
3/26	Test and debug DSP algorithm with microcontroller and antenna/proximity sensor system Research and figure method for mounting devices onto bicycle	Ian Nate
4/2	Full integration test for entire system, test for efficiency and functionality, debug if necessary Start preparing for presentation and Demo	Parth Ian
4/9	Start preparing for presentation and Demo	Nate
4/16	Start preparing for presentation and Demo Start final documentation for Final Report	Parth Nate
4/23	Demonstrate results on Demo day Final documentation for Final Report	Ian Nate
4/30	Finish Final Report	Parth