

# ECE 4011 Project Summary

<b>Project Title</b>	Underground Power Vault Inspection
<b>Team Members</b> (names and majors)	Stephanie Chan Electrical Engineering Elizabeth Fuller Electrical Engineering Adrian Muñoz Electrical Engineering Nelson Raphael Electrical Engineering Lemek Robinson Electrical Engineering
<b>Advisor / Section</b>	Lukas Graber / A06
<b>Semester</b>	2019/ Spring Semester      Circle: Either Intermediate or <b>Final</b> (ECE4011) <b>(ECE4012)</b>
<b>Project Abstract</b> (250-300 words)	<p>The goal of our project is to design and produce a remote controllable robot with the ability to test the conditions of underground power vaults. The robot will be used to decrease the dangers that utility workers face when working in underground power vaults. Typically, it can take hours to inspect a power vault to make sure that the conditions are ok to work in. With the power vault inspection robot, it would be possible to immediately send it in and start the inspection process which will speed up the repair time. This can also reduce the amount of time the power grid is down and will reduce the risk for the utility workers.</p> <p>Currently, the mechanical design of the robot is complete, but it is a shell and needs to be completely outfitted with motors, sensors, cameras and any other peripherals. Most of the parts needed for the sensor package can be scrapped from older projects and reused so that the overall expense for the robot is reduced. Some sensors that will be useful in determining if a power vault is safe for human workers to enter are a camera, a microphone, gas sensors, and an infrared sensor. In addition to the sensors, the GUI design has started and connection diagrams of the system have been drafted.</p> <p>We will transfer a high quality image from the robot's cameras back to the user in real time. A visual remote inspection of the vault will positively impact utilities' downtime costs, as well as, aid in reducing further worker incidents. All software and hardware integrations will need to be developed to receive, transfer, and interpret data from the sensor package.</p>

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List <b>codes</b> and <b>standards</b> that significantly affect your project. Briefly describe how they influenced your design.	<ul style="list-style-type: none"> <li>• Ethernet: IEEE 802.3 <ul style="list-style-type: none"> <li>◦ This standard ensures that the ethernet ports for the robot's microprocessor and the machine the application is running on are compatible. This includes TCP/IP protocols.</li> <li>◦ It also standardizes the speed of communication between the devices.</li> </ul> </li> <li>• Wireless: IEEE 802.11 <ul style="list-style-type: none"> <li>◦ This standard ensures wireless local area network (WLAN) communication between separate systems are compatible.</li> </ul> </li> <li>• Serial Bus Communication: RS-232, RS-422 and RS-485 <ul style="list-style-type: none"> <li>◦ RS-232 is the oldest and most widely used serial communication protocol and is used in most laptop serial interfaces. RS-232 was developed in 1962.</li> <li>◦ RS-422 and RS-485 are newer and faster communication protocols.</li> </ul> </li> <li>• I<sup>2</sup>C Protocol <ul style="list-style-type: none"> <li>◦ This standard ensures a specific serial bus master slave protocols works between devices. <ul style="list-style-type: none"> <li>■ This makes it easier to send complex information between multiple processors by putting one in charge of the others while only using 2 wires.</li> </ul> </li> </ul> </li> <li>• USB 1.1 2.0, 3.0/3.1 <ul style="list-style-type: none"> <li>◦ USB 1.1 was the first edition of the USB standard, developed in 1988. Since then, the standard has been upgraded to 2.0 and 3.0/3.1 which have faster speeds.</li> <li>◦ This allows for universal ports that enable communication.</li> </ul> </li> </ul>
List at least two significant <b>realistic design constraints</b> that applied to your project. Briefly describe how they affected your design.	<p>Budget of 500\$</p> <ul style="list-style-type: none"> <li>• The cheaper the sensor, the less accurate the results typically</li> <li>• Limits options of integrating higher quality VR systems</li> </ul> <p>Size of Robot</p> <ul style="list-style-type: none"> <li>• Must be able to fit inside a manhole</li> <li>• All add ons must be built on top of the robot</li> </ul> <p>Environment Constraints</p> <ul style="list-style-type: none"> <li>• must be water-proof, shock proof, dust resistant</li> </ul> <p>Sensor Constraints</p> <ul style="list-style-type: none"> <li>• Power drain from the sensor package must be minimal to extend battery life.</li> </ul>
Briefly explain two <b>significant trade-offs</b> considered in your design, including options considered and the solution chosen.	<p>Wireless V.S. Ethernet communication:</p> <ul style="list-style-type: none"> <li>• Wireless: Allows robot more freedom but may not be as effective through walls of the vault</li> <li>• Ethernet: Restricts movement but is a more reliable form of communication and easier to implement</li> <li>• Option Chosen: Ethernet</li> </ul> <p>Low Light Video Camera vs Logitech Webcam</p> <ul style="list-style-type: none"> <li>• Logitech Webcam: cost less because it is already purchased but is limited in low light</li> <li>• Low Light Video Camera: Will work better in low light but will cost more money</li> <li>• Option Chosen: Low Light Camera</li> </ul>

<p>Briefly describe the <b>computing aspects</b> of your projects, specifically identifying <b>hardware-software</b> tradeoffs, interfaces, and/or interactions.</p> <p><i>Complete if applicable; required if team includes CmpE majors.</i></p>	<p>Human interface that receives information from the robots sensors and displays it in an intuitive format. may also communicate with robot to control its movement</p> <ul style="list-style-type: none"> <li>● C# <ul style="list-style-type: none"> <li>○ Easy to design</li> <li>○ Libraries</li> </ul> </li> <li>● Matlab's App Designer <ul style="list-style-type: none"> <li>○ Better at Graphing</li> <li>○ Easy to design</li> </ul> </li> <li>● Python3.7.1 <ul style="list-style-type: none"> <li>○ Versatile Language</li> <li>○ Libraries <ul style="list-style-type: none"> <li>■ Kivy Library <ul style="list-style-type: none"> <li>● Mobile build</li> </ul> </li> <li>■ OpenCV Library</li> <li>■ Pandas/Numpy Library</li> <li>■ Socket Library</li> </ul> </li> </ul> </li> <li>● I<sup>2</sup>C <ul style="list-style-type: none"> <li>○ Microcontroller needs to master the tablet, the microcontroller controlling the movement and the sensors.</li> </ul> </li> <li>● Google Tango Tablet for SLAM</li> </ul>
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