ECE 4012 Project Summary

Project Title	Underground Power Vault Inspection
Team Members (names and majors)	Stephanie Chan Electrical Engineering Elizabeth Fuller Electrical Engineering Adrian Muñoz Electrical Engineering Nelson Raphael Electrical Engineering Lemek Robinson Electrical Engineering
Advisor / Section	Lukas Graber / A06
Semester	2019/ Spring Semester Circle: Either Intermediate or Final (ECE4011) (ECE4012)
Project Abstract (250-300 words)	The goal of our project was 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 powervault 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. The mechanical design of the robot is complete, and has been completely outfitted with motors, sensors, motor controllers and a camera. The sensors chosen are an object/ambient temperature sensor and an air quality sensor. An audio sensor was not integrated in the mechanical design but it is in the software design. In addition to the sensors, a GUI was designed and coded to display the sensor and video information to the user. A high quality image from the robot's camera is transferred 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 are developed to receive, transfer, and interpret data from the sensor package.

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List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	Wireless: IEEE 802.11 ● This standard ensures wireless local area network (WLAN) communication between separate systems are compatible. Serial Bus Communication: RS-232, RS-422 and RS-485 ● 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. ● RS-422 and RS-485 are newer and faster communication protocols. MQTT (Message Queuing Telemetry Transport): ISO/IEC PRF 20922 ● Client Server publish/subscribe messaging transport protocol. USB 1.1 2.0, 3.0/3.1 ● 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. ● This allows for universal ports that enable communication.
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	Size of Robot ● Must be able to fit inside a manhole ● All add ons must be built on top of the robot Environment Constraints ● Must be waterproof, shock proof, dust resistant
Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	Wireless V.S. Ethernet communication: ● Wireless: Allows robot more freedom but may not be as effective through walls of the vault ● Ethernet: Restricts movement but is a more reliable form of communication and easier to implement ● Option Chosen: Ethernet Low Light Video Camera vs Logitech Webcam ● Logitech Webcam: cost less because it is already purchased but is limited in low light ● Low Light Video Camera: Will work better in low light but will cost more money ● Option Chosen: Low Light Camera

Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** tradeoffs, interfaces, and/or interactions.
 	
Complete if applicable; required if team includes CmpE majors.
	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
	● C#
	   ○ Easy to design
	   ○ Libraries
	● Matlab's App Designer
	   ○ Better at Graphing
	   ○ Easy to design
	● Python3.7.1
	   ○ Versatile Language
	   ○ Libraries
	      ■ Kivy Library
	         ● Mobile build
	      ■ OpenCV Library
	      ■ Pandas/Numpy Library
	      ■ Socket Library
	      ■ Matplotlib
	      ■ cv2
	      ■ pickle
	      ■ struct
	      ■ PIL
	      ■ random
	      ■ datetime
	      ■ time
	      ■ Paho
	      ■ io
	      ■ serial