

EEL 4914 Senior Design I

Divide and Conquer: Version 1

Fire Extinguishing Robot

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Project Description

Introduction

Robots and autonomous devices are making their way into the life of everyone more and more as time passes. They are part of an attempt to ease the difficulties of the daily life of most people. There are areas where robots and autonomous devices are being integrated into society. An example is kitchen assistant robots. In Japan, one of the leading countries in robot technology, they use robots as assistants in the kitchen to make sushi and chop vegetables. They are also used in earlier steps of food production such as planting rice and growing crops. Another example would be the use of vacuum cleaner robots that are programmed to go around the house keeping it clean on their own. Our project involves building a fire extinguisher robot that would help with the security and protection of people, since all people, regardless of whether they work in a kitchen or not, are exposed to the dangers of fires. Among the three major causes of house fires, two of them can happen due to heating equipment problems and electrical malfunction. These problems can happen when no one is paying attention and that might lead to several damages, injuries, and the loss of lives. In those cases, firefighters are the ones responsible for putting out the fire as soon as possible to save as many lives as possible and try to minimize the damage caused. Because of this, every second is important when dealing with home fires.

For example, if a possible malfunction happens and a fire starts, it will take some steps for the firefights to be notified of what is happening. First, the fire will have to produce enough smoke to activate the sprinklers and to notify the authorities. In case the sprinkles fail, one would depend on other residents to notify the authorities about the situation. This delay is enough to have major damage caused by the fire and maybe even the loss of the lives of those who were unable to escape the fire, should the fire get big enough to pose a life-threatening danger. Our project is going to be a robot that is going to be reliable enough to put out a small or medium sized flame on its own with little to no user interaction. Later, the project could be the basis for a more ambitious product that could be placed in every home and help to keep the fire to a minimum until the firefighters arrive at the place. Since almost 50% of the causes of home fires are not related to the action of people and can happen at any time, the presence of a robot that helps to mitigate the spread of fire would be very welcome.

Some fire departments have their own fire extinguisher robot. Those robots usually are designed to work on larger fires where the fire has already spread to multiple places. Our motivation for working on this project is to develop a product that will help be able to put out small fires on its own. We also want to make it simple to use and to set up. Our goals and objectives with this project are to develop an accurate, easy to use, portable and simple robot that would track down small to medium flames and try to put them out.

The robot that we are proposing to design will have multiple sensors that would be responsible for constantly being on the lookout for possible flames. The sensors would be connected to an ADC that would translate the information to the digital domain for the MCU to use it. We also wanted a way of notifying people in the immediate area in case a flame is spotted so that they can take necessary action. For this reason, we are implementing a siren that would

alert people in the surroundings that a flame has been detected. These parts will be placed on top of a platform that will move the robot around when needed. It will also have a container that will be used to put out the flames when detected.

Motivation

The motivation for creating a fire extinguishing robot came from our desire to innovate a device that could help keep humans safe without the risk of putting others in harm's way. House fires as well as fires occurring outside have been an issue for many years. The creation of a fire extinguishing robot could become particularly useful and beneficial to the safety of others. Having a device in the house that could detect a flame and put it out within seconds could result in a much less devastating incident. Fires can escalate very quickly and a fire extinguishing robot could be a first line of protection for many homes. This robot could begin as a simple deterrent from fires developing into bigger fires. Eventually, this robot could be upgraded into one that can take the place of a firefighter from them having to put their lives at risk and entering houses on fire. Instead, they could send a robot that would be able to withstand the heat and fumes inside to put out the fire. In building this type of robot, the hope is that it could spark conversations and potential innovations for more powerful and durable fire extinguishing robots in the future.

Goals and Objectives

The goal of this project is to design a functional robot that can detect a flame using an IR Flame Sensor and maneuver its way to put the fire out. Our primary focus is to make sure the robot we design is accurate and precise with every detection of a flame. Another objective is to make sure the robot is well designed in order for it to be able to move around and to get to specific places without having any issues or damage caused to the robot. We want the design to be simple but effective.

Functionality

Our fire extinguishing robot will be able to move towards a fire when a flame is detected to put it out. This will be done by using an IR flame sensor to detect any amount of infra-red light emitted by the fire. The robot will then maneuver its way to the flame and pump out water to put the fire out. This will all be done without human intervention.

Requirement Specifications

Specifications

- Robot should be between 19.6 in and 23.6 in.
- Robot should have at least 3 sensors to detect the flames.
- ADC should be used to read the output from the sensors.
- MCU is going to be used to control the actions of the robot.
- Robot should have its own reliable power supply.
- Robot should have its own way of moving around.
- Robot should be able to use its fire extinguisher whenever a flame is detected.
- Robot should have its own siren or buzzer.
- Robot should be no more than 50 lb.
- Robot should be able to sense a flame that is 8 meters away from it.

Constraints

The most crucial constraint in this project will be time. We have two semesters to design and implement our project as well as write the documentation for how it was all constructed. Another constraint or obstacle we may face is testing our robot. A lot of the equipment used in this project is not waterproof so we will have to find a way to protect the components. The main objective in this project is for the robot to pump out water and put the flame out, so it will be vital for us to not damage any of the parts that are not waterproof.

Block Diagrams

Figure 1: General Hardware Diagram for Design

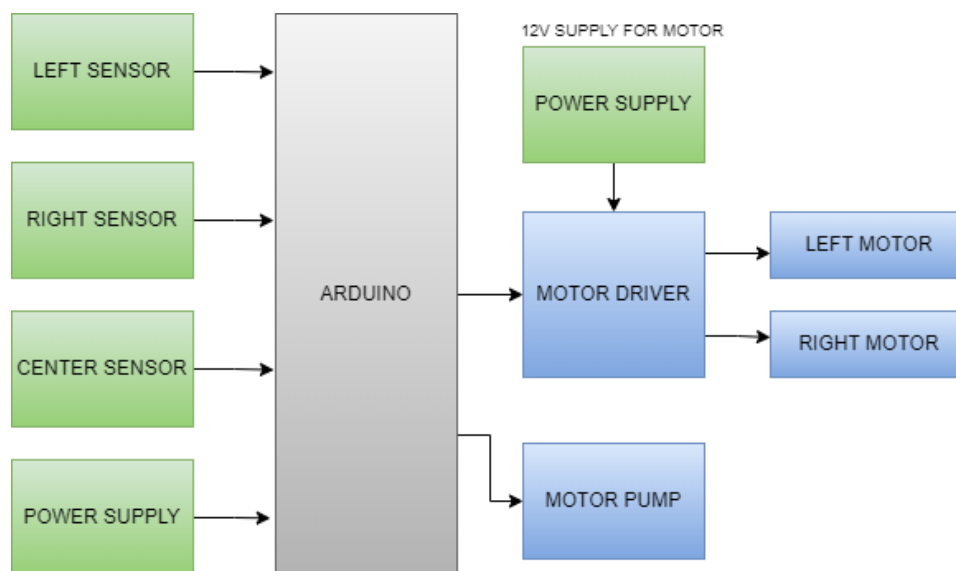


Figure 2: Detailed Hardware Diagram

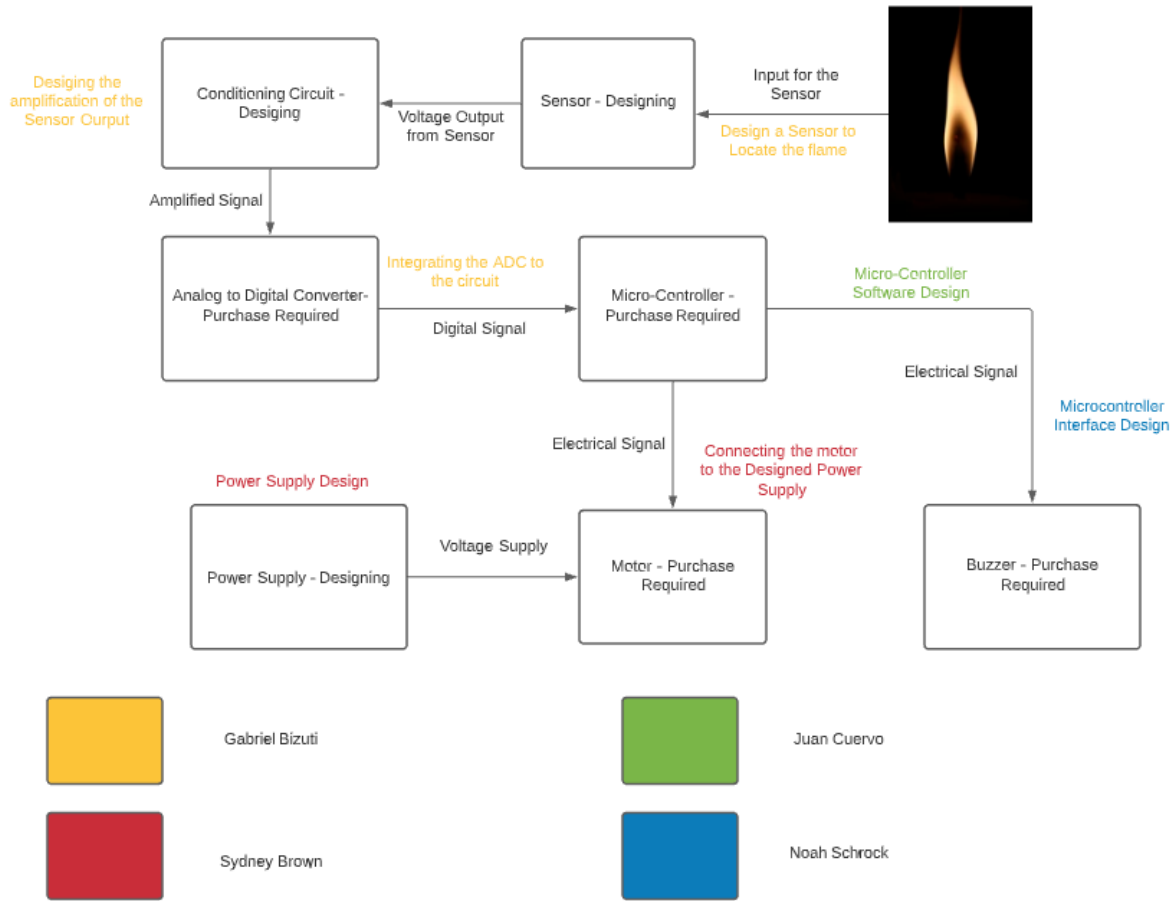
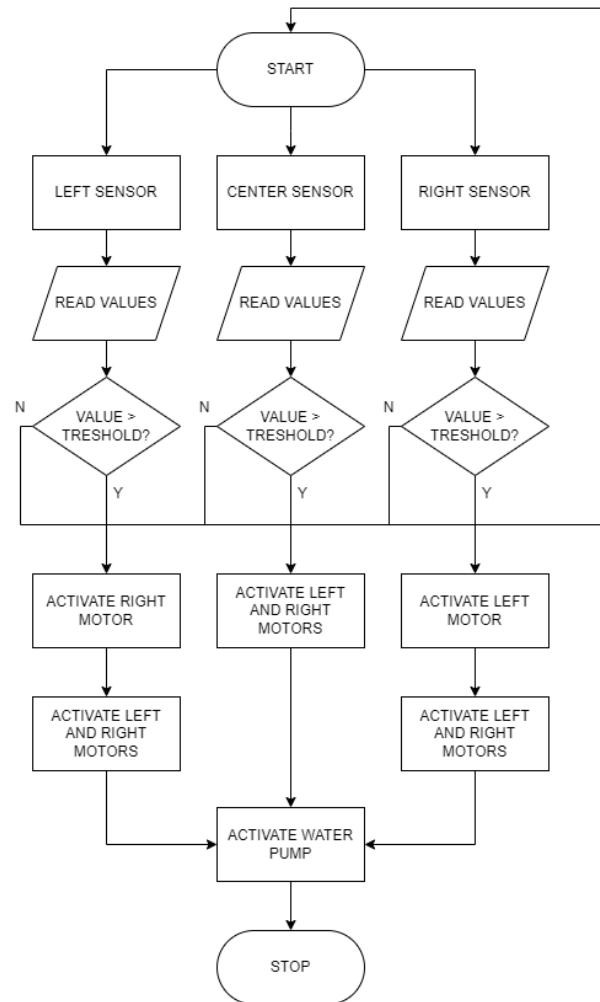


Figure 3: Software Diagram



Budget and Financing

This project is being financed by our project members. We will split any of the costs evenly between the four of us. Some members may already have parts we will need for the project so that will not be included in the costs. The prices and components are subject to change in the future.

Table 1: Estimated Pricing for Project Design

Part Description	Quantity	Price
Arduino Uno	1	~\$25
Fire/Flame Sensor	3	~\$10 total
Servo Motor	1	~\$10
L293D Motor Driver Module	1	~\$8
Mini DC Submersible Pump	1	~\$5
Small Breadboard	1	~\$10
Robot Chassis (with 2 motors and 2 wheels)	1 Chassis 2 motors 2 wheels	~\$20
Small Can/Water Holder	1	~\$5
Connecting Wires	Several	~\$5
Total		~\$100

Milestones

Senior Design I

Task	Date
Divide and Conquer Version 1	February 4, 2022 (2/4)
Divide and Conquer Version 2	February 18, 2022 (2/18)
Assignment on Standards	March 11, 2022 (3/11)
Senior Design I Documentation (60 pages)	March 25, 2022 (3/25)
Updated Report (100 pages)	April 8, 2022 (4/8)
Final Document	April 26, 2022 (4/26)

Senior Design II

Task	Date (exact dates TBA)
Prototype	Early SD2
Testing	Early SD2
Final Build	Early SD2
Midterm Demo	Mid SD2
Final Demo/Presentation	Late SD2

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<https://www.thezebra.com/resources/research/house-fire-statistics/>

IRJET-V8I6583.pdf

https://www.amazon.com/?tag=amazusnavi-20&hvadid=381823688839&hvpos=&hvnetw=g&hvrnd=6200169160307518101&hvpone=&hvptwo=&hvqmt=e&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9011779&hvtargid=kwd-289616759&ref=pd_sl_28nm7nbam1_e&hydadcr=28884_11845471&gclid=EAIAIQobChMIirT7xLHI9QIVzMizCh0ymAYkEAAYASAAEgLiGfD_BwE