SACRAMENTO STATE
COLLEGE OF ENGINEERING & COMPUTER SCIENCE

Assignment 8 - End of Project Documentation

A.F.E.S
Advance Fire Escape System

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Elevator Pitch

We are senior design engineering students building a fire escape system. This system will generate the best-case evacuation route. The system is to be used in a multi-story building.

Executive Summary

This report will go through all the challenges our team will face to achieve the goal of making the evacuation process faster and more efficient. It will analyze the cost of production, marketability, demographic of buyers, and design process. At the end of the report, The team will have a clear understanding of the abilities and shortcomings of our product. Then The team can assess the success rate of the product. After much research, a fire detection system that provides the best scenario escape plan. Also provides live data to the first responder. The team decided to tackle this issue by combining two elements of building fire safety. Evacuation and Detection are the two main elements our design would solve. To be organized and efficient The team broke down the workload into 6 major tasks. Each task has different subtasks and a work package. The 6 tasks are layout, sirens, sensors, LEDs, LCD display, and system code. The team assigns each work package to a team member. Some of the packages were too hard to work on individually so The team assigned them to two team members. The team met weekly to ensure that the project is heading in the right direction. The team will make some adjustments to the work if the team needs to. To accomplish the project, The team needed to set a timeline to ensure that everything went according to plan. The team used milestones to track progress throughout the timeframe. Building the layout, acquiring the parts, finishing the coding, and placing the parts on the layout were some of the milestones for our project. In this project, the team maintained a low-risk factor throughout the project by making sure to have mitigation for all possible risks the team might encounter. Having 300+ parts The team knows that the team will have some parts malfunction. To fix that the team assessed each part of the project and categorized it into a different level of probability/impact. The team has managed to have a better grasp of the problem The team chooses to resolve. The team narrowed our focus to fast deployment and accuracy. Our original problem statement nailed the point the team just needs to keep improving it by making sure the team stays on track. The team will test different parts of the deployable model to guarantee all parts are working autonomously. The group will test seven vital parts in a controlled space to eliminate any external factors that might change the report's result. To work productively collectively, the tests are being parted among the gathering, each gathering part is entrusted to test two parts. The tests consist of timing, decibels, the brilliance of LEDs, reaction time among floors lastly guaranteeing the two designs can impart appropriately. The Work Breakdown Structure and the Timeline outline have been refreshed to show when and who will be dealing with what in the Device Test Plan. With the information that The team will accumulate from the testing, The team will actually want to decide whether the deployable model meets the quantifiable measurements for us to decide its prosperity rate. The fire safety market is huge. The team has a lot of different ways that The team can approach it. From a government legislative to a mandate. The team can also enter the market in cooperation with insurance companies. The insurance companies could provide an incentive to their customers. Large companies are a huge clientele because they cover a vast majority of the business. Several large companies are global enterprises which means they have a lot of establishments/buildings where The team could deploy our product into. The testing that the group did throughout the prototype matched or exceeded the expected results. The team had to modify some of the parts to ensure they fall on the expected results. After doing all the tests in the test plan The team is more confident of the readiness of our product. The testing that The team did meets what The team initially set out to do at the beginning of our project.

Abstract

Due to the increasing number of fires the demand to improve the evacuation plan has become apparent.The group’s solution to this is a fire detection system that provides the best scenario escape plan for people in buildings as well as live data to first responders.This document outlines all the work that was completed throughout the Fall 2021 and Spring 2022 semesters. This document outline goes into detail about the problem and our proposed solution. The group's members divided the proposed solution into parts and created a timeline. Additionally, information such as the cost and funding, work breakdown structure, research on the relevant market for our product, project milestones, risks involved all throughout the duration of the creation of the project, and testing results are all highlighted in this paper. All of the project’s documentation is recorded in this report.

Keyword Index Fire, escape plan, building, Raspberry Pi, python, gas sensor

I. INTRODUCTION

Fire safety and prevention had been an important topic for a long time. Living in California means you have been affected by fire in a certain way either by an actual fire or smoke. The problem that The team are focusing on is buildings that are caught on fire. The problem with building on fire is the fact that it has more factors to be considered when thinking about an emergency escape plan.

A fire detection system with a best-case scenario evacuation route. Additionally, it delivers real-time data to the first responder. The team chose to approach this problem by integrating two aspects of building fire safety. The two key factors that our design would address are evacuation and detection.

To make the job more orderly and effective, The team separated it into six tasks. Each job has subtasks and many work packages. The six responsibilities are layout, sirens, sensors, LEDs, LCD display, and system code. A team member is assigned to each job package.

To complete a year-long project, The team decided to set a timeline to ensure that everything went as planned. The team used milestones to track progress throughout the timeframe. Building the layout, acquiring the parts, and finishing the coding with parts on the layout were some of the goals The team set for ourselves. The construction of the second and third floors, the implementation of all code and hardware, and a fully functional project will be the milestones for the second semester. The job was divided among the four members of the team.

The team maintained the risk factor minimal throughout the process. The team ensured that The team had a strategy in place to deal with any potential threats. It's unavoidable that some of the 300 parts will fail. To deal with this, The team assessed each facet of the project and assigned it a specific probability/impact level.

The team was able to obtain a deeper knowledge of the problem The team selected to address throughout the first half of senior design class. The team narrowed our focus to speedy deployment and accuracy. Our original problem statement was spot on; all The team has to do now is stay on track and continue to improve it.

The various components of the deployable prototype will be tested to ensure that all parts work independently. The team will test the seven key components in the controlled room to remove any external factors that may change the data result. The work breakdown structure and the time scale diagram have been updated to show when and who will be working on what to test the devices. With the data we'll collect from the test, The team can determine whether the prototype being deployed meets measurable indicators so that The team can measure its success.

The market for fire-fighting equipment is massive. It can be approached in a variety of ways. From a government-enacted law to a directive. With the support of insurance companies, The team may be able to break into the market. Insurance companies may offer a discount to customers. Large organizations make up a considerable customer because they account for a vast amount of business. Several huge organizations are worldwide enterprises, which means our product could be employed in a vast number of locations/buildings.

The group's testing results were similar to or better than expected throughout the prototype. In order to attain the desired results, some of the parts must be changed. After performing all of the tests in the test plan, The team is more confident in the readiness of our product. Our testing accomplished the goals The team set for ourselves at the beginning of the project.

II. SOCIETAL PROBLEM

A. First Semester Interpretation of the Societal Problem

When the team thinks about a building on fire the first thing that comes to mind is how to get out. Having to evacuate a large number of people in a short amount of time needs a lot of coordination and planning. The problem is when people do not know how to get out and then panic arises. This creates chaos and confusion that leads people to be stuck within the building. The building architecture does take into consideration

the fire evacuation routes but if the people in the buildings do not know, then it does not matter. According to the National Fire Protection Association, in their report Fire Safety in the United States since 1980, every 24 seconds a U.S. fire department responds to a fire. And every 43 minutes a home fire injury occurs in the U.S. Although fire injuries and home fire dollar loss are trending down compared to 1980 there is a big room for improvement (Ahrens & Messerschmidt, 2021)

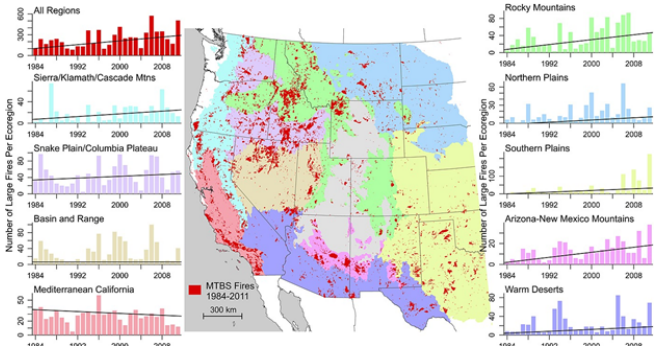

Figure 1 (Large wildfire trends in the western United States)

In Figure 1, The team can see an average of wildfires throughout the western United States. Eight regions show an increase in wildfires from 1984 to 2012. If this trend continues, The team has no option but to be ready. Not only does this destroy homes and lives, it always affects the neighboring states around it.

According to the Critical review of health impacts of wildfire smoke exposure report from an environmental health perspective. Wildfires contribute to many health issues, one of them is respiratory morbidity with growing evidence supporting an association with all-cause mortality. (Reid, Colleen E., et al., 2016)

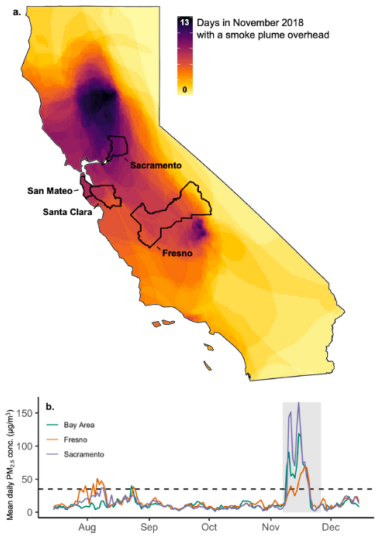

Figure 2 (Map of California counties)

In figure 2 the map of California shows study counties and the number of days with smoke plumes overhead during the Camp Fire in November 2018; data on daily observations of smoke plumes were obtained from the NOAA Hazard Mapping System. Daily mean concentrations from measurements at EPA Air Quality System monitors located in each county during the 2018 fire season. Bay Area includes data from monitors in San Mateo and Santa Clara counties. The shaded area shows the duration of the Camp Fire (the same period represented in the panel, and the dashed line is the NAAQS 24-hour standard for PM2.5 of 35 µg/m3(Santana et al., 2021)

B. Second Semester Improved Interpretation of the Societal Problem

Unfortunately The team keeps seeing tragic fires in buildings. The sad news keeps telling us that the problem still needs to be addressed. When The team chose this societal problem The team did not expect the amount of information and skills The team will have to get in order to make an impact on it. The team talked about the problems The team will be facing such as having to evacuate a large number of people in a short amount of time needs a lot of coordination and planning. The team has come to learn that another factor that

may impact the entire project is the visibility inside the building in a fire scenario.

The tragic event that occurred on January 10 of 2022 in New York only reinforced our motivation for this project. 19 people died during this event because a building caught on fire. Not all died from the fire, but many died from suffocation caused by the poor visibility.(Southall et al., 2022) The team wanted to ensure that the LED would provide a clear path showing the exit even under poor visibility circumstances. smoke goes up toward the ceiling so The team made sure to place the LEDs in the best spot possible to make sure of great visibility. According to Morgan Winsor from ABC News, the fire started at 11 a.m and the smoke took less than 3 hours to envelop all 19 floors.(Winsor, 2022) The New York case gave us a lot of information that The team had to think about. if those people had an easier route to exist and fast detection The team would save more lives.

In another fire situation in downtown Los Angeles, the fire was not as bad as the one in New York but still, The team has learned from the incident. according to Sophie Flay from abc7 "Where's the emergency plan? Where are the residents supposed to go," said Lisa Fink, a 255 Grand tenant.(Flay, 2022) This further proves to us that The team has to make it easy for tenants to get out of the building in an organized fashion.

In another situation, “A large fire at a commercial yard in Adelanto destroyed two buildings, including a former fire station, on Wednesday as San Bernardino County firefighters battled intense flames and other hazards.” This is according to the LA Times.

III. DESIGN IDEA

A. Design Philosophy

When The team started our design The team talked about the scope of our system and whether it would include an extinguishing element in it or not. When The team discussed it with each other The team came to an agreement to focus our power only on detection and evacuation. In our design, The team have to take into consideration the system’s different escape routes, the position of the LED lights, and finally the different types of sound alerts that can be used.

Feature	Measurable Metric
Fire sirens that will be heard around the building, rooms, and hallways.	Each room will have its own 5V buzzer with a noise level of 85dB. The buzzer will have a siren pattern by delaying the buzzer 0.5 seconds in the on and off position. The buzzer will be placed behind the entrance of each room.
A sensor that will detect if there is a fire or flammable gas and smoke in each room	An MQ-2 sensor that is capable of detecting in the range of 300 to 10000 ppm. The sensor will be placed in each room. The sensor will send a signal to the raspberry pi to execute the plan.
The design will allow people to navigate their way out of the building in a fast and safe way using LEDs.	Hallways will have LEDs lights that are placed 1 inch apart. There are two types of LEDs, red and green. The red will indicate the rooms where there is a fire going and

	redirect people to turn around. The green will be used to direct people to exit the building.
The system will deploy the best escape route in a short amount of time.	The system will react to a triggered sensor within seconds. And deploy the plan to evacuate the people in the building using the LEDs. The System criteria are that people go to the nearest exit without going toward the fire.
LCD that shows live data of which room is on fire. The firefighters will know the exact location of the fire.-+	A 16x2 LCD will display the room number and the floor to allow first responders to locate the fire.

Table 1 (Punch List)

B. Specific Design Component

In our project, The team will be using a list of different components, Raspberry Pi 4, LEDs, MQ-2 gas sensor resistors, and 5V Buzzer.

IV. FUNDING

Since our project is not being externally funded. The team had to limit our spending on the project parts. The team has set $400 as our group project budget.

Source of Funding	Amount in US Dollar
Kyle Cruz	$100
Omar Almousa	$100
David Gil	$100
Marco Pablo	$100

Table 2 (Project Funding)

V. WORK BREAKDOWN STRUCTURE

The team divided the job into six tasks to make it more organized and efficient. Each job has multiple subtasks as well as a work package. Layout, sirens, sensors, LEDs, LCD display, and system code are the six duties. Each job package is assigned to a team member. The team divided several of the packages into two teams since they were too difficult to work on alone. The team met once a week to confirm that the project was on track. If necessary, The team will make revisions to the job. The team are averaging 80 hrs a week and by the end of the project, The team will have a total of around 2000 hours.

Feature	sub-tasks	work package	Assigned to	Hours
Layout	Design layout for multiple floors Construct the model floor.	Construct the first floor	Omar, Marco	40 hrs
		second floor	David, Kyle	40 hrs
Sirens	Implement with layout	test the siren		30hrs
		code the siren with Raspberry		30hrs

		Pi		
		place sirens throughout the layout		30hrs
LED Lights	Ensure LED works with the layout	build breadboard for LED		50hrs
		ensure LED works with code		20hrs
		solder LED lights		40hrs
		place LED throughout the layout		50hrs
Sensor	to make the sensor work with the system layout	Test and calibrate the sensor		40hrs
		implement code for the sensor.		30hrs
		place 1 sensor per room		30hrs
		wiring the sensor and connecting them to each assigned pin in the Raspberry Pi		20hrs
LCD display	configure the LCD display	code the LCD display to display the room and the floor		30hrs
		LCD wiring to Raspberry Pi		25hrs
System Code	write a python code with all functionality.	implement sensor		30hrs
		implement code for the buzzer		10hrs
		implement code for the LED configuration.		35hrs
		implement code for the LCD		20hrs

Table 3 (Work Breakdown)

VI. PROJECT MILESTONES AND TIMELINE

In order to complete a year-long project, The team had to create a timeline to help ensure that the project was going as planned. The team set milestones along the timeline as indications of progress. Some of the milestones that The team set were building the layout, gathering the parts, and completing the code with parts on the layout. The second semester's milestones will be the completion of the second and third floor, the implementation of all code and hardware, and a

fully functioning project. The work was split between the four team members.

For the first semester, the team wanted to focus on creating one working floor layout. The team wanted to ensure that The team could get a prototype working in time. To ensure the completion of the full project, The team created a PERT diagram and Gantt Chart (Appendix E).

A. Class Assignments Fall 2021

First, The team had to focus on the class assignments since The team is doing the project in a class setting. In the fall The team had 8 different assignments to do. The team chooses two days in the week to meet on Zoom just to do the assignment. Each team member will do their part of the assignment on their time.

- Assignment 1 - Individual Problem Statement Assignment 2 - Team Problem Statement Assignment 3 - Design Idea Contract – Project Proposal with a specified feature set
- Assignment 4 Work Breakdown Structure – August 2021 to May 2022
- Assignment 5 - Project Timeline – August 2021 to May 2022
- Assignment 6 - Risk Assessment Report Assignment 7 - Laboratory Prototype Technical Evaluation
- Assignment 8 - Public Laboratory Prototype Presentation

B. Class Assignments Spring 2022

For the second semester, The team will have a similar approach to completing our year-end project. The team will meet weekly assignments throughout the semester and tackle each problem individually and as a team.

- Revised Problem Statements
- Device Test Plan Report
- Market Review
- Feature Report
- Testing Results Reports
- Activity Report
- Deployable Prototype Evaluation
- End of Project Report
- Deployable Prototype Report Public Presentation

As a team, The team chose a project to work on that could solve a societal problem. The team had to create a budget plan, part list, and create a blueprint for the floor layout. The team had to order the different parts. A problem The team predicted was the delay and lack of certain parts that The team had to purchase. In order to stay on track, The team had to use different parts available online. After getting all the parts The team tested all of them and made sure The team got familiar with them. For example, the MQ-2 sensor had some learning curves to calibrate and use with the Raspberry Pi. The team divided the code into 4 parts each team member would take one of the parts to do. After that, The team implemented all the code parts together and tested their functionality. The team started to build the First floor and place the parts on the layout. The team had to wire all the different parts to the 8-channel relay board. Soldering the LEDs took most of the time since The team had to solder more than 270 LEDs in total. For the second semester, The team will implement all the floor functions together to complete the system. The team will begin with the 2nd floor and then test it individually to make sure everything is working the right way. Next, the last floor will be made and tested as well. At the end of the second semester, The team will demonstrate the whole system to our class with all the parts working in the right way.

VII. RISK ASSESSMENT

Throughout the project, The team had to set clear criteria to maintain a low-risk factor. The team took into account the project's critical paths and potential events that may risk the compilation

of the project. By doing so The team has looked for mitigation for each one of the risks.

The first critical point The team focused on is the functionality of the parts. In this project, The team has more than 300 parts. Having that many parts introduce the problem of potential failure that hinders the functionality of the whole project of some of its features. Since most of our team members don't have a background in modeling floors, The team had to ensure the stability of the floors. A final critical path would be ensuring no short circuits since The team are dealing with so many components.

There are several risks that may hinder the completion of the entire project. Some of the main risks that The team will focus on will be experiencing some sort of natural disaster or state lockdown. The team has seen both in the last few years so it is something The team must take into account. A second potential risk would be losing a team member due to foreign regulations. Finally, The team must also take into account the risk of using defective parts within the project.

In the project, the team is dealing with a maximum voltage of 5V which is not very risky, but the real problem lies in the wiring of the parts. For example, the LEDs in the build have a voltage of 3V so if The team had any shorts that would mean The team have to replace a whole section of LEDs to fix that. Moreover, sensor reliability is a great factor to consider. Although The team tested the sensor when The team got them The team still had to consider the longevity of the sensor quality and accuracy.

Possible mitigations for the first risk event would be to record our project working completely. By doing so, The team can ensure that The team has proof of a completed project. In the video, The team will demonstrate different case scenarios as if The team were to show them in person. Our solution to the possibility of losing a team member due to deportation is to keep communication via the Internet. The team plan on continuing the communication regardless of the location of team members in order to complete the project. The main brain of the project is the Raspberry Pi. If The team had any problem with it The team would have a problem with the whole system working. To solve that The team had to buy another Raspberry Pi just in case the first one is not working.

Probability						
	5					C
	4			A		
	3					
	2					
	1				B	
	0	1	2	3	4	5
	Impact					

Table 7(Risk matrix)

A: natural disaster or state lockdown
B: losing a team member
C: parts not functioning correctly

VIII. DEPLOYABLE PROTOTYPE STATUS

a.

The team will be testing various components of the deployable prototype to ensure all parts are working independently. The team will be testing seven key components in a controlled room to remove any outside factors that may change the data result. In order to work efficiently as a

team, the tests are being split among the group, each group member is tasked to test two components. The tests consist of timing, decibels, the brightness of LEDs, the response time between floors and finally ensuring both layouts can communicate properly. The Work Breakdown Structure and the Timeline chart have been updated to show when and who will be working on what in the Device Test Plan. With the data that The team will gather from the testing, The team will be able to determine if the deployable prototype meets the measurable metrics for us to determine its success rate.

b.

After testing the project The team got the next results.

Test ID: TI1000

The speed test for the floor to floor and room to room communication was verified and the actual results show very similar to the expected results. Our expected result for the speed test with regards to a one-floor cycle was <30 seconds, and our actual results tested to be about <25 seconds. This test was conducted using a stopwatch. The team would begin the trial once the system is initiated and runs a full cycle through rooms 1 through 6.

Test ID: TI1001

The decibel testing was conducted using the BAFX3370 Digital Sound Level Meter to test the decimal of the buzzer. The test was conducted on each individual buzzer to ensure that each one works independently of the other and that all buzzers are functional. The expected sound level was an advertised 85dBs, but our actual values came out to be around 82-85dBs. There is a small margin of error for our actual results compared to the expected, but each buzzer is verified to be functional.

Test ID : TI1002

The testing of the Green LED requires the use of the HoldPeak HP-881D Digital Lux Meter. The testing requires multiple testing of LEDs to see if they meet the specified brightness. The testing that the group did found the average brightness to be 1700mcd 100mcd lower than expected. This is within the operable conditions and satisfies the measurable metric that the team set out to achieve. The Green LED seems to be working optimally and is set to deploy.

Test ID : TI1003

The testing of the Red LED requires the use of the HoldPeak HP-881D Digital Lux Meter. The testing requires multiple testing of LEDs to see if they meet the specified brightness. The testing that the group did found the average brightness to be 3650mcd, 350mcd lower than expected. This is within operable conditions and satisfies the measurable metric that the team set out to achieve. The Red LED seems to be working optimally and is set to deploy.

Test ID: TI1004

The test for the sensors on the first floor was to make sure they were all working and responding at an appropriate time. Testing resulted in activating the sensors on the first floor and checking the response time. The test was to look at how quickly the MQ2 gas sensor would detect the smoke or gas-particle and send it to the main processing unit. The average times for the response of the gas sensor were 4.25 sec. These results satisfy the measurable metrics that The team set out to achieve and are ready for deployment.

Test ID: TI1005

The test for the sensors on the second floor was to make sure they were all working and responding at an appropriate time. Testing resulted in activating the sensors on the first floor and checking the response time. The test was to look at how quickly the MQ2 gas sensor would detect the smoke or gas-particle and send it to the main processing unit. The average times

for the response of the gas sensor were 4.32 sec. Although there are more than the first floor, these results satisfy the measurable metrics that The team set out to achieve and are ready for deployment.

Test ID: TI1006

For this test The team had to devise a plan to test the communication between the two floors of the modal. The team first had to set certain parameters that are acceptable for our project.

First, the communication has to be reliable and fast. The team made a little mechanism that has two parameters.

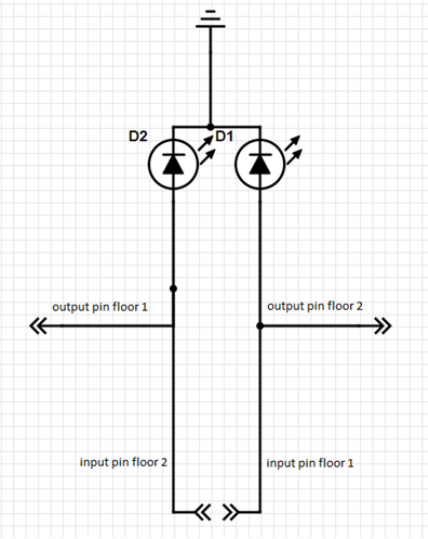

Figure 3 (The communication mechanism)

To test the mechanism I triggered the first floor and timed the other floor's response. The result that The team got was satisfactory for us. The team got less than a 5-second response in more than 15 tests.

Test ID: TI1007

This test was one of the easiest tests. The team had to test all the sensors independently to make sure it is working and accurate. The two main points The team focused on were speed and accuracy. At first, The team had to choose a number of times The team would ping the system to get the result. The more The team ping the more accurate but The team would sacrifice the speed of the result. The team chose to ping the sensor 100 times per cycle. The team found it a sweet spot that ensures speed and accuracy. The team tested the sensor more than 20 times per sensor. After that, The team eliminated the bad sensors that were defected from the factory and only used the ones that passed all the tests.

IX. MARKETABILITY FORECAST

At the end of the project The team will have a fully functional product that could be implemented in different buildings. The product needs to be refined in a couple of aspects. First is the response time, The team is set to achieve a 20-second deployment after a sensor has been triggered. The second aspect that The team would like to improve is the communication between the different floors. The team wants to achieve a 5-second response between the floors.

After all that The team can start to market our product to different entities.

Consumers

First: Government agency

Our first potential clients are local fire protection agencies such as CAL FIRE. The team could market the product to be deployed in different government offices and buildings. After The team shows our product's effectiveness The team could lobby the government to pass a Bill where such devices as the product will be mandated to be used in all federal buildings.

Second: Commercial agency

Our second potential client could possibly be insurance companies that could enforce the use of the products to their clients. Having the product installed in their buildings will increase the chances of survival in a fire emergency.

Third: Industrial agency

Our third potential clients are global manufacturing companies such as General Electric and Siemens. The team could market the product to be deployed in manufacturing factories where a high risk of operational fires could occur.

Our market environment:

The team competes in the market of fire safety equipment. The team did our research and The team couldn't find any product that has the same element The team are proving with our product.

According to the Fire Safety Equipment Market Size (2022 - 2030) Report, "The global fire safety equipment market is predicted to increase at a compound annual growth rate (CAGR) of 6.4 percent from 2022 to 2030, with a market value of USD 46.59 billion in 2021."(*Fire safety equipment market size report, 2022-2030* 2022)

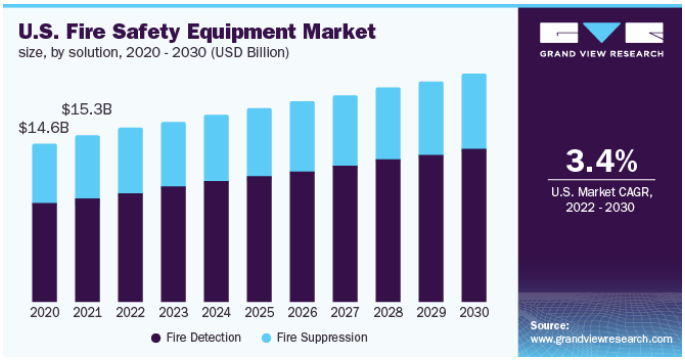

Figure 4 (U.S. Fire Safety Equipment Market)

Comparison

Our closest competitors would include other fire alarm manufacturing companies such as Bosch, Bay Alarm, Honeywell, etc… Most of these companies produce fire alarm and smoke detections systems but do not include the same design that our design encompasses. Our design includes additional features to aid in the escape of a fire scenario. Other products may only detect and alert.

SWOT Analysis

Strength: Our product shows great strength in many aspects. The main aspect that shows its strength is innovation.

Weakness: The weakness of our system is that it requires a configuration for each building since they will not have the same layout.

Opportunities: Our product allows us to be used in virtually any building.

Threats: System malfunction in a fire scenario. Even though The team has tested our product a lot of times. One of the threats is the lack of maintenance of the system which will make it have a small chance to malfunction.

X. CONCLUSION

At the end of the project, this product will ensure that more people are evacuated in a more timely manner and ensure lives are saved. This product will illuminate the best escape route and alert you to loud noise. Having clear paths will help the crowd to easily run toward the exit. In such a fire scenario saving seconds could make the difference between survival and death.

Our design will lead people to safety by using a combination of LEDs and buzzers that is controlled by a Raspberry pi. The LEDs will work as a path for people to follow to the nearest exit. Hopefully, by the end of the project, our design will help to make buildings safer in case of fires. Moreover, it will achieve the goals The team set which are saving more lives.

To make the job more organized and effective, it was divided into six tasks. For each task, there are subtasks and a working bundle. The six jobs include layout, sirens, sensors, LEDs, LCD display, and system code. Each work package has a team member assigned to it. Because several of the packages were too tough to

work on alone, The team split them into two teams. Once a week, The team met together to make sure the project was on track. The team will make changes to the project if necessary.

The team decided to create a timeline to guarantee that everything went according to plan for a year-long project. The team used milestones to keep track of our progress over the course of the project. Some of the objectives The team set for ourselves were constructing the layout, procuring the parts, and completing the coding with parts on the layout. The second semester will be marked by the completion of the second and third floors, the implementation of all code and hardware, and the completion of a fully functional project. The task was shared among the team's four members.

Throughout the procedure, The team kept the risk factor to a minimum. The team made certain that The team had a plan in place to deal with any dangers that might arise. Some of the 300 pieces are unavoidably going to fail. To address this, The team evaluated each aspect of the project and assigned a probability/impact level to it. After assigning the impact The team proposed a way to deal with the risk as a way to leave minimal impact on the project.

Throughout the first half of senior design class, The team were able to gain a better understanding of the problem The team chose to address. The team honed in on quick deployment and great accuracy. All the team has to do now is stay on track and continue to improve our original problem statements.

Test the various components of the deployable prototype to ensure that all parts work independently. The team tests seven key components in the control room to eliminate external factors that can alter the data results. The test consists of time, decibels, LED brightness, the response time between floors, and finally ensuring that both models can communicate correctly.The team will use the data collected from the test to determine if the deployed prototype meets measurable indicators and measure its success.

The fire-fighting equipment market is enormous. It can be tackled in a number of different ways. From legislation passed by the government to a directive. The team might be able to break into the market with the help of insurance firms. Customers may be eligible for a discount from insurance companies. Because they account for such a large quantity of business, large corporations are significant customers. Several large corporations are global operations, which means our product could be used in a wide range of places and structures.

Throughout the prototype, the group's testing outcomes were close to or better than projected. Some of the parts must be modified in order to achieve the desired outcomes. The team is more confident in the readiness of our product after completing all of the tests in the test plan. Our testing met the objectives The team set out for ourselves at the start of the project.

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Glossary

1. **Raspberry pi 4** : A small computer that includes processor, memory and graphics processor in a single, very small, board. It has GPIO pins that could be programmed to do different tasks.

2. **gas sensor**: A sensor that works on 5V It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations.

3. **Autonomous:** To be self-directed.

4. **LEDs:** A light-emitting diode that provides a source of light when current flows through

5. **Relay Switch**: an electrically operated switch.

6. **Buzzer Piezo:** a electronic devices that can generate basic beeps and tones

Appendix A. Hardware

items	description	photo
Raspberry pi 4	A small computer that includes processor, memory and graphics processor in a single, very small, board. It has GPIO pins that could be programmed to do different tasks.	
MQ-2 gas sensor	A sensor that works on 5V DC. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations.	
relay board	computer boards with an array of relays and switches. They have input and output terminals and are designed to control the voltage supply.	

piezo buzzer	A piezo buzzer is a type of electronic device that's used to produce a tone, alarm, or sound.	
LEDs	A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it.	
16x2 LCD	16x2 LCD display screen with I2C interface. It is able to display 16x2 characters on 2 lines, white characters on blue background.	 

Appendix B. Software

Python Programming Language	
library	source
LCD driver	cgomesu https://github.com/the-raspberry-pi-guy/lcd.git
RPIO	https://pypi.org/project/RPi.GPIO/
Time	https://docs.python.org/3/library/time.html

```python
import RPi.GPIO as GPIO
from time import sleep
import drivers
display = drivers.Lcd()
room1 = 20
room2 = 13
room3 = 21
room4 = 16
room5 = 26
room6 = 19
led1R = 17
led2R = 18
led3R = 22
led4R = 23
led5R = 24
led1G = 10
led2G = 9
led3G = 25
led4G = 11
led5G = 8
buz1 = 27
#27
send = 4
res = 5
GPIO.setwarnings(False)
GPIO.cleanup()
GPIO.setmode(GPIO.BCM)
GPIO.setup(room1,GPIO.IN)
GPIO.setup(led1R,GPIO.OUT)
GPIO.setup(led2R,GPIO.OUT)
GPIO.setup(led3R,GPIO.OUT)
GPIO.setup(led4R,GPIO.OUT)
GPIO.setup(led5R,GPIO.OUT)
GPIO.setup(led1G,GPIO.OUT)
GPIO.setup(led2G,GPIO.OUT)
GPIO.setup(led3G,GPIO.OUT)
GPIO.setup(led4G,GPIO.OUT)
GPIO.setup(led5G,GPIO.OUT)
GPIO.setup(buz1,GPIO.OUT)
GPIO.setup(room2,GPIO.IN)
GPIO.setup(room3,GPIO.IN)
GPIO.setup(room4,GPIO.IN)
GPIO.setup(room5,GPIO.IN)
GPIO.setup(room6,GPIO.IN)

GPIO.setup(send,GPIO.OUT)
GPIO.setup(res,GPIO.IN)

GPIO.output(led1R,True)
GPIO.output(led2R,True)
GPIO.output(led3R,True)
GPIO.output(led4R,True)
GPIO.output(led5R,True)
GPIO.output(led1G,True)
GPIO.output(led2G,True)
GPIO.output(led3G,True)
GPIO.output(led4G,True)
GPIO.output(led5G,True)
GPIO.output(buz1,True)
GPIO.output(send,False)

def main():
    x='2'
    while x == '2':
        GPIO.output(send,False)
        print("choose one:")
        print("1-turn on the system")
        print("2-test a senario")
        x = input()
        if x=='2':
```

```
        if x=='2':
            print("choose Room")
            print("Room 1")
            print("Room 2")
            print("Room 3")
            print("Room 4")
            print("Room 5")
            print("Room 6")
            w = input()
            roomTest(w)
    while True:
          display.lcd_display_string("    Riverside   ",1)
          display.lcd_display_string("      Hall      ",2)
          sensorCheck(room1,1)
          sensorCheck(room2,2)
          sensorCheck(room3,3)
          sensorCheck(room4,4)
          sensorCheck(room5,5)
          sensorCheck(room6,6)
def sensorCheck(room,Num):
    e = 0
    while (e<2):
        w=0
        for z in range(100):
            w=w+GPIO.input(room)
            sleep(0.01)
        sleep(1)
        if (GPIO.input(room)==0 and w==0) :
            while True:
                print(" Room "+str(Num)+" fire")
                display.lcd_display_string("Floor 1 Room "+str(Num)+"",1)
                display.lcd_display_string("  Is on Fire  ",2)
                GPIO.output(send,True)
                ledControal(Num)
                GPIO.output(buz1,True)
```

```
                sleep(1)
                GPIO.output(buz1,False)
                sleep(1)
            e = 3
        elif (w == 100):
            sleep(1)
            print(" sensor is working")
            print(" Room "+str(Num)+" no fire" )
            e = 3
        else:
            print("Testing sensor of room " + str(Num)+" try:"+str(e+1))
            e= e+1
            if(e == 2):
                sleep(1)
                print("Room "+str(Num)+" sensor is offline")
                print("Please check the sensor")
                sleep(5)
        w=0
        for z in range(100):
            w=w+GPIO.input(res)
            sleep(0.01)
        if(GPIO.input(res)==1 and w ==100 ):
             print("other floor is on fire ")
             otherFloor()

             display.lcd_display_string(" Fire Detected  ",1)
             display.lcd_display_string("     Evacuate   ",2)
             while True:
                GPIO.output(buz1,True)
                sleep(1)
                GPIO.output(buz1,False)
                sleep(1)

def ledControal(num):
    if (num == 1 or num == 2):
```

```
        GPIO.output(led1G,False)
        GPIO.output(led2R,False)
        GPIO.output(led3G,False)
        GPIO.output(led4G,False)
        GPIO.output(led5G,False)
    if (num == 3 or num == 4):
        GPIO.output(led1G,False)
        GPIO.output(led2R,False)
        GPIO.output(led3R,False)
        GPIO.output(led4G,False)
        GPIO.output(led5G,False)
    if (num == 5 or num == 6):
        GPIO.output(led1G,False)
        GPIO.output(led2G,False)
        GPIO.output(led3R,False)
        GPIO.output(led4G,False)
        GPIO.output(led5G,False)
def roomTest(room):
    GPIO.output(send,True)
    if (room == '1' or room == '2'):
        GPIO.output(led1G,False)
        GPIO.output(led2R,False)
        GPIO.output(led3G,False)
        GPIO.output(led4G,False)
        GPIO.output(led5G,False)
        display.lcd_display_string("Floor 1 Room "+str(room)+"",1)
        display.lcd_display_string("  Is on Fire  ",2)
    elif (room == '3' or room == '4'):
        GPIO.output(led1G,False)
        GPIO.output(led2R,False)
        GPIO.output(led3R,False)
        GPIO.output(led4G,False)
        GPIO.output(led5G,False)
        display.lcd_display_string("Floor 1 Room "+str(room)+"",1)
        display.lcd_display_string("  Is on Fire  ",2)
```

```
    elif (room == '5' or room == '6'):
        GPIO.output(led1G,False)
        GPIO.output(led2G,False)
        GPIO.output(led3R,False)
        GPIO.output(led4G,False)
        GPIO.output(led5G,False)
        display.lcd_display_string("Floor 1 Room "+str(room)+"",1)
        display.lcd_display_string("  Is on Fire  ",2)
    else:
        print("Wrong Entry!!")

    print("enter anything to reset")
    x=input()
    GPIO.output(led1R,True)
    GPIO.output(led2R,True)
    GPIO.output(led3R,True)
    GPIO.output(led4R,True)
    GPIO.output(led5R,True)
    GPIO.output(led1G,True)
    GPIO.output(led2G,True)
    GPIO.output(led3G,True)
    GPIO.output(led4G,True)
    GPIO.output(led5G,True)
def otherFloor():
    GPIO.output(led1G,False)
    GPIO.output(led2G,False)
    GPIO.output(led3G,False)
    GPIO.output(led4G,False)
    GPIO.output(led5G,False)


if __name__ == "__main__":
    main()
```

Appendix D. Work Breakdown Structure

Feature	Subtask	Work Package	Assigned to
layout	Design and construction of multiple model floors	Construct the First floor	Omar, Marco
		Construct the Second floor	David, Kyle
Sirens	Implement with layout	Test siren	Kyle
		code siren to Raspberry Pi	David, Kyle
		place sirens throughtout	Marco
LED	Ensure LED Work with layout	build breadboard for LED	Omar, David
		ensure LED works with code	Kyle
		solder LED lights	Omar,Kyle
		place LED throught layout	David, Kyle
Sensor	Make the sensor work with system layout	Test and calibrate sensor	Marco
		implemnt code for the sensor	Omar
		place 1 sensor per room	Omar
		wiring the sensor and connecting them to each assign pin in the Rasperry pi	Omar,Kyle
LCD Display	Configure LCD Display	code the LCD display to display the room and the floor	Kyle
		LCD wiring to Raspberry Pi	Omar,Kyle
System Code	Write a Python code with all functionality	implement sensor	Omar
		implement code for the	Omar
		implement code for the LED configuration	Omar
		implement code for the LCD	Omar
Testing	Test the System to see if it matches benchmark	speed test	Kyle
		Decibel test	Kyle
		LED test	Marco
		Floor Case Scenario	Omar,David
		Gas Sensor	Omar

Table 4 (Work Breakdown Structure)

Appendix E. Timeline Charts and PERT Diagrams

Fall	2021							Team Leader
week 1	30-Aug							
week 2	6-Sep			Research idea individually				
week 3	13-Sep		Assignment 1					
week 4	20-Sep	Team Activity		Creat eBudge Plan, part list, and blueprint for layout				
week 5	27-Sep	Team Activity	Assignment 2	Order Parts				Kyle Cruz
week 6	4-Oct	Team Activity	Assignment 3	Begin floor layout				
week 7	11-Oct	Team Activity	Assignment 3	Test each part				
week 8	18-Oct	Team Activity		Write code for LCD desiplay, siren LED, and MQ-2 sensor				
week 9	25-Oct	Team Activity	Assignment 4	place and wire the parts				
week 10	1-Nov	Team Activity	Assignment 5	implement code to design layout				
week 11	8-Nov	Team Activity	Assignment 6	connect Raspberry Pi				
week 12	15-Nov	Team Activity		Project prototype complete				Omar Almousa
week 13	22-Nov	Team Activity						
week 14	29-Nov	Team Activity						
week 15	6-Dec		Assignment 7/8					
Spring	2020				Device Test Plan			
week 1	24-Jan	Team Activity		Create part list for second flor	Kyle	TI1000		
week 2	31-Jan	Team Activity	Assignment 1	Order Parts		TI1001		
week 3	7-Feb	Team Activity	Assignment 2	Begin second layout	Marco	TI1002		
week 4	14-Feb	Team Activity		Test all parts		TI1003		Marco Pablo
week 5	21-Feb	Team Activity		write code for LCD display, siren, LED, and MQ-2 sensor	Omar	TI1004		
week 6	28-Feb	Team Activity	Assignment 3	place and wire the parts of 2nd layout		TI1005		
week 7	7-Mar	Team Activity	Assignment 4	Implement code to design layout	David	TI1006		
week 8	14-Mar	Team Activity				TI1007		
week 9	21-Mar	Team Activity						
week 10	28-Mar	Team Activity		connect all wires, paerts and Respberry Pi				
week 11	4-Apr	Team Activity	Assignment 5	Implement code to desgin layout				
week 12	11-Apr	Team Activity						David Gil
week 13	18-Apr	Team Activity	Assignment 6	Testing all system functionality				
week 14	25-Apr		Assignment 7					
week 15	2-May		Assignment 8					
week 16	9-May		Assignment 9	Project Complete				

Table 5 (Gantt Charts)

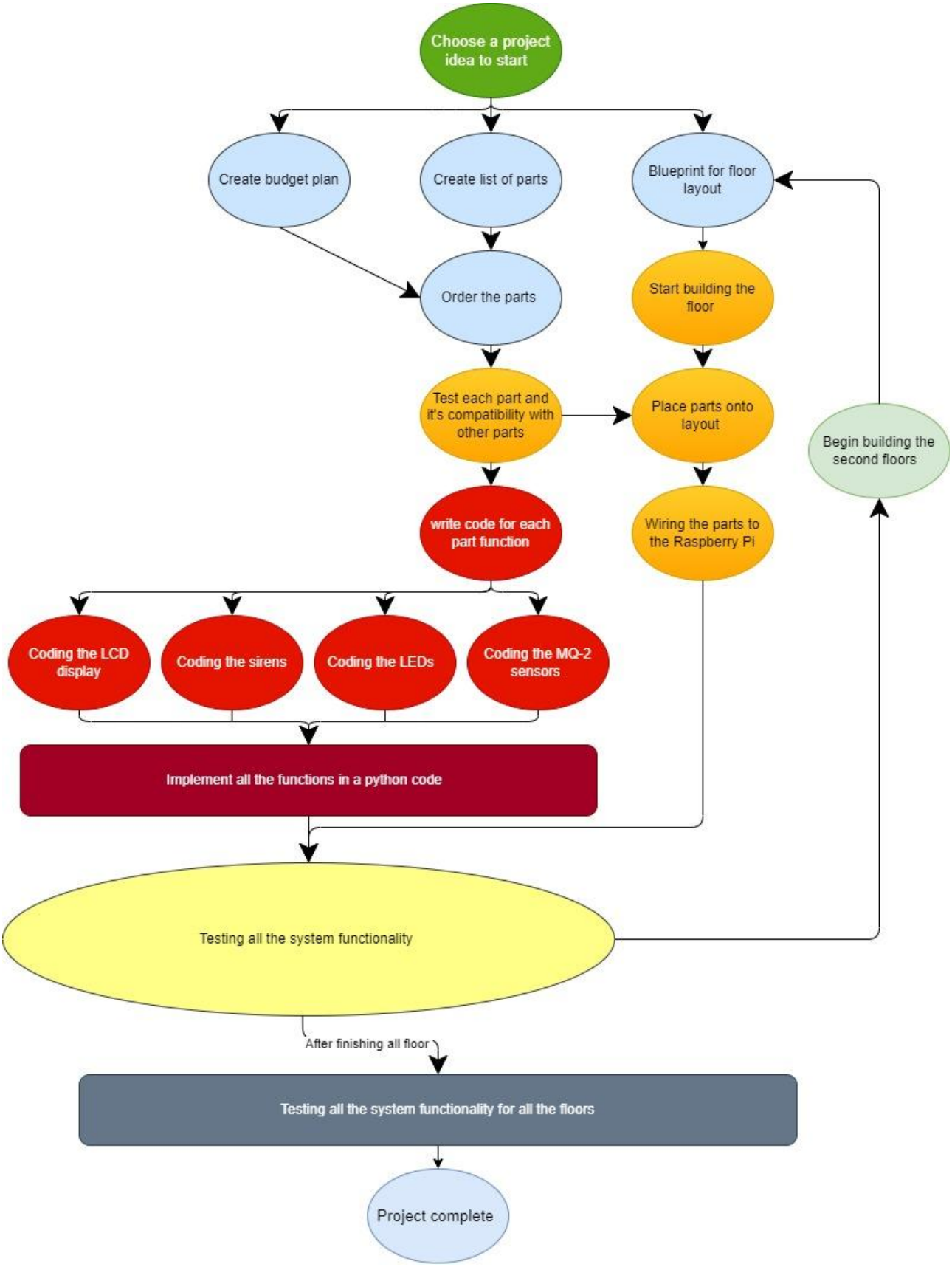

Table 6 (Pert Diagram)

Appendix F. Device Test Plan

Name	Test ID	Test Description	Expected Results	Actual Results	Pass/Fall (to Measurable metrics)	Date Required 04/04/2022
Kyle	TI1000	Speed Test	<30 seconds	~28.5	pass	X
Kyle	TI1001	Decibel Test	85db	83db	pass	X
Marco	TI1002	LED Green	1800mcd	1700mcd	Pass	x
Marco	TI1003	LED Red	4000mcd	3650mcd	Pass	x
David	TI1004	Case Scenario Test First Floor	All sensors working with response time less than 5 seconds	~4.25sec	Pass	x
David	TI1005	Case Scenario Test Second Floor	All sensors working with response time less than 5 seconds	~4.32sec	Pass	X
Omar	TI1006	Case Scenario Test Combined Floors	Both floors to communicat e which room is on fire and create escape plan	Worked with less than 5 second delay	Pass	X
Omar	TI1007	Gas Sensor	Each gas sensor works independent ly, response time < 5 seconds	~4 seconds	Pass	X

Table 8 (Device Test Plan)

COMPUTER ENGINEERING STUDENT

KYLE CRUZ

GET IN CONTACT

Mobile: 415-624-4050
Email: kylecruz456@gmail.com

3075 Redding Avenue, Apt 1614
Sacramento, CA 95820

SKILLS

- Circuit Design and Analysis
- Java, C and Python experience
- Assembly Language
- Verilog and VHDL
- Microsoft Office and Google Drive
- Computer Architecture
- Data Structures and Algorithms
- Computer Hardware Design
- Hands on experience with Microprocessors

RELEVANT COURSES

- Object-Oriented Programming I & II
- Discrete Structures
- System Programming in UNIX
- Computer Interfacing
- Circuit Analysis
- Computer Hardware System Design
- Advanced Logic Design
- Data Structures and Algorithm Analysis
- Network Analysis

PERSONAL PROFILE

Full time student at California State University, Sacramento currently pursuing a Bachelor of Science in Computer Engineering – ABET Accredited. Driven to pursue a career in software development as well as computer hardware engineering. Willing to work with computer hardware and software in order to create new innovations with the purpose of enhancing technological efficiency and improving AI software.

As of right now, I am looking to gain more experience in my field of interest and expand my knowledge through actual hands-on corporate work. Though I do not have much professional experience in my current field, I am willing to work through any task given to me in order to build my expertise in the industry. It is my goal to contribute to the technology industry anyway that I can in order to further technological advancements that may improve the quality of life for all individuals around the world.

EDUCATION HISTORY

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

Bachelor of Science in Computer Engineering, 2018 – Present
- Dean's Honor Roll
- Cumulative GPA: 3.5

VANDEN HIGH SCHOOL, FAIRFIELD, CA

Graduated Class of 2018. Honor Roll. High School Diploma
- Member of Key Club
- Athletics in Football
- Athletics in Wrestling
- AP United States History, AP Physics, AP Biology, AP English Language and Composition

Marco Mendoza

Sacramento, CA, 95823

Cell: (209)200-5848 Email: marcopablo8@gmail.com

Objective

Seeking for full time job where I can assist and grow my current skills

Skills

MS Word, Excel, PowerPoint, Outlook, Teams; Problem Solving: Troubleshooting Network Problems, Internet Connection Issues, Printer connection errors and Login problems.
Hardware/Software: change and replace various computer components.

Work Experience

Information Technology Associates

California State: Department of Parks and Recreation September 2021 to Current

- Support 5,000 user's
- Create, delete and modify users account
- Deployment of computer to various locations across CA
- Solve Tier 1 and Tier 2 problems

IT Help Desk

University Enterprise Inc July 2020 to September 2021

- Worked the Help Desk providing PC support, diagnosing, troubleshooting and resolving client issues with hardware maintenance, installations and upgrades
- Prepared equipment for employee use, performed or ensured proper installation of services, operating systems, or appropriate software
- Worked with Active Directory to build user network profiles, reset passwords, unlock accounts, etc.
- Installed, repaired and setup computer peripherals

Data Analyst Intern (CIRB)

California Homebuilding Foundation January 2020 to March 2020

- Maliciously gather, sort and enter data to database
- Gather residential and commercial building permits
- Maintain good relationship from all cities and counties in California

Education

B.S. Computer Engineer expected graduation '22 Sacramento State University

OMAR ALMOUSA

Computer Engineering Student

I3mr77@gmail.com | 323-540-1439

Sacramento, CA 95826

EDUCATION

California State University - Sacramento - Sacramento, CA *05/2022* **Bachelor of Science**: Computer Engineering
3.58 GPA

- Dean's List [Fall, 2018]
- Dean's List [Spring, 2019]
- Dean's List [Fall, 2019]
- Dean's List [Spring, 2020]
- Dean's List [Fall, 2020]
- Dean's List [Spring, 2021]

PROFESSIONAL SUMMARY

Versatile Computer Engineer conversant in most aspects of the field. Eager to grow alongside companies' IT needs and technical arsenals. Committed to maintaining maximum uptimes and optimal operational efficiencies. Enthusiastic and eager to contribute to company success through hard work, attention to detail and excellent organizational skills. Clear understanding of The Tasks and set on being a contributing member of the team. Motivated to learn, grow and excel in The Work.

SKILLS

- Leadership
- Data management
- Excellent work ethic
- Microsoft Office
- Computer proficiency
- Adaptability

WORK HISTORY

Volunteer | Expanding Your Horizons - Sacramento, CA *10/2018 - 10/2018*

- I assisted in the planning of a fun, hands-on, and engaging STEM educational experience. Specifically targeting middle-school girls, the majority of whom are BIPOC girls from under-resourced neighborhoods.
- In the field of computer engineering, I mentored 12 young girls.
- By offering information about the STEM field, I was able to assist.

Peer Ambassador Leader | EF Education First - Santa Barbara, CA *01/2017 - 10/2017*

- Assist students in fully integrating into university life.
- Serve as a spokesperson for the student body.
- Assist the activities team with on-campus and off-campus activities.
  Assist in improving the entire student experience.

AFFILIATIONS

Tau Beta Pi member- The Engineering Honor Society

SOFTWARE

- C
- Java
- Python
- Verilog/VHDL

LANGUAGES

Arabic:
Native or Bilingual
English:
Full Professional

David Gil

Objective

Seeking an internship in the areas of Electrical Engineering.

Skills & Abilities

C Programming, MATLAB, OrCAD PSpice, STM32CUBEMC, VMWare, Oscilloscope, Signal Generator, FPGA, x86 Assembly, Analog Circuits, Arduino, Autodesk Inventor, Multisim, Raspberry Pi, Arduino, Microsoft Office

Network Analysis, Applied Electromagnetics, Signals and Systems, Probability & Random Signal, Modern Communication System, Intro to Feedback Systems, Electromechanical Conversion, Intro To Microprocessors, Engineering Economics, Power System Analysis, Intro to Machine Vision, Digital Control System, Intro Digital Signal Process, Applied Digital Signal Process, Digital & Wireless Communication, Robotics

Education

August 2019-May 2022 BACHELOR OF SCIENCE Electrical & Electronic Engineering
SACRAMENTO CA, California State University, Sacramento

Communication

Minimum Spanish reading and writing