SACRAMENTO STATE

Water Purification

Assignment 8 - End of Project Report

Team 10

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ELEVATOR PITCH

Water pollution is a serious issue that affects the world as 80% of the world's water contains contaminants and in California more than 718,000 [15] people have unsafe drinking water. As senior design students, we are coming up with a way to efficiently purify water from contaminants in homes that do not get water from municipal or privately owned water companies. We will be including methods for user feedback using an application. To filter the water we will use Reverse Osmosis, which utilizes a 5 stage filter and is able to effectively filter 99% of water. This filter will include IoT capabilities and can connect with smart home networks like Homekit and Nest. This enables greater user control over their water. Our filter should be yours and the consumer's choice because unlike typical filters, this has smart capabilities and minimizes the reverse osmosis filter system.

EXECUTIVE SUMMARY

After brainstorming ideas to efficiently purify water, we ended up going with reverse osmosis - as a way to remove chemicals such as Lead, Copper and Mercury from drinking water. Our water filter will be a portable device that has smart capabilities. These smart capabilities serve to distinguish the product in the market and offer consumers in-depth insights to their water quality. The work breakdown structure broke down level 1 tasks into level 2 subtasks, and then into their own subtasks. By breaking down our tasks, we will know what we need to accomplish to complete the project.

The project timeline is a time estimate of each task and what needs to be done, deadlines and the order the task will be done. Each team member has been given a designated section of tasks for the project.The risk assessment is a crucial step during the course of this project. We want to ensure that everyone is safe and that no one gets injured. By avoiding any injuries, we will be able to work efficiently towards the goal of completing this project.As we've worked longer on this project, we can see the areas where we were overeager. This product was intended to be for everyone, but during our research we see that it would be more helpful in underdeveloped areas that lack clean water. A big part of the project is testing - this will ensure that our product is functioning the way it is supposed to. All aspects of the project will be tested by some if not all the team members. Exploring the market we intend to enter is an part of this project. We want to have the best chance in succeeding with this product - the more research that we can do about the market and what we are coming up against, the better.

Abstract

This project presents an integrated water filter and smart monitoring app. This system is simple enough to install in consumer's homes and filters out a significant amount of pollutants. Many filtration methods were considered but reverse osmosis (RO) was chosen. This method has been proven to be effective on all types of polluted water and can be cheaply maintained. The filter cycle will follow a Python algorithm that determines optimal consumer times. This program will collect data on water dispensing time and schedule filter sessions outside of those time constraints. The system is also capable of detecting highly polluted water and alerting the end user through a web app. If a contaminant threshold is triggered, the filter will lock until the user drains the water.
This product will be a portable and stationary water filtering solution. By using a web app, users can view in depth statistics regarding their water usage and cleanliness. This product will have water quality test strips integrated in the reservoir tank and output spout. These strips will work in tandem with machine vision to show relative water quality differences. This will prove that the filter works and the water is safe to drink. Along with this, the mentioned Python algorithm will serve to differentiate this product in the market.
It is important to have a clear breakdown of the work schedule for this project. In doing so, we are able to break down the big tasks into more manageable sub-tasks. Setting deadlines for these tasks would help us be more efficient in completing the tasks.
A project timeline is an important tool when it comes to project management as it helps organize the work that needs to be done and keeps everyone accountable for completing the work. It is important that we maximize our safety whilst working on this project, as any injury could potentially slow down the process of finishing the end project. By testing our project prototype, we are making sure that the prototype is working as intended. If errors and bugs are found, there would be no point of releasing this product into the market - as it will be unusable.

Key Index - parts per million (ppm), contaminants, PFAS - polyfluoroalkyl substances, reverse osmosis (RO)

I. INTRODUCTION

A. *Societal Problem*

The goal for this project is to create a portable solution for identifying and purifying polluted water. There are a lot of criteria that need to be met such as federal and national regulations.

B. *Design Idea*

The design idea for this project is really important, since we want to make sure this product is efficient with the idea of reverse osmosis filtering being the goal that we want to achieve. For this project idea, we are incorporating many features in order to make this filter user-friendly and easy to use.

C. Work Breakdown Structure

The work breakdown structure broke down level 1 tasks into level 2 tasks, and then into even simpler level 3 tasks. By doing so, we were able to know what we need to accomplish - in terms of the simpler parts - to complete the overall tasks.

D. Project Timeline

The project timeline goes over the tasks that each team member is responsible for, with an estimated time that would be needed for the task to be done within.

E. Risk Assessment

The risk assessment section can be split into different types of risks - from injury/sickness, component malfunctions, weather issues, COVID-19 protocols, and any software malfunctions.

G. Device Test Plan

The device test plan is split into the different categories the project is composed of - the coding, electronic components, the enclosure system, the water system, and camera limitations. Each part is discussed in detail throughout this report and Appendix B - the tester, the testing range, and expected results before performing the actual testing.

H. Market Review

The market review is split into three different sections - consumer research, SWOT analysis, and market placement. It is important to consider each of these sections when placing our product in the market.

II. SOCIETAL PROBLEM

A. *First Semester Interpretation of the Societal Problem*

A. *World Issue*

Water pollution is an issue that affects the entire world, not just one specific country or location. It can be very complicated, expensive and oftentimes impossible to remove pollutants from water. To this day, 80% of the world's wastewater contains everything ranging from human waste to harmful industrial waste [11]. Whatever pollutants can be found in freshwater and how much of it is found gives an indication about the sustainability of water for human use - most of all for drinking. As the human population increases, the demand for fresh water increases too.

B. *Local Issue*

There are currently over 39 million people residing in the state of California, which is a large population to ensure safe and clean drinking water. According to Pacific Institute, more than 80% of Californians rely on groundwater for at least part of their drinking water. Groundwater provides natural storage and treatment. If the system were to be contaminated, costly and complex systems would have to be introduced. Chemicals such as “PFAS” or per- and polyfluoroalkyl substances, which are used to produce heat and water resistant materials, have been found in California groundwater. Observations in 2019 found nearly one third of all observations of the chemical in the groundwater were over the limit of notifying government officials. These chemicals are not regulated at a state or federal level. Surface water in California is commonly polluted by pesticides, nutrients, metals and fecal indicator bacteria [3]. In a report by the Environment Working Group or EWG, the City of Sacramento has tap water that is compliant with federal health-based drinking water standards, but has 23 total contaminants, nine exceeding EWG health guidelines [1]. Chemicals such as Copper, Mercury and Lead can be found in the City of Sacramento water. When drinking water is within legal limits, it does not mean that it is always safe to drink. Residents are encouraged to use water filters to filter out the contaminants.

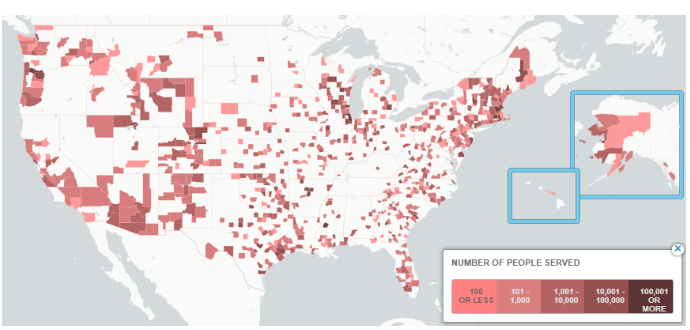


Figure 1. Communities exceeding the EPA’s lead action level of 15 parts per billion (ppb). [3]

In Figure 1, areas with the chance of groundwater pollution get progressively more red. This image shows how California is one of the main areas in the West Coast that is pollution prone.

C. Water Importance

“Safe water, sanitation and hygiene at home should not be a privilege of only those who are rich or live in urban centers. These are some of the most basic requirements for human health, and all countries have a responsibility to ensure that everyone can access them”, says Dr Tedros Adhanom Ghebreyesus, WHO Director-General [7]. The importance of water to the human body is shown by the fact that every human body is 60% water. The presence and consumption of contaminated water can lead to deadly health conditions - varying from cholera, typhoid and hepatitis A. Access to fresh and clean water should be available to everyone around the world, without any additional cost.

D. Pollutants

As seen above, water pollution takes many forms. According to the EPA, contaminants can be categorized as physical, chemical, biological, or radiological. Of these contaminants, physical, chemical, and biological are the most prominent sources of contamination. However, due to physical matter being more easily controlled, the parts of physical matter that are often focused on are chemical. Chemicals such as Lead and other heavy metals are some of the most common pollutants. So in order to properly combat the issue of pollution, EPA guidelines on maximum contaminant level goals (MCLG) and maximum contaminant level (MCL) for drinking water must be followed. Potential health effects from long-term exposure above the MCL of Lead are delays in physical or mental development in children and Kidney problems or high blood pressure in adults. Sources of Lead in drinking water are Corrosion of household plumbing systems; erosion of natural deposits. [4]

Chemical	MCLG (mg/L)	MCL or TT (mg/L)
Lead (Pb)	0	TT; Action Level=0.015
Copper (Cu)	1.3	TT; Action Level=1.3
Mercury (Hg)	0.002	0.002

Table 1 . Lead, Copper and Mercury levels required for water to be drinkable.[4]

Pollutants that fall under the biological umbrella such as bacteria and viruses can be extremely difficult to measure. So instead of measuring the amount of bacteria or virus present, what is tested is the presence of said biological pollutant. Using Total Coliforms, Heterotrophic plate count, and Turbidity will help to indicate their presence [4]. Turbidity is measured using two methods: turbidimetry and nephelometry. Turbidimetry is the measuring of how well light passes through water, and nephelometry is measuring how well light scatters in water. [5]

Figure 2. Examples of Turbidity measures[6]

Total Coliforms is a term used to describe the bacteria that can exist in polluted water. It is not necessarily harmful but it can often indicate the presence of harmful pathogens. The easiest method that seeks to identify these bacteria are best used in water with high turbidity and takes a long period of time under normal circumstances.[10] Luckily There are easier tests that are more immediate and more akin to a litmus test.

E. Implementation

We've chosen to implement a smart, compact reverse osmosis water filter. We chose reverse osmosis (RO) for our filtration method because it's been proven to be the most effective and efficient way to filter water. A typical RO filter has 4-5 chambers whereas ours will only have 3. These 3 will be a pre-sediment filter, carbon filter, and RO membrane. The RO membrane is the most important part of this system since it's the final filter step and handles wastewater with all the pollutants.

Hydrologic cycle is important to know the natural cycle of water and what step our filter is in that cycle. The RO system has a rate of about 1 gallon of clean water for every 3 gallons of inline water. The wasted water is the concentration of pollutants from the inline water. RO requires precise pressure throughout the system to ensure the RO membrane operates properly. Low pressure can cause contaminants to mix with clean water and high pressure can cause unnecessary water waste.

With these factors considered, our filter will utilize smart controls in order to verify water cleanliness and efficiently filter water. To verify water cleanliness, two methods will be used. First, the intake valve will contain quality test strips to detect water quality. The same test strips will be affixed to the output to see the change in quality. This quality check eases consumers and ensures contaminated water isn't dispensed. If the output detects contaminated water, the spigot will remain closed until the water is drained. The system will also integrate with smart home networks. This feature requires 2 small proprietary circuits, but adds immense compatibility for the product. This integration will ensure consumers of their water quality at the click of a button. Important statistics like chemical presence can be displayed.

B. Second Semester Improved Interpretation of the Societal Problem

Upon further research, we found our problem statement to be too broad and generic. Our project would be much more helpful and effective in places in extreme need of clean water. Lack of clean water is an issue throughout this country and this filter could be a reliable, smart solution to this problem.

In order to better cater to these markets, our design will have to face price cuts. By changing the type of battery and enclosure used, this product could cost up to $200 less. Initially, the battery was supposed to be LiPO for increased reliability. This choice is comparably expensive to lead acid batteries which provide a similar reliability for a much lower cost. The motor and electronics need a minimum of 60W, requiring a battery of at least 100Wh. A LiPo battery with this spec costs $120 while a similar lead acid costs $30. This results in a minimum $90 savings, potentially more based on cells bought. Additionally, the enclosure had to be changed from a rolling backpack to a suitcase. A rolling backpack has less vertical space along with less maneuverability. This choice was based on ease of access, but the backpack is detrimental to our design. Placing water reservoirs on the same vertical level as important electronics pose a very high risk. The suitcase solves this by allowing a much more maneuverable, vertical structure. This allows us to secure the electronics higher than the filter which greatly reduces risk. This revised choice also saves around $100 since the suitcase will be procured from a second hand store.

These modifications improve our product and will make this smart filter even more efficient. The 5 filter system will be stored at the bottom of the suitcase and hooked up to our 60W motor. The motor, initial CV testing, and dirty water reservoir will be at the filter input. The final CV testing and clean water reservoir will be connected to the filter output. The motor and RPi will be connected to the lead acid battery. This entire system will be housed in the suitcase with easy access valves for dirty and clean water. This full assembly will effectively filter water and prove cleanliness.

III. DESIGN IDEA

A. Design Philosophy

In order to combat water pollution for consumers using privately owned municipal water companies, we need a device that is portable and effective. We need to implement technologies lacking in most water filters such as IoT, redundancy, and user control. Our idea is a portable water filter that is capable of delivering real time water statistics through multiple avenues. For this idea, many factors must be considered. The most important is the filter's form factor. If it's too bulky, few consumers will adopt the product and its application will be heavily limited. Too light and the lack of rigidity could crush the filtration system and electronics. We must find a middle ground where the components are protected without excessive weight. Following its form factor, the filter system is an important aspect. This system will consist of 5 filter tanks. These tank removals made the most sense since our electronics allow us to effectively monitor the water. After the method of filtering, we had to decide on what smart features to implement. When implementing IoT for a device, we are able to have a device configured to our specifications. IoT integration will allow us to collect data from our test strips and find the levels of contamination in a given sample. The Raspberry Pi will be the brain of the IoT operations due to the wireless internet and computing capabilities.

Feature	Measurable Metric
Product will effectively filter water.	Water quality test strips will be the input & output to measure r difference. If the output measur within a safe limit, the water wa filtered properly. Measuring the presence of lead and copper.
Portability	-Product will be powered by ba -It will be enclosed in a rolling backpack.
Machine vision code	-live recording of water testing chamber -finds color values -records values and calculates metrics
Machine vision sensor for Lead, copper, mercury	Visible colors on test strips will read to indicate concentration
RPi4	Receives data and sends it to a Webapp
Camera module	Is able to capture color values with accuracy and is able to send data reliably
Control from application	On and off signals to and from the device
Provide water quality statistics to a webapp.	The data from test strips will be transmitted from an onboard RPi4 to a server for calculation. After calculation, the server will output water quality metrics on the webapp.
Python Algorithm for Filtration Times	The filter will be used while the algorithm runs. After a 12 hr window, the program will have enough data to execute. While this runs, data will still be collected to optimize the program. The program will be proven to work once the filter is shown to operate in anticipation of usage due to a formed pattern.
Test Strip Functionality	Raw data transmitted and decoded from RPi4 and vision algorithms to the app.

Table 2: Specific Device Features

B. Specific Design Components

This filter will consist of three separate filtration tanks, RO, carbon, and sediment. All three filter tanks will be about 11 inches in length. They will be enclosed in a 3D printed shell and routed using PVC. The water runs through the sediment filter first which will take out a majority of bacteria. The filter can trap 85% of particles 5 microns or larger. Common bacteria range from 5 to 10 microns in length. [16] After this, the water will go through the RO filter. The RO filter uses a semi-permeable membrane to remove the remaining contaminants.

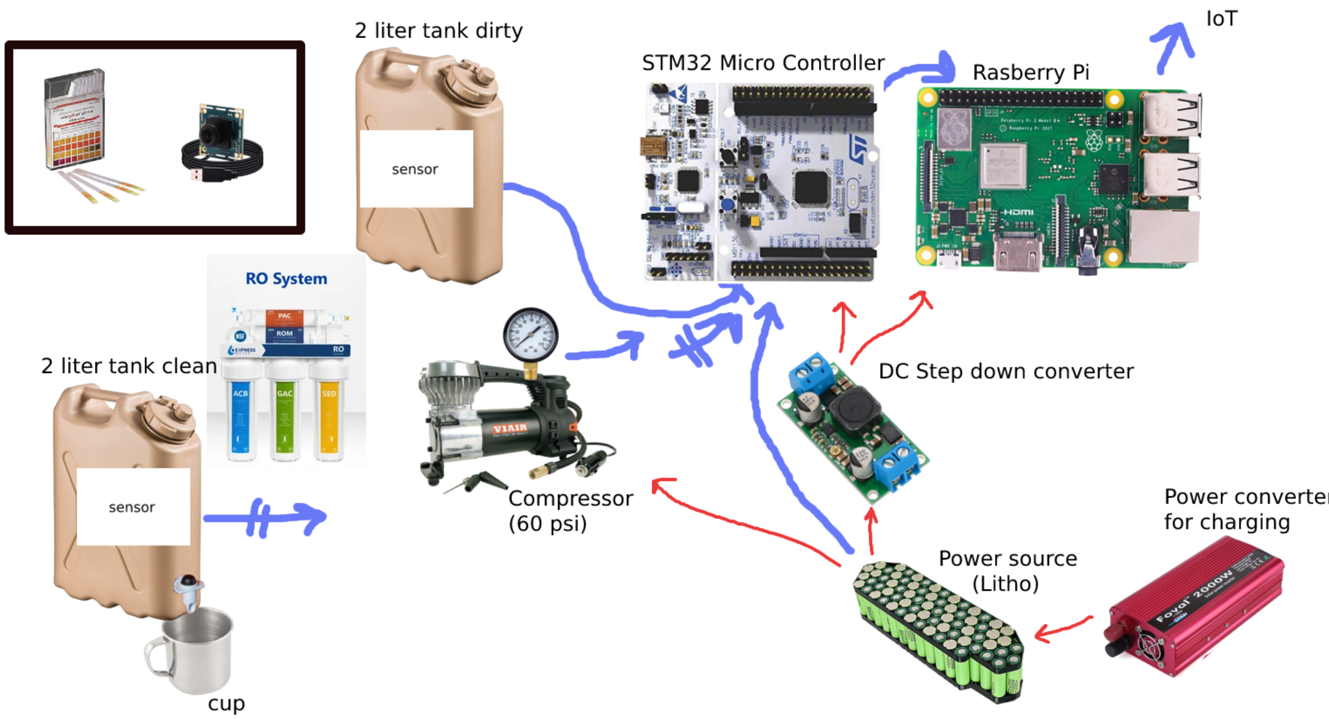
The RO filter is the most important step as it filters out the most contaminants. The water pressure through the RO filter is extremely important, so a compressor will be used to supply 60 psi to the system. The contaminants and clean water go to separate sections as the water continues flowing. The carbon filter will be the last and it's designed to add taste to the water and filter out remaining contaminants. Before the filter, dirty water will enter a reservoir that holds water test strips that will give more accurate feedback on what is in the water. This test can find many contaminants such as Lead, Mercury and Copper. These strips will be read by a Raspberry Pi 4 Camera running our machine vision algorithm. This method will be used because the greatest inaccuracy in water test strips is result readability. [17] This reservoir setup will be replicated at the output valve as well.

Most of the project will be run on a Raspberry Pi 4 microcontroller which will manage the sensor data and battery data in real time. This data will be recorded and calculated on a server hosted by the Raspberry Pi 4 to output to our webapp. The Raspberry Pi will control the camera. The Raspberry Pi has internet connectivity, which will allow us to transmit and receive data. After data interpretation, the Raspberry Pi will transmit water data from the server to the web app. This web app will show the water quality data and relating graphs to the quality in the consumer's area.

The three filter tanks, RPi4, additional electronic components, water storage, batteries. and supports will be enclosed in a rolling backpack design. This backpack will have a spout for clean water and an inlet to hook up to a water supply.

To power all of these devices we will use LiPO batteries. This type of technology has been used for applications in electrical bicycles and other larger rechargeable consumer electronics. This power source will need a step down converter so that the voltage can properly supply the Raspberry Pi 4.

The software required for this product will be written in mostly Python along with some HTML and node.js. We will be implementing machine vision using MATLAB, OpenCv and Python. By using Python and the pandas library, we will be able to create visualizations of your data. We will use a 3D printer to create customized enclosures and parts for our project. Access to electronic testing equipment would also be required.



IV. Funding

Item	Purpose	Cost ($)
RPi4	To act as a central hub for our filtration and smart system.	0
3D Printer	To design prototypes for the filter support and enclosure.	0
Water Test Strips	These test strips are necessary to enable many of our filter's features. They will ensure the consumer's water is always clean.	5-50
3 Consumer Filters	These 3 filters will be RO, carbon, and sediment. They are the most essential parts to the project. Needed for filter function.	150-200
Assorted Electrical Components	This will consist of: resistors, capacitors, LEDs, relays, wires, any other applicable parts we may need.	0-100
Batteries	Li-Po batteries were chosen for resilience, but Li-ion batteries are a viable alternative.	20-120
PVC Pipes	Will be needed for water transportation	10-100
	Total:	**230-620**

Table 3: Overall Costs

As of right now, the only funding for this project is ourselves. It would likely be an equal split between all team members. As the weeks go on and our idea becomes clearer and clearer, we aim to look for sponsors that are willing to help fund this project.

Sources	Amount ($)
Abdul	125
Alyssa	125
Isa	125
Philip	125
Total:	500

Table 4: Funding

V. WORK BREAKDOWN STRUCTURE

A. Activities

In order to build a smart, portable, and accurate water filter the features needed are complex. The reverse osmosis filter system is the most important part. This 3 chamber filter has to be compact enough to fit in the rolling back. Once the filter is proven to work, this mechanical system has to become “smart”. This functionality will be enabled by the RPi4 and code. These components will control the water flow, pressure system, and water output. The machine vision portion will facilitate the validity of the filtered water. Test apps must be made to test Raspberry Pi 4 capabilities and the camera’s limitations. Pandas, OpenCV and TensorFlow are the best software choices for our application. Pandas is a module used in Python. It will manage the collected water data from OpenCV and provide a graphical representation. OpenCV is a machine vision library for computer vision. It will enable our camera’s vision capability and manage the collected camera data. TensorFlow is an open-source machine learning software that will provide us with the training models needed for our color detecting camera. These three components will need to be tested for interoperability with each other and our hardware. Once functionality is validated, the vision program to detect water strip colors will be developed. The colors will be coordinated to the respective pollutants with the hue intensity indicating how much of each pollutant is present. The machine vision program needs to be output to a webapp. This will require an API to allow communication between both programs. Programming is only half the story. The camera will have to be connected to the Raspberry Pi and both programs have to be validated with the hardware. The water strips require procurement, validation, and implementation. For validation, various water samples with known contaminants will be used. For implementation, a 3D-printed housing will be used to hold the strips and camera. Github will be used to deploy the webapp. This will require the machine vision program, API, and Raspberry Pi to all be compatible.

B. Activity Assignment

Between all four group members, this project has uncharted territory. Machine vision and water filtration are unexplored fields for all of us. As a result, this requires a large amount of research and documentation so members understand project constraints. Each member should expect to work 60 hours each for project completion. Abdul and Phillip will be covering the machine vision software portion. Abdul has a strong programming background and will guide development efforts. The machine vision software will take 120 hours. The test apps will take 20 hours and be developed by Abdul. The main vision program will take 60 hours. Phillip will validate the Raspberry Pi compatibility with the program, which will take 10 hours. The remaining 20 hours is a buffer for necessary research and debug. Alyssa will cover webapp hosting, 3D printing, and the camera. She has a strong programming background, a 3D printer, and a Raspberry Pi to connect the camera. 30 hours will be needed for webapp development. 3D printing will take 20 hours with Phillip assisting in CAD design. The Pi and camera connection will take 10 hours. Isa will be covering hardware implementation. The hardware includes the filter system, sensors, shut off valve, and backpack implementation. 30 hours will be needed for filter assembly. The backpack implementation will take 20 hours and RPi4 connections will take 10 hours.

VI. PROJECT TIMELINE AND MILESTONES

In order to create our functioning prototype, we have created a project timeline to break down how long it will take to do certain tasks. We break these tasks into notable milestones for when we make significant progress in the project. One of our main components is creating the reverse osmosis water filtration system. This was split into two parts, the hardware and software for the system. Creating the hardware for the water filtration system consists of designing the parts, ordering the part, assembly and connection to the electronics. This will take about 30 hours total. The reverse osmosis filtration system will primarily put together by Isa Guragain. A major milestone for this section will be a working filtration system and having the Raspberry Pi connected. Another portion of the project is creating the machine vision system. The machine vision hardware consists of a Raspberry Pi running the Debian operating system and the pi camera module. Alyssa Rendon configured the Raspberry Pi hardware with a camera, and passed the controller to Philip Lozano. Philip and Abdul are leading the creation of the machine vision script. The total machine vision section is predicted to take 30 hours total. A major milestone for this section is running machine vision script working with the camera. Another task is using our test strips. Isa is running the tests with the water pollution test strips, while Philip creates a 3D printed housing for the strip to be set in. The housing will be 3D printed by Alyssa. The milestone for this section is the completion of the housing and having it integrated with the system. The water quality application website will be created by Alyssa. This is predicted to take 30 hours. Another milestone will be connecting the power sources to the system, this will be a sign of complete integration. Lastly, every week we are tasked with in-class assignments. Team activity reports are due every week and take about 1 hour for each member. We also have to add to our report in different sections, adding figures to tables as well as writing narratives for the section. These take about 3-4 hours per team member per assignment. A milestone is completing half the report and completing the full report.

VII. RISK ASSESSMENT

I. Member Incurs Injury or Sickness

If a member is sick, meaning short term, then there are a few things that must be considered based on if the members tasks are software/documentation oriented or if the task are project assembly oriented. Risks include, getting other members sick, and a member not being able to finish their tasks, causing other group members to have to do their work in addition to their own. This will either slow down or halt the project altogether depending on the individual's tasks and how much it is needed to move forward. Ways to mitigate damages in this event are to be quick and adjust tasks where needed and find ways to fill the hole that this member has left for the others. If the member has tasks that do not risk other members getting sick as well, then it may be possible to have them continue their tasks with a reduced load. However, this is only for those who are working on coding or some other form of online work. If the member is ill then the risks labeled above are similar but with some more extreme consequences. If the member is ill, meaning long term sickness or something more severe, then they may have to stop working all together and just split the individual workload between the remaining members. And the implications of one person down means that the project will probably be set back by a lot of time. Ways to counter this will be smart planning and possible adjusting of the scope of the project. If a member has an injury, then depending on the severity of the injury there could be a variety of risks. If the injury is light, being something that does not require a hospital trip, then there should be little hindrance to the project's schedule. If the member has a serious injury, like a deep cut or a broken bone, then the member might be unable to finish any task for a period of time. This slows down the project's progress and in this event the group needs to distribute the members' tasks among themselves. In the situation that a member is dead or has a disease/injury that incapacitates them for a period of time longer than the 2 semesters of Senior Design, then in the long term, the project will have to be re-adjusted to account for the loss and the work of the member will be properly distributed among the other members. In the event that several members are injured or sick, then the project may not be able to continue, depending on severity. If there is not too much work to be done, then remaining members can choose to pick up the slack and efficiently organize the remaining tasks.

II. Unforeseen Component Malfunctions

In the event that a component physically breaks, like a hose or plastic piece, then we will have an incomplete product and we will have to replace a part. If the part is 3d printed it will need to be printed again and redesigned if necessary. The project won't reach completion, and more funds or time will need to be spent to get back on track. Ways to mitigate these problems from arising are to purchase extra components and/or have alternative solutions ready. If the component is a piece of electronics and it catches fire or explodes, then we have some other added risks. In addition to what was said above, we have the added risk of member injury or property damage which could potentially stop the project in its tracks. To reduce the chances of this happening, we can be more cautious when dealing with these components and have alternatives ready. And in the case that this does happen, being expedient in getting the new part or implementing a backup plan is the best course of action.

III. Weather

In the event of weather risks, including flooding, snowstorms, strong winds, electrical outages or an earthquake. We would need to work with the current conditions and take the recommended safety precautions. The project will be delayed if we are required to take shelter or evacuate. Possible ways to mitigate, are to work on components remotely till it is safe to meet up again.

V. COVID-19 Social Distancing

In the event of COVID-19 social distancing, the team will have to take proper precautions put in place by the university and Sacramento county. The potential impacts this would have on our project would be delaying in-person meetings, and delaying the overall project from completion. Possible ways to mitigate this would be to follow the CDC guidelines, wear masks and to not meet up if we are experiencing symptoms of COVID-19.

VI. Software Malfunctions

In the event of Software Malfunctions, including broken packages, outdated packages, software bugs and corrupt programs. The potential impacts would be the project won't reach completion, and more time will need to be spent to get back on track. Ways to mitigate these problems from arising are to have alternative solutions ready, such as back-up programs that run similar functions.

VIII. DEPLOYABLE PROTOTYPE STATUS

I. Test Strip Enclosure Temperature Limits

The enclosure which holds the test strips needs to be tested for the temperatures that can be withstood. The materials that are used in the enclosure are 3D printed PLA and Acrylic Plastic. So Philip will be testing for any fluctuations to the material and enclosure as a whole under expected temperature ranges that might be introduced into the system.

II. Test Strip Enclosure Pressure Limits

Since water will be entering the enclosure, we need to check for how much pressure the enclosure can handle before it breaks or starts to leak. The enclosure is not going to be under a lot of pressure, but in the situation that the system is left on, we need to see how much pressure will build up and how much the case can handle.

III. Test Strip Visibility Tests

Since the camera viewing the test strip has a clear barrier and a liquid between itself and the strips, there may be situations that impair visibility and thus the functionality of the system as a whole. Philip will be testing to see how visibility of the test strip is affected if warm water is entered into the system or if the whole system is in a high temperature environment

IV. Coding Stability and Speed Tests

We will be testing the system by seeing how fast the code runs and how much it strains the processors on our microcontrollers. These tests will be done by Philip, Abdul and Alyssa. These tests will include running the code with various edited images as well as trial runs to see how fast the code executes as well as the limits of how accurate the code can isolate and identify the strip pollutant tabs.

V. Machine Vision Error Limits Tests

In order to test accuracy of the machine vision code, we will need to run a lot of test strips through the processes and then see how close they are to human evaluations of the strips. Philip will be running the tests with the code and then possibly sending the water out to get results for comparison if results are not already available.

VI. Camera Vision Tests

In testing the camera vision, Alyssa will be performing tests for different environments the camera will be exposed to. Alyssa will be testing the camera outdoors, with no photo box so it is exposed to all elements. The expected result is the photo has too much light exposure, which impacts the outcome of the photo. The next test is using the camera with indoor lighting, typically fluorescent lighting, and no photo box. The expected result is either too much lighting or not enough, impacting the photo. The next test is using the custom photo box, created for a consistent photo environment, to receive a photo with the right level of lighting. The camera is housed right next to the test strip enclosure, which has water introduced to it. Alyssa will be testing how the camera works as water is introduced, and if any water impacts the photo. If the enclosure is sealed correctly, the electronics should not be impacted. This system is designed to be portable, meaning it will exist in different scenarios and even movement. The camera will be tested as the entire system is being moved around such as in transport. This should result in a clear photo, as the camera should be secure and stable. Lastly, many things can happen to our existing variables, such as the photo box shifting or being damaged. This would allow for external light to be introduced, impacting the photo. Alyssa will be testing what happens in this scenario and it is expected the colors are misinterpreted.

VII. Camera Exposure Tests

In this portion, Alyssa will be testing the exposure limits of the camera. This will be done using the onboard software of the pi camera to set the limits. Alyssa will first test how the camera takes a photo with a high exposure, it is predicted the photo will make the colors not appear as they should. The camera will also be tested with the lowest exposure limit, also resulting in a not usable photo. The purpose of these tests is to test the limits of our system, in case they may actually result in a usable photo.

VIII. Electronics Components Specifications Tests

To test the components used. Each component will be measured by Isa and Philip to ensure component specs are met per company given datasheets. Each component used will be tested to make sure that proper information is given and received if needed.

IX. Electronics Microprocessors Temperature Tests

When the processors are running the system there may be an increase in temperature in addition to environmental temperature. To test limits, we will make sure that the stem has proper cooling if needed and then make sure that the system can run under all foreseeable situations.

X. Electronics System Environment Tests

Lastly for all the components being used Isa and Philip will be testing the component performance relative to other components used to see if all components are properly cooperating with each other. This will be done by measuring voltages and currents along each stage of the system and making sure there are no areas of weakness that might break another component

XI. Water system

IX. MARKETABILITY

Consumers

The market our product exists in is to populations that need quick access to safe drinking water. Our primary audience is people who have unsafe drinking water in their communities and populations impacted by a natural disaster such as hurricanes, earthquakes, and more. A consumer could purchase the product in advance for their own disaster preparation, or organizations such as Red Cross or FEMA could purchase several units and distribute them when a disaster strikes.

Historically, bottled water is distributed to people impacted by disasters, or consumers stock up on their own in preparation. Research shows that bottled water prices increase 5 to 15 percent when a disaster such as a hurricane is approaching. After the hurricane, prices increased up to 135%[18]. Our product would save consumers more money and guarantee the security of always having access to clean water. The market should continue to rise due to aging infrastructure, we will always have natural disasters, and the push for using water filters as a water bottle alternative, our product offers accessibility and is environmentally friendly.

Market Environment

This product competes within a niche for the water filter market. In terms of mobile filtering, there are many other cheap options that aren't as bulky but fail to offer water validation. For example, the LifeStraw is $20 and claims "99.99% bacteria and parasite removal".[19] This is an extremely accessible product, but it lacks water verification. This verification is the niche our product fills. Currently, the only purchasable mobile RO systems are only intended for commercial use with $10k+ price tags to match.[20] Even at this price point, there is no verification. The product's retail price will be $650, which places it in between standard under counter filters and commercial RO filters. Innovation in battery and motor technology can decrease the price by $200 max within the next 5 years. This allows us to use cheaper, more efficient batteries along with much smaller motors that can still fulfill our 40 PSI requirement. Future development can consist of filter manufacturing, enclosure tuning, and battery reduction. A lower retail price encourages market adoption especially in remote areas that we want to focus on. This product can expedite the water filtration process for many individuals without other options. This product can change how families get clean water.

Competitors

The biggest competitors to this product are the Lifestraw [19] and mobile, commercial filters. [20] Currently, no patents exist for a similar product. There are patents for innovations in filter technology, but nothing in terms of a full system. The Lifestraw is basic, dip one end into dirty water, and suck in for clean water. This is levels of sophistication below our product. Commercial filters are typically towable units that are hitched on trucks. They are diesel powered motors capable of filtering 10k+ liters of water. There isn't a system for water verification, a strong selling point of our product.

Strengths

There are many strengths of this product which are part of its core design. Most notably of these is portability. Of all of our features, one of the most unique features when speaking of filters is portability. When looking at filters that fall are marketed as portable, many are small models intended to be put on water bottle nozzles.

Another strength of this product is that the RO has a lifespan of 3 years running 100 gallons per day according to the RO systems datasheet seen in Appendix. 4 Figure. 5. This means that in the perspective on long term usage, it is a strong attribute to have from a consumer perspective.

Our product gives the user very valuable data via the easy to use interface that communicates with the device. When looking at competitors there are none that we were able to find that would give pollutant values. For before and after filter cycles, let alone in a portable form factor.

Weaknesses

Now addressing the first strength mentioned previously. Our strength was portability for our features given, but what we gain in features, we lose in form factor. Our filter is portable, but the product is the size of a large rolling suitcase and thus not viable for certain situations that are restrained by the size of the product.

Weakness as weight. With an increasing amount of features and water capacity we increase the amount of load that the user has to move. Since the product has several components that are interacting with large reservoirs of water, the product will be quite heavy and thus is one of the big weaknesses when considering possible consumer demographics.

Another variable to consider as a weakness when marketing is the noise that the system generates. The system has a motor pump and flowing water in the system and those factors generate noise. This noise can be reduced, but the system will be unable to be marketed as a silent system.

Due to the product being contained in a suitcase apparatus, there are only so many different types of terrain that the product can traverse. Not only this, but there may be terrains in extreme cold, where water freezes or extremely hot climates that push the components to their heat and pressure limits. This means that the product will be limited to a certain temperature range.

Opportunities

It is important to think about the possible opportunities in the market that we might be able to exploit with our product. With our project, we have a software and hardware combination. The software part is the key that is marketable - given the fact that the consumer will be able to get output readings of the contaminants found in the sample of water, along with a visual output in the form of graphs. This product can be geared towards RV owners given the fact there is a lot of space for the filter to occupy. After performing our research, we found out there are very few competitors for portable reverse osmosis systems with some sort of pollution detection features - such as the software functionality mentioned above.
If placed on the market and is made available to the public, we would imagine

that this product would not be priced more than $400.

Threats

There are a couple of threats associated with this product in terms of marketability. Everything that we are doing can also be done with a $10 Lifestraw - without the validation aspect that our product is providing. Given that a pump is part of the RO system, it could be considered not safe to have around young children. There are also temperature limits of any particular location. The location can not be used in locations where the temperature is not too hot. As of now, we don't know what is considered to be 'too hot'.

X. CONCLUSION

A. Societal Problem

In conclusion, water pollution impacts millions across the world, including California. Drinking water contains contaminants such as Copper, Mercury and Lead. Consuming contaminated water could lead to long term health impacts and to deadly health conditions like cholera, typhoid and hepatitis A. Our project presents an integrated water filter and smart monitoring app. Water filtering will be done by reverse osmosis because the method has been proven to be effective on all types of polluted water and can be cheaply maintained.

B. Design Idea

The reverse osmosis filter is incorporated with many user-friendly features that allows the filter to be usable in many different instances - such as it being the right size, not being too big or too small. All of these factors, along with the fact that it must do its job, will depend on how well it might do on the market.

C. Work Breakdown Structure

The work breakdown structure helped us efficiently plan our time out for all the tasks that we need to complete. We were able to delegate these tasks to all the group members and set deadlines for when these tasks need to be fulfilled.

D. Project Timeline

The project timeline assigns each group member their main goal for this project. An estimation of how long we might need is indicated as well. However, there is constant communication between all members of the group about deadlines and the progression of all tasks.

E. Risk Assessment

The risk assessment is a crucial step as our group begins prototyping. It's important for all members to know the risks and unforeseen circumstances we may encounter with this project. This allows us to plan efficiently and become more flexible.

F. Problem Statement Revision

This revision is a crucial step to our project's development. We have to ensure the hardware of the system is economical and efficient. By refining the project's audience, we have a better understanding of the compromises needed to be made.

G. Device Test Plan

By testing, we are ensuring that our design works the way we intend it to. We also make sure that if any bugs or errors are brought up or found, we are then able to fix them. This is done by comparing the expected output with the actual output after we perform the tests.

H. Market Review

We are able to gain valuable knowledge by performing an extensive analysis about the market our product is going to be placed in. This information will be used to put our product in a favorable consumer position.

I. Testing Results

REFERENCES

[1]Group, E. W. (n.d.). EWG's tap water Database: What's in your drinking water? EWG Tap Water Database. Retrieved September 27, 2021, from https://www.ewg.org/tapwater/system.php?pws=CA3410020.

[2]Person, Hanak, E., & Chappelle, C. (2021, August 26). California's water Quality Challenges. Public Policy Institute of California. Retrieved September 27, 2021, from https://www.ppic.org/publication/californias-water-quality-challenges/.

[3] Erik D. Olson & Kristi Pullen Fedinick, Suh, R., Waikar, A., Mae Wu - Alum, Wu, M., Olson, E. D., MacMillan, A., & Sedbrook, D. (2020, May 4). *What's In your water? flint and beyond*. NRDC. Retrieved October 12, 2021, from https://www.nrdc.org/resources/whats-your-water-flint-and-beyond.

[4] Environmental Protection Agency. (n.d.). National Primary Drinking Water Regulations. EPA. Retrieved September 27, 2021, from https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations.

[5] Ben GB Kitchener, J. W. (1992, August 1). A review of the principles of turbidity measurement - BEN GB Kitchener, John wainwright, ANTHONY J Parsons, 2017. SAGE Journals. Retrieved September 27, 2021, from https://journals.sagepub.com/doi/epub/10.1177/0309133317726540.

[6] USGS. (n.d.). Turbidity and Water. Turbidity and water. Retrieved September 27, 2021, from https://www.usgs.gov/special-topic/water-science-school/science/turbidity-and-water?qt-science_center_objects=0#qt-science_center_objects.

[7] Aid and International Development Forum (AIDF). (n.d.). 5 reasons why everyone needs clean drinking water. AID & International Developement Forum. Retrieved September 27, 2021, from http://www.aidforum.org/topics/health-and-wash/5-reasons-why-everyone-needs-clean-drinking-water/.

[8] Pacific Institute. (2020, October 5). From source TO Tap: Assessing water quality in California. Pacific Institute. Retrieved September 27, 2021, from https://pacinst.org/from-source-to-tap-assessing-water-quality-in-california/.

[9] Mekonnen, M. M., & Hoekstra, A. Y. (2018, January 24). Global anthropogenic PHOSPHORUS loads to freshwater and associated grey Water footprints and water Pollution Levels: A HIGH‐RESOLUTION global study. AGU Journals. Retrieved September 27, 2021, from https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017WR020448.

[10] Ballance, R., & Bartram, J. (1996). Water quality monitoring: A practical guide to the design and implementation of freshwater quality studies and monitoring programmes. CRC Press. https://www.who.int/water_sanitation_health/resourcesquality/wqmchap10.pdf

[11] Tackling global water pollution. UN Environment Programme . (n.d.). Retrieved September 27, 2021, from https://www.unep.org/explore-topics/water/what-we-do/tackling-global-water-pollution.

[12] USGS. (n.d.). Groundwater Quality. Groundwater quality. Retrieved September 27, 2021, from https://www.usgs.gov/special-topic/water-science-school/science/groundwater-quality.

[ns] Fresh Water Systems. (n.d.). What is a reverse osmosis system and how does it work? Fresh Water Systems. Retrieved September 27, 2021, from https://www.freshwatersystems.com/blogs/blog/what-is-reverse-osmosis.

[ns]Fresh Water Systems. (n.d.). Why fresh water is a critical resource. Fresh Water Systems. Retrieved September 27, 2021, from https://www.freshwatersystems.com/blogs/blog/why-fresh-water-is-a-critical-resource.

[15] Rowan, H. B. (2020, January 16). *A million Californians don't have clean drinking Water. Where do they live?* Kaiser Health News. Retrieved September 27, 2021, from https://khn.org/news/a-million-californians-dont-have-clean-drinking-water-where-do-they-live/.

[16] Dr. Biology. "Bacteria Overview". ASU - Ask A Biologist. 03 Jul 2014. ASU - Ask A Biologist, Web. 4 Oct 2021. https://askabiologist.asu.edu/bacteria-overview

[17]*The best water test kits for maintaining healthy water in your home*. Bob Vila. (2021, March 25). Retrieved October 12, 2021, from

https://www.bobvila.com/articles/best-water-test-kit/#:~:text=Test%20strips%20are%20considered%20to,a%20wide%20range%20of%20contaminants.

[18] Vlk, B. (2015, July 24). New Research Examines Bottled Water Sales During Hurricane Season. UVA Today. https://news.virginia.edu/content/new-research-examines-bottled-water-sales-during-hurricane-season#:~:text=Early%20results%20show%20that%20bottled

[19] Amazon. (2016). *Amazon.com: Lifestraw Personal Water Filter* . Retrieved February 28, 2022, from https://www.amazon.com/LifeStraw-Personal-Camping-Emergency-Preparedness/dp/B09SDWF48X

[20] Leonard. (2007, October 31). *WTC 500 GT Water Purification System* . Retrieved February 28, 2022, from https://www.leonardodrs.com/media/1938/wtc-500_datasheet.pdf

GLOSSARY

Appendix B:

Test ID [Team Member]	Description	Testing Range	Expected Results	Actual Results	Pass/Fail
Camera Outdoors, no box [Alyssa Rendon]	Testing how the camera works using outside lighting, with no photobox		Photo has too much light exposure to see test results. Photos would be washed out and cannot capture colors accurately.		
Camera Indoors, no box [Alyssa Rendon]	Testing how the camera works using inside lighting, with no photobox		Photo has too much light exposure that impacts the colors and cannot be read by machine vision script.		
Camera with Photobox [Alyssa Rendon]	Testing how camera works using the custom photo box created for a consistent environment		Photos are taken with the right level of exposure, allowing the colors to be captured with the most accuracy.		
Camera after water introduction [Alyssa Rendon]	Testing how camera works after water has been introduced to the enclosure		Given enclosure is sealed, the camera should not be impacted and		

			work properly.		
Camera with movement [Alyssa Rendon]	Testing how camera works while entire enclosure is in motion		Camera should be secure, so photo should be clear and not blurry due to movement.		
Camera with light leaks [Alyssa Rendon]	Testing if photobox is shifted or out of place, causing light leaks to impact the photo		Colors will be misinterprete d due to additional light leaking into the enclosure.		
Camera high exposure [Alyssa Rendon]	Testing camera with highest exposure settings		Colors will be too washed out to be captured accurately.		
Camera low exposure [Alyssa Rendon]	Testing camera with lowest exposure settings		Colors will be hard to read properly due to the photo being dark.		
SHOOP Enclosure external temp. Test [Philip]	Seeing how a warmer environment can affect the system.		No enclosure issues as melting point for pla is between 170 and 180 °C		
SHOOP Enclosure internal temp. Test [Philip]	How does water temperature affect the materials or visibility?		No enclosure issues as melting point for pla is between 170 and 180 °C		

SHOOP Enclosure Water Pressure Test [Philip]	Testing the water pressure limits of the enclosure.		Stress Points will break at high pressure		
SHOOP Enclosure Visibility Tests [Philip]	These tests will be coinciding the above tests and observing if test strip visibility is impared		There will be some visibility issues at high temperatures, and possibly some with a full enclosure of water		
SHOOP Enclosure Extended usage Time Test [Philip]	Testing to see if exposed to water over extended periods of time, will there be issues with the design.		No leaks		
Machine Vision Stability Tests [Philip]	Testing how stable the program is under different stress points and fixing those bugs if necessary		The program will have few bugs that impair the user		
Machine Vision Accuracy Tests [Philip]	Feeding the code different images to see how far we can get from an original image while maintaining accuracy		Program will be accurate by 10% variance in RGB and HSB depending on pollutant square		
Machine	Running the		The program		

Vision Speed Tests [Philip]	program several times and seeing how fast the program is and if slow, improving it.		will give a high percent accuracy on average		

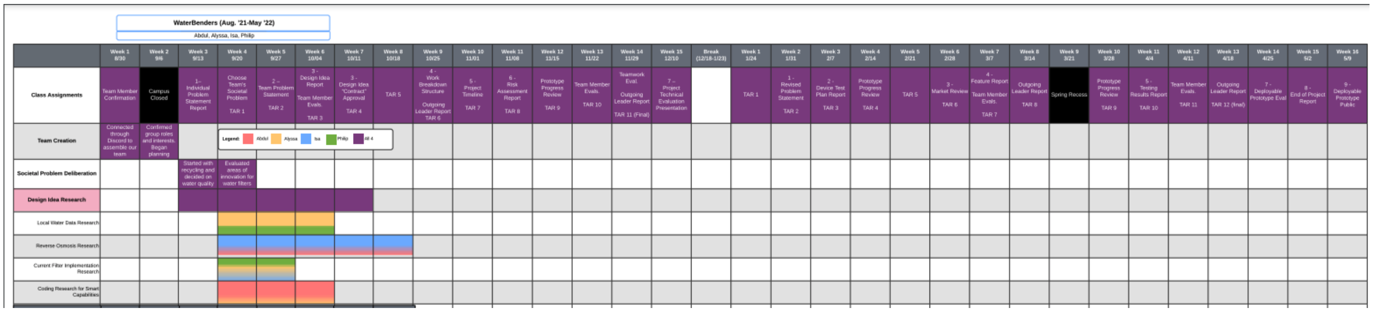
Test ID [Team Member]	Description	Testing Range	Expected Results	Actual Results	Pass/Fail

Appendix D. Work Breakdown Structure

Level 1	Level 2	Level 3
1.Reverse Osmosis Hardware Led by Isa	1.1 Develop Reverse Osmosis system	1.1.1 Research parts needed for Reverse Osmosis
2. Reverse Osmosis Software Led by Isa & Abdul	1.2 Test Ordered Parts	1.1.2 Order filters and required parts
3. Machine Vision Software Led by Philip & Abdul	2.1 create script for controller running RO system	1.2.1 Find methods to test part functionality
4. Machine Vision Hardware Led by Philip & Alyssa	3.1 Create machine vision test applications	2.1.1 Create real time system using RPi4 for RO system
5. Testing Strip functionality Led by Isa & Philip	3.2 Create machine vision script for identifying colors	3.1.1 Study and learn Machine Vision
6. Water Quality Application Site Led by Ayssa	3.3 Connect machine vision output to application site	3.1.2 Install/acquire needed software for machine vision (OpenCV and Tensorflow)
7. Class Assignments Lead by everyone	4.1 Connect camera to Raspberry Pi 4	3.1.3 Make sure software is compatible with Raspberry Pi
8. Connect power source to system Led by Philip and Isa	4.2 Run machine vision script to identify colors	3.2.1 Create machine vision script for identifying colors off of a water test strip, and output the pollutants read.
	5.1 Test functionality of test strips	3.3.1 Use an API to allow data to be displayed from machine vision script onto the web application
	5.2 Design case for test strips	4.1.1 Research and purchase camera module
	6.1 Create and host web app	4.1.2 Connect camera module to Raspberry Pi and initialize set up
	6.2 Display data on web app	4.2.1 Run completed script off of Raspberry Pi
	7.1 Create and complete team activity reports	5.1.1 Purchase water pollutant test strips
	7.2 Create and complete a final report	5.1.2 Test the strips with different samples of water

	8.1 connect all needed power management components	5.2.1 Create and finalize design for test strip case
	8.2 write any scripts needed to control the power management devices	5.2.2 3D print case for test strips
		6.1.1 create a simple web app and host locally or on Github server
		6.2.1 Use an API to display data visualizations from machine vision data.
		7.1.1 Arrange meetings and take notes
		7.1.2 Fill out and submit team activity reports weekly
		7.2.1 Create and contribute to final report every week
		8.1.1 Research needed power and needed components to deliver power
		8.1.2 Purchase powersource and power management devices
		8.2.1 Find information needed to control the power management devices

Appendix E. Timeline Charts and PERT Diagrams



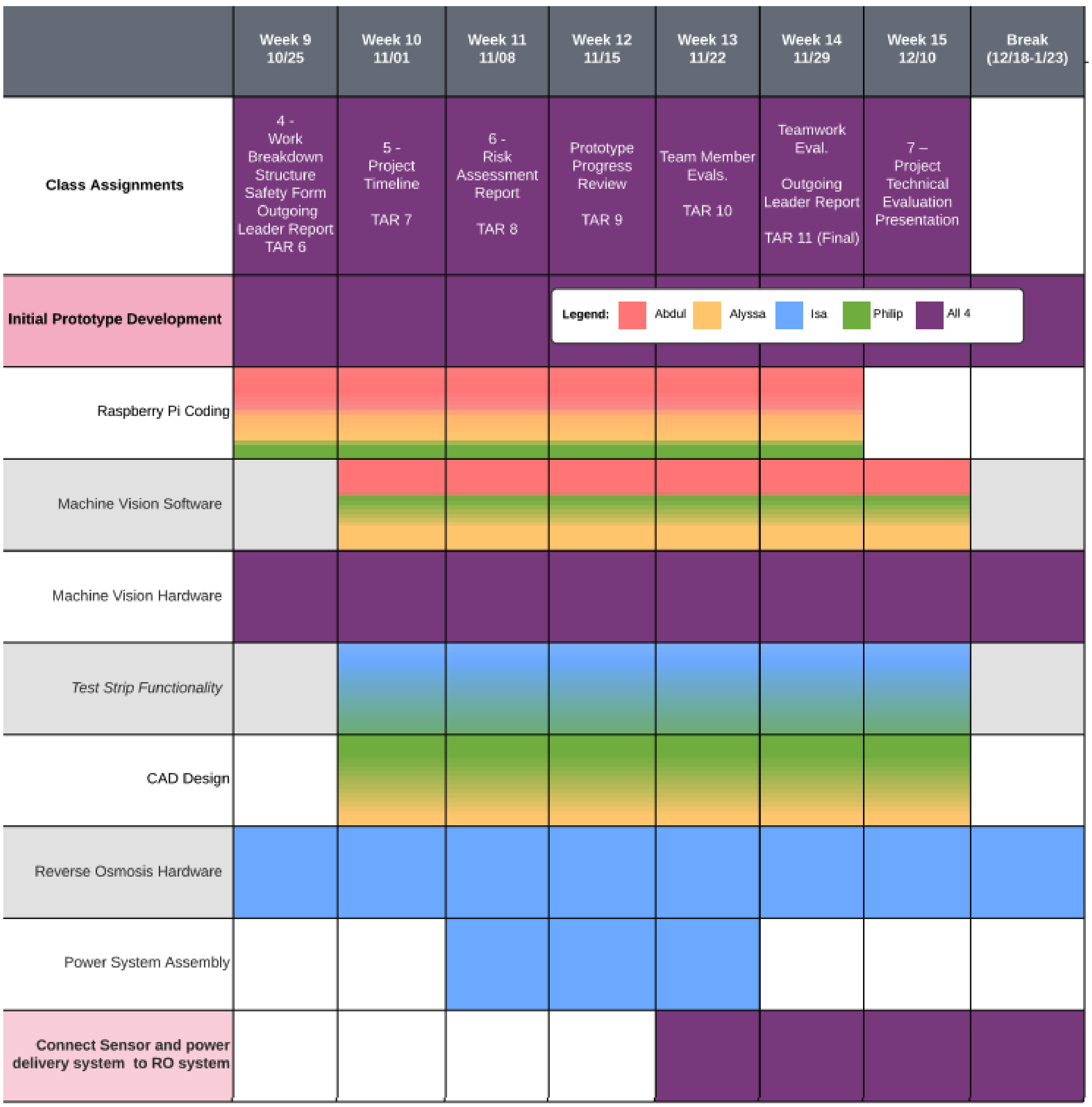


Figure 3. Gantt Chart Project Timeline

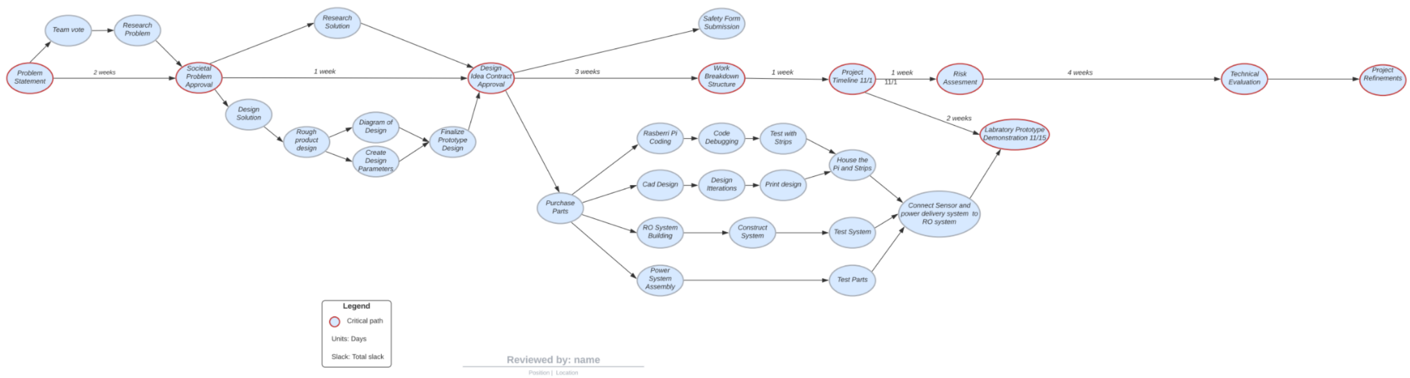


Figure 4. PERT Chart Project Timeline

Specification:
FEED WATER PRESSURE: 40 - 100 PSI
TEMPERATE:40-110°F/5-45°C
PH:3.0 -11.0
MAX TDS :1000 PPM
TURBIDITY <1.0 NTU
MAX SDI <4.0
HARDNESS <5 GPG
Shelf life: 3Years
Warranty: 1 year limited warranty

More valuable information:
✪What is dimension of installed Geekpure RO4-100G(TK) system?
RO unit: Length 14.80 inch, Width 9.2 inch, Height 5.2 inch.

✪What is 4 stage filter and function?
the 1st stage: PP spun filter, Remove sand, dirt, sediment.
the 2nd stage:Carbon filter, Remove chlorine, taste & odors, very fine particulates.
the 3rd stage: Ro membrane, Removes up to 99% of contaminants including arsenic, chlorine, lead, fluoride, mercury, cadmium, odor, heavy metals, and 1000+ contaminants.
the 4th stage: Post coconut carbon filter, Polish water for refined taste.

Figure 5. Reverse Osmosis System Specs

Appendix F: Resumes

Alyssa Rendon

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amrendo22@gmail.com
linkedin.com/in/alyssa-rendon-cpe/

EDUCATION

BS Computer Engineering – *California State University, Sacramento,*
AUG 2017 – MAY 2022

EXPERIENCE

Software Engineering Intern – *Ecolab,* Remote - Naperville, IL
MAY 2021 - AUG 2021

- Active member of the Automation RDE Team.
- Researched and tested if Azure IoT Edge libraries could be installed on a custom ARM-based micro controller.
- Used BitBake to create a custom kernel configuration for a Raspberry Pi 3.

GIS Student Assistant – *California Complete Counts 2020,* Sacramento, CA
FEB 2020 - MAY 2021

- Working with ArcGIS to create maps for the SwORD platform for Census Outreach.
- Using Python (pandas) and Microsoft Excel to organize data.
- Reviewing and ensuring quality data is submitted by California Complete Count 2020 stakeholders and partners.

iOS Developer Intern – *Pacific Gas and Electric (PGE),* San Francisco, CA
JUNE 2020 - AUG 2020

- Working on the Digital Catalyst team and supporting the internal iOS application "Inspect".
- Performed unit tests and assisted in system/integration testing of the application.

STEM Student Assistant – *Sacramento Municipal Utility District (SMUD),* Sacramento, CA
FEB 2019 - JULY 2019

- Supported IT Business Relationship Management workgroup and assisted with daily tasks.
- Worked on projects such as following up on enhancements requests for different business units and working closely with Grid Strategies and Operations.
- Implemented Python (pandas), HTML/CSS, and Sharepoint to maintain and update internal dashboard website.

Technical Intern – *Northrop Grumman,* Palmdale, CA
MAY 2018 - AUG 2018

- Supported Enterprise Services Sector and assisted with IT solutions.
- Worked along side System Engineers on projects for the F-35 Lightning II manufacturing line.
- Troubleshot scenarios where equipment would be used in the production line.

PROJECTS

Smart H20 Pollution Solution
AUG 2021 - PRESENT – *CPE 190*

- Senior Design Project using Machine Vision to analyze water testing strips to compile data on water contamination and filter water using a reverse osmosis system.

Capacity Assistant
FEB 2021 – *SacHacks 2021*

- Won Best Hardware. Created hardware and software for a counter counting when user enters or exits an environment when triggering a sensor. Sensor was created using household products. Web application hosted online to show the count in real time.

SKILLS

Programming Languages

Verilog
VHDL
Python
C
Java
Assembly (x86)
HTML/CSS

Microcontrollers

Raspberry Pi
Arduino
Texas Instruments
Launchpad TM4C123G

Proficient in:

Microsoft Office Suite
Microsoft Azure
Sharepoint
ArcGIS
Unix

Misc.

3D Printing
3D Printer Troubleshooting
PC Hardware Troubleshooting
Rapid Prototyping

INVOLVEMENT

ASI Director of Engineering and Computer Science
JULY 2021 – PRESENT
Associated Students Inc.

President
JULY 2020 – MAY 2021
SHPE: Leading Hispanics in STEM

Isa Guragain

STUDENT INTERN

www.linkedin.com/in/Isaguragain

RELEVANT COURSEWORK

Feedback Systems	Electronics
Calculus I,II,III	Intro to C++
Differential Equations	Network and Power Analysis
Microcontroller Design	

SKILLS

Coding Languages :	Spoken Languages :	Proficiences:
C/ C++/ C#	English	Adaptability
Javascript	Spanish	Conflict Resolution
Python	Cambodian	Urgently Curious
Verilog/VHDL		

EDUCATION

2018-2022

Bachelor's of Science Electrical Engineering

California State University, Sacramento

2014-2018

High School Diploma

Merrill F. West High School

Space and Engineering Academy

PROJECTS

PC Repair

Learned to build and troubleshoot computers, smartphones and server equipment to help family and friends fix various technical issues. This project was pursued to help with family bills.

CAD Robotics

Gained a familiarity with Creo Parametric in order to develop robots to perform specific tasks. This also required an understanding of how to use C++, Arduinos and CAD specs.

San Joaquin H2O Hackathon

Developed a water conservation app to help combat droughts in California and engage the public. Our app won 2nd place out of 16 teams and was a helpful calculator that showed user's water

Space and Engineering Senior Project

Coordinated with a local elementary school to help build neccessities for their science department. Our school needed 2 cabinets to house extra supplies, so my team designed a mockup in Creo and gained approval from the school. This cabinet had to be fiscally reasonable, so we built it from scratch.

EXPERIENCE

December 2019 - January 2021

Intel Corporation

Undergraduate Technical SSD Intern

- Developed scripts in Python to update and log SSD's easily.
- New familiarity with JIRA, electronics repair, and Python.
- Managed many cross-team meetings to drive product release.
- Hosted and planned two college Outreach events. The 2nd event required a new approach to maintain audience attention.
- Gained invaluable knowledge for remote work and life.

June 2019 - August 2019, June 2018 - August 2018

Tesla Motors

Production Associate

- Recommended specialized tools, removing unnecessary equipment, and simplifying flaw prevention to increase yield.
- Collaborated with management to ensure correct processes.
- Exceeded production expectation both years with this help.
- Daily 12 hour shifts demanded safety be staff's first concern.

August 2018 - May 2019

CSU Sacramento

Office Administrator

- Renewed processes to maintain paperwork flow, administrative tasks, faculty requests, and tech support.
- Effectively communicated with staff to elevate concerns and necessary office rules and procedures.
- Developed a system to minimize faculty backlash and internal issues by mandating deadlines.

July 2017 - June 2018

iStyle Repair Shop

Interim Manager

- Managed inventory, completed weekly orders and drove sales for products and services to maintain profitability and sustainment
- Adapted a strong attention to detail to deliver robust repairs.
- Simplified process to reduce customer delays and repair issues.
- Befriended nearby carriers to induce alternative customer flow.

Interests and Hobbies

I

Developing new workflows	Neuromorphic Computing
Efficiently utilizing technology	Applying tech to support disadvantaged countries
Discovering new technology	Increasing production yield
Accelerating Moore's Law	

H

Water Polo	Prototyping
Music Creation/Analysis	Traveling
Car Maintenance	Stand-Up Comedy
Electrical Hardware	PC Building for Family
Hiking	Record Collecting

ABDUL-RAHMAN A. FATTAH

SUMMARY

Hardworking, aspiring college student seeking a position in **Computer Engineering** with an opportunity to develop a career path with the objective of gaining experience and contributing to the organization.

KEY STRENGTHS

- Knowledge of Verilog, Python, Java, and C++
- Hardware experience with Raspberry Pi and PIC24F Curiosity Development Board
- Experience building circuits using resistors and capacitors
- Experience with Microsoft Office applications (Microsoft Word, Excel, and PowerPoint).
- Active listener and quick learner with the ability to work individually and as part of a team.
- Organized and efficient with excellent time management skills.
- Honor-roll at Folsom Lake College for two straight years.
- Tau Beta Pi – CA Upsilon chapter member at Sac State; top 8% of the class as junior and top 5% as a senior.
- Parking Garage Project incorporating various sensors.

EDUCATION

California State University, Sacramento | Computer Engineering 2020 – Present

GPA: 3.6/4.0 - Expected date of graduation: Spring 2022

Folsom Lake College | Folsom, CA - Computer Engineering (GPA: 3.7/4.0) 2017 – 2019

Park House English School | Doha, Qatar - High School I GCSE 2016 – 2017

RELATED COURSES

Advanced Logic Design	Circuit Analysis and Electronics I	Computer Hardware Systems
Data Science and AI	Object-Oriented Programming with C++	Introduction to CIS
Public Communication	Algorithm Design/Problem Solving	Advanced Organization
Structured Programming	Discrete Structure for Computer Science	Computer Interfacing

EXPERIENCE

Mathnasium – Math Learning Center | Folsom, CA - Math Tutor **2019 - Present**

- Assisting elementary and high school students improve their math abilities.
- Assisting the center director in running the day-to-day operations of the center, including opening and closing.
- Grading and awarding the students worksheets and providing feedback on their progress and areas of improvement.

Folsom Lake College | Folsom, CA - Math and Science Tutor **2019 - 2020**

- Tutoring students in computer science subjects and college math classes.
- Helping the tutoring center lead in organizing student appointments and ensuring all students get the help they need in their classwork.

MCF Youth Committee | Folsom, CA **2018 - 2019**

- Participate in weekly meetings to plan upcoming events for the benefit of the youth.
- Brainstorm for creative ways to increase committee member engagement.

Philip Lozano

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(916) 308-7705

EDUCATION

Bachelor of Science, Electrical and Electronics Engineering — Expected Spring 2022
California State University, Sacramento — 3.390 GPA

PROFESSIONAL / WORK EXPERIENCE

Night Man/ Hall Maintenance Assistant, — Fall 2018-Spring 2019
Independent Order of Odd Fellows Temple Association, Sacramento CA

- Responsibilities included for opening and closing the hall for groups ranging from 10 to 100 people, as well as observing and monitoring Odd Fellows Hall and the surrounding property.
- Communicated, interacted, and met the needs of diverse groups varying in age and culture.
- Completed maintenance duties as needed, and secure building before and after events.

PROJECT OR LAB EXPERIENCE

Amplifier Circuits Lab: (*Electronics I*)(*Circuit Fundamentals*) — Spring 2021

- Used Pspice to design an amplifier circuit and simulate the output.
- Assembled inverting and non-inverting op-amp circuits and manipulated the output signal by changing component values.
- Used an Analog Discovery to analyze the circuit, its output and compare results with Pspice.
-

Traffic Warning Light: (*Intro to Microprocessors*) (*C, Circuits)* — Spring 2020

- Worked in a group setting to design a traffic warning light with the potential to be viable for real life use.
- Utilized a microcontroller specified to handle the inputs and outputs in real time.
- Aided teammates with writing and debugging 116 lines of code.

Mini Piano and Metronome: (*Intro to Microprocessors*) *(C)* — Spring 2020

- Designed a device utilizing a microcontroller as well as knowledge of circuits and programming.
- The device helped the user keep time with a built-in metronome and utilized the microprocessors IO functions.
- Wrote 60 lines of code and took an approximate 2 days to finish.

The Slick-Bit: (*Intro to Engineering*) — Spring 2019

- Collaborated in a group of 4 students, in the span of 14 days, to design a hypothetical product that would help aid the elderly with dementia and health problems.
- Lead the group to keep the project moving according to schedule and turn the report in on time.
- In charge of a research and the design/image of the finished product. Utilized skills in photoshop.

KNOWLEDGE AND SKILLS

- Proficient with Microsoft Office and Google Suites
- Experience with NI Multisim and Pspice
- Experience with MATLAB
- Coding languages: C
- Team Player
- Self-Motivated
- Hard working
- Responsible
- Efficient time management skill

CAMPUS INVOLVEMENT / ACCOMPLISHMENTS / ACTIVITIES

Society of Professional Hispanic Engineers (SHPE), *Member* — Fall 2018-Present

- Volunteering at a local Elementary school for a STEM night with 50+ kids.
- Arduino projects with the Junior Chapter. Aided students with brainstorming and using the microcontrollers.

MESA Engineering Program (MEP), *Member* — Fall 2018-Present

Society of Professional Hispanic Engineers (SHPE), *Officer* — Fall 2019-Spring 2020

- Responsible for coordinating STEM events for high schoolers in the SHPE Junior Chapter. Average group size of 30 to 40 people.
- Event that have been coordinated include: Rockets, Hot air balloons, Rubber band / solar cars, Airplanes.

Hornet Leadership Program — Spring 2019

- Met various leaders, active in STEM careers, who talked about what it means to be a leader in the work field. Understanding core values and priorities as well as how a leader should think and act.

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