Smart Fish Tank

Group #9

Initial Project Document - Divide and Conquer

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Understanding the problem and providing a solution

The smart fish tank is meant to be a project that will allow practical experience for concepts learned in a group setting. Along with having to apply knowledge from our respective majors to the creation of a solution to a problem without heavily defined instructions, this project will also reflect engineering industry work where communication and teamwork skills are expected, schedules and deadlines must be planned and met, and self-managed effort must be put into doing research and making progress towards an end result with multiple potential solutions.

Goals for the fish tank project most importantly include designing and implementing a product that will fulfill the functionalities as stated, while completing milestones within the deadlines that have been agreed upon. This product is designed to keep the needs of a customer in mind; therefore, the fish tank will have features that reduce the labor and supervision required of the consumer as much as possible. The tank's primary functional needs will be automated to the greatest degree which is feasible. Another goal for the fish tank is for it to be easy to use. Since one of the main benefits of the fish tank is to simplify the process of easily managing the tank and its needs, knowing how to set up and maintain the system itself should be easy too.

Considering that aquariums can house many fish for many years, durability is an aspect that will be addressed so as to avoid having to repair or replace the system multiple times. Because the tank will always be on, another major consideration will be ensuring that the power consumption of the system due to average use is low, such that the long term costs are not problematic. In addition to efficient power usage, the fish tank will also be as low cost as possible without compromising reliability -- a standard expectation and desire for potential users. Accuracy is an especially essential quality because many sensors, timers, and other devices are implemented into the fish tank. They help the consumer identify if something is wrong with the tank and ensure the wellbeing of the fish; measurements and timings must be as reliable as possible.

Many features have been considered for the smart fish tank, taking into account the basic needs of fish and the functionality of standard aquariums. One of the most crucial parts of aquariums is making sure that the water is kept at proper conditions for the fish. However, if something is wrong with the water, it may not be easily noticeable to the consumer. As a result, sensors for various properties of the water will be included in the self-maintaining fish tank, which will alert the user if there is something wrong with the water. It is expected that the smart fish tank will be utilized constantly over a long period of time, so the sensors must require little power, must be durable, and must require little attention and calibration.

Properties of water that need to be monitored include pH and the salinity of the water. Unseeable by eye, these properties heavily affect the health of the fish. Turbidity of the water is an additional good indicator of the quality of the water. The higher it is, the more suspended particulate matter there is, polluting the water of the fish and resulting in a cloudy tank. Sensors will be added to the smart fish tank to measure all of these properties at regular intervals and notify the consumer if the water needs to be partially changed. Temperature will also be measured by sensor, triggering an automatic

adjustment of the heating of the tank to an ideal level if needed; a water level sensor will notify the customer if the volume of the water needs attention.

Food may be another concern of the customer. In cases where they might have to be away from their home or business for an extended period of time, it would not be desirable to have to worry about feeding their fish. Therefore, an automatic fish feeder will be implemented. This will allow the tank to dispense food on a regular schedule every day as determined by the user, and will require only minimal interference primarily for the purpose of refilling the dispenser.

Lighting for the aquarium must also be maintained. Especially in an indoor environment where lighting may be kept on at irregular intervals or constantly, the amount of light and the time in which fish are exposed to light can negatively impact the circadian rhythm of the fish, and thus their behavior. For additional examples of the effects of unregulated light, too much light could cause algae to grow too quickly within the aquarium and stress the fish, and too little light could affect the behavior of fish by causing them to become inactive or sick. The smart fish tank will include a feature that will turn on and turn off the light at fixed times to ensure that the fish get a sufficient amount of both light and darkness.

Last but not least, the tank will be managed via an app. By making an app, this will give the user an easy-to-use interface with which to adjust and control the various devices of the aquarium. These devices(which are shown in Figure 1) will communicate with the application by sending their respective data. The user will be able to check the current conditions of the fish tank, set timers for devices such as the light and feeder, and control all of this remotely for instances where the user is far from the fish tank. They will be notified through the app if conditions in the tank have become problematic. This will create a cohesive app that anyone will be able to use.

Figure 1: Concept diagram of final components inside

Specifications:

Our system specifications are shown below in table 1, the numbers with asterisks (*) are specifications that can be demoed to potential clients and show the speed and accuracy of our system.

	Marketing:	Engineering Requirement:	Justification:
1	A compact system that can be easily stored and carried is necessary.	The system's *dimensions* should not exceed 8'' 5'' 6''	Having a compact system allows the system to be used in a wider variety of aquarium systems.
2	The system will have components that meet the needs of a consumer for aquarium maintenance.	*PH sensor* should read ph levels between: 7.6 and 8.4 *Salinity sensor* should read levels of 1 - 2 or 30 - 34 ppt *Heater* should heat water up to 85 degrees fahrenheit	A user must have access to most when it comes to maintaining and knowing key information about their aquarium system. The components must meet these standards a aquarium owner might have.
4	Fish feeder will provide the necessary amount of food at the correct intervals.	*The fish feeder* should have an operating speed of at least .12 seconds with a stall torque of at least 17.5oz /in. It will handle depositing food at least 1 time per 30 minutes.	A fish feeder that has the necessary operating speed and torque will allow the food to be deposited into the tank at intervals delegated by the application
5 *	System interacts using WIFI to deliver results at any given time and place.	*The microcontroller* should use the Wireless LAN 802.11b/g standard to communicate to a server	Communicate information about the tank and facilitate remote operation. IoT device market is heavily reliant on wifi technology.
8 *	Thresholds set in app will deliver fast notifications to users.	*Alerts* should be received when thresholds set through app are reached within 1 minute.	Fast response times allows our system to be usable even a user is not directly accessing the application.
6 *	Fast and responsive application for users to interact.	Application should not have *loading screens* exceeding 2 seconds	Market analysis for application design
7	The app and tank should be easy to set up for the average consumer	*Set up time* should not exceed 10 minutes	IoT Market success is dependent on ease of use and setup.
8	Accurate sensors and data	*Ph sensor, tubidity, salinity, and temperature sensors* should be accurate within 7 percent.	Qualitative data of sensors is important for users that deal with sensitive aquarium systems.

Table 1: Specifications

Block Diagram Hardware:

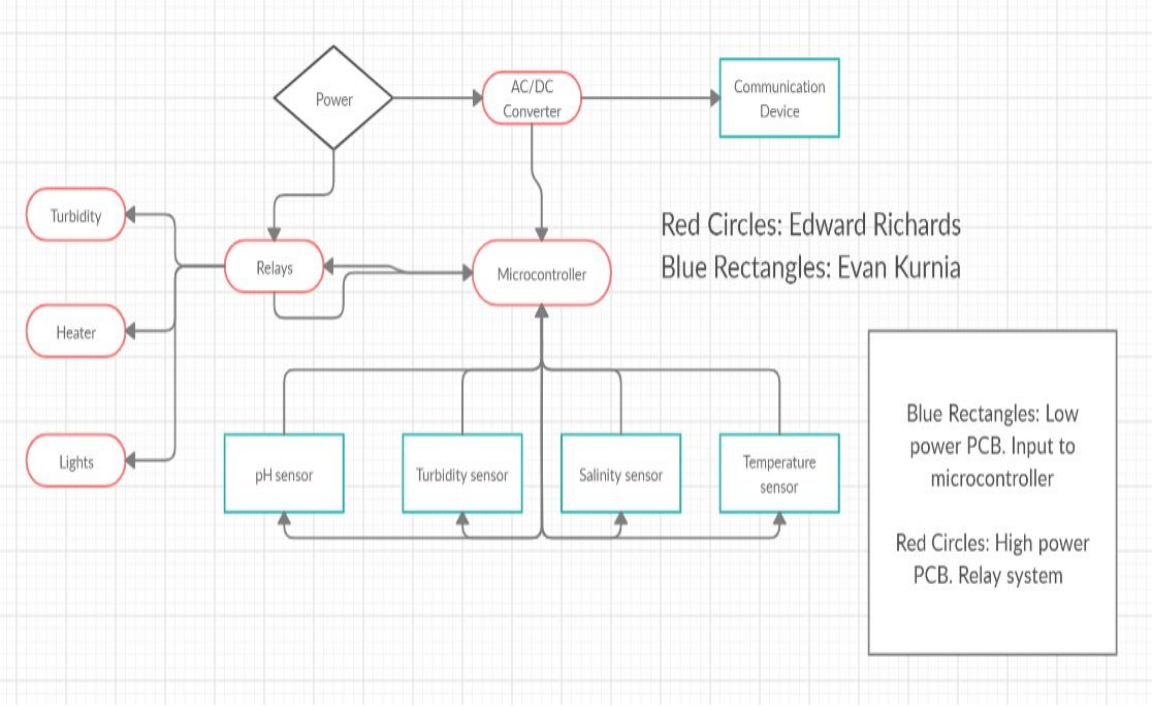

Figure 2: Hardware block diagram

In figure 2 we can see that part of the input power is converted from AC to DC which is then used to power the microcontroller, sensors, pH sensor, heater, lighting, communication via wifi and circulation pump. The input power is also sent to the feeder, heater and lights via relays. The microcontroller controls the relays on/off. The information from the different sensors is transferred through the data bus when the relay is on.

Hardware Centric Responsibilities:

1. Evan Kurnia
    a. Create PCB board which supplies power to all sensors
    b. Supply different communication devices with power

2. Eddie Richards
    a. Creating an relay system that works with the microprocessor for the higher powered A/C components
    b. Create PCB board which supplies power to the different components

Block Diagram Software:

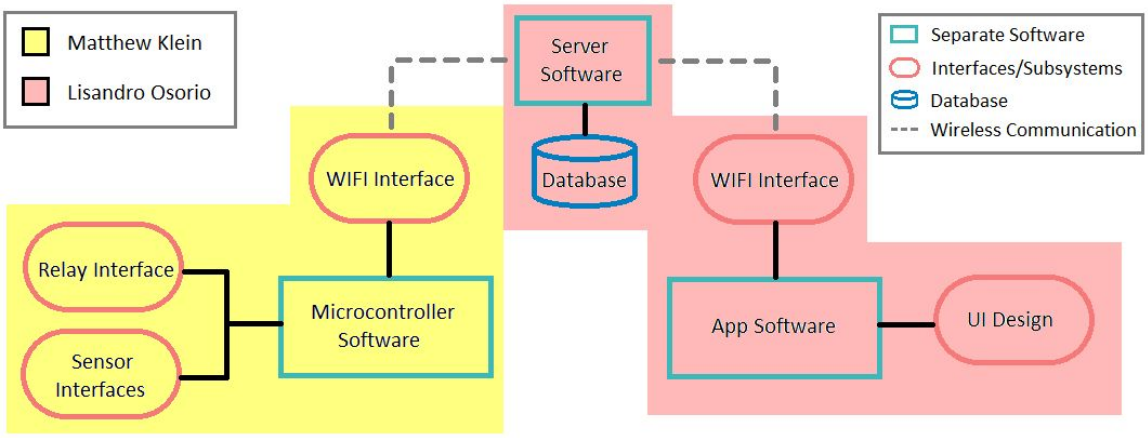

Figure 3: Software block diagram

As shown in figure 3, the main communication stems from the microcontroller and a wifi module, from here the system will communicate to a server where the data will constantly be fed. The application will be in charge of making calls to obtain the information found in this server depending on what the user selects. The application will use a standard layout of having a front end with api architecture to properly make these calls. Currently with our block diagram all items are in progress.

Software Centric Responsibilities:

3. Matthew Klein
    a. Microcontroller programming, including interfacing with the various sensors and controlling the functions of the tank.
    b. The tank's side of communications with the app
4. Lisandro Osorio
    a. Ui design and API interface for the application.
    b. Microcontroller interface to application
    c. Designing a way for data from microcontroller to reach the application wireless, without needing bluetooth connection for improved distances.

House of Quality

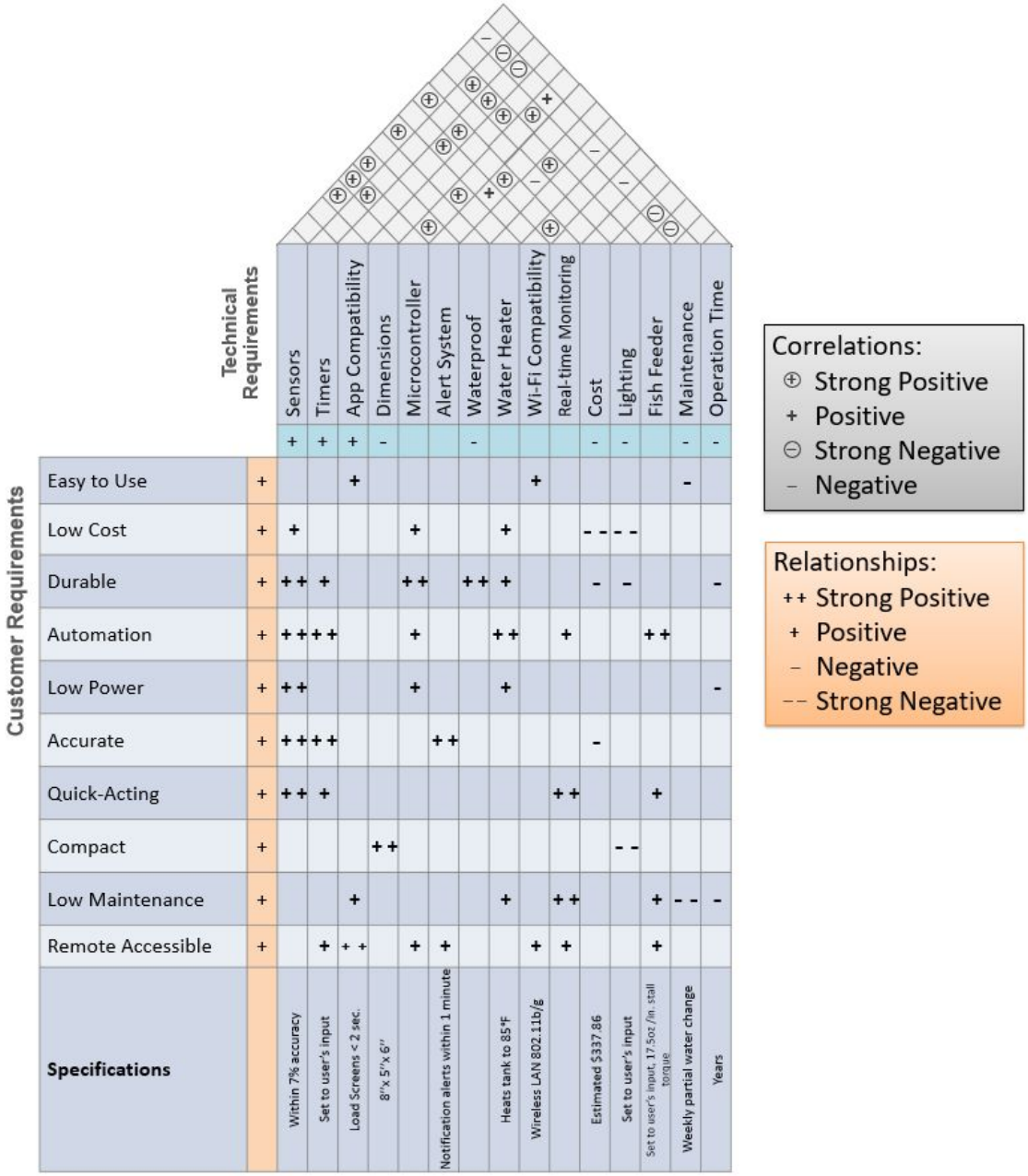

Figure 4: House of Quality diagram

The above House of Quality diagram outlines the relationships and correlations between various aspects of the project, including features that are directed towards providing benefits to potential customers and requirements that will be the main considerations of the project from a production viewpoint. By looking at the table, it can be seen how the different characteristics interconnect. Adding in certain features can support other benefits or features, while some will have to be implemented at the cost of establishing limitations on others.

Budget

Our budget for the smart fish tank is largely dependent on the sensors we will have access to. As shown in Table 2, the sensors like the salinity sensor have a higher than average cost.

Device to purchase	Device description	Price Per unit	Amount	Total cost (Prediction)
5 Gallon fish tank	Used to hold all the necessary components	19.99	1	19.99
Analog Ph tester	Measuring the ph level	29.99	1	29.99
Salinity tester	Measuring salt content of salt water tanks	119.99	1	119.99
Turbidity tester	Testing water transparency	9.99	1	9.99
Fish feeder and its components (Motor, power supply, casing)	Custom made solution that uses a timer	19.99	1	19.99
Arduino,MCU and Slave components	Programming of all components	59.99	1	59.99
Enclosure(3D printed)	For holding the various components	4.99	4	19.96
Waterproof Leds	Used for lighting in the tank	24.99	1	24.99
Temperature reader	For measuring the temperature in the tank	3.99	2	7.98
Water heater	Raise water temperature	24.99	1	24.99
TOTAL				337.86

Table 2: Budget

Project milestones and timeline

Due to our plan to incorporate both software and hardware components into our project we will divide this into the sub sections shown below, table 3 shows the timeline that we are reaching for. Some dates are still being determined due deadlines not being set in stone. Show below are how we will be able to meet this timeline and the goals we have set in regards to the broader scope.

Documentation

- To create the first draft document of a large scaled project consisting of project overview, choice of materials, and a discussion of design.
- Document all steps taken and meet weekly to discuss further topics
- Finish the final document which is the continuation of the draft.

Hardware

- Learn about the various ways to connect the sensors and allow communication between a controller and software level
- Understand the necessary components that will be needed for an individual sensor. Some might require amplifiers.
- Build and assemble a unique solution that is both easy to set up and looks like a finished product.
- Test and provide a final and finished aquarium.

Software

- Learn the various languages and libraries that will be used in generating the application.
- Create an application that will interface with all the components in the hardware level.
- Application is to have a well designed interface such that information is easily accessible.

Milestone Date Chart

Milestones	**Due date**
Choose the final idea	1/15/2020 - 1/18/2020
Divide and conquer V1 Document	1/18/2020 - 2/1/2020
Begin researching the connections between all components and begin drafting layout	2/2/2020-2/10/2020
Revise document and finish V2 of Divide and conquer based on recommendations from the meeting.	2/2/2020 - 2/14/2020
Continue with research and begin creating schematics for the layout of the board. Team is to start learning skills that might be necessary for the rest of the project.	2/14/2020 - 3/20/2020
Start of the initial draft for the final documentation. This will be split into sections for individual team members to focus on.	2/20/2020 - 3/20/2020
Begin ordering the necessary parts needed for initial prototype stage	3/20/2020-4/10/2020
Start testing parts received to make sure all components are working as intended.	4/10/2020 - 4/20/2020
Have assignment on their sections and bring together the final document	3/20/2020-4/21/2020
Begin prototyping	TBD
Start testing the current solution	TBD
Revise solution	TBD
Final additions/Final testing	TBD

Table 3: Milestones