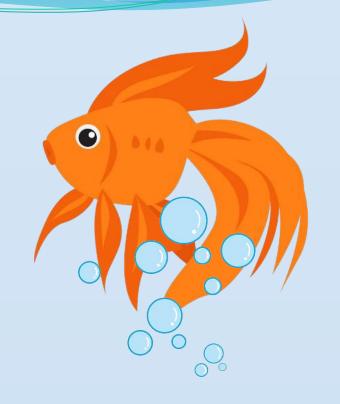
Trull Touls

A Fish Tank Helper



Critical Design Review - Group 14

The Team



Gabriel Besana Electrical Engineering



Rafael Nieves Computer Engineering



Jazz Olario Computer Engineering



Christian Rosado Arroyo Computer Engineering



Problems and Motivation

Problem

- Inconsistent fish care
- Challenges of taking care of aquatic pets during absence
- Balancing fishkeeping with other responsibilities

Motivation

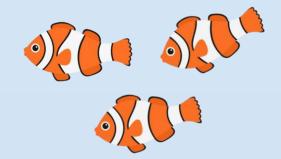
- Improve the aquatic pet's well being.
- Simplify and enhance fish ownership.
- Personal convenience.
- Support fish owners of all experience levels.





Goals and Objectives

- Basic Goals
 - Ensure optimal water conditions.
 - pH sensor
 - Temperature sensor
 - Turbidity sensor
 - Automated feeding
 - ρΗ solution dispenser
 - Smart light systems
 - Mobile application for full remote monitoring and control
- Stretch Goals
 - Integrate live feed camera
 - Bubble System
 - Comprehensive Aquarium Monitoring and Analytics Dashboard

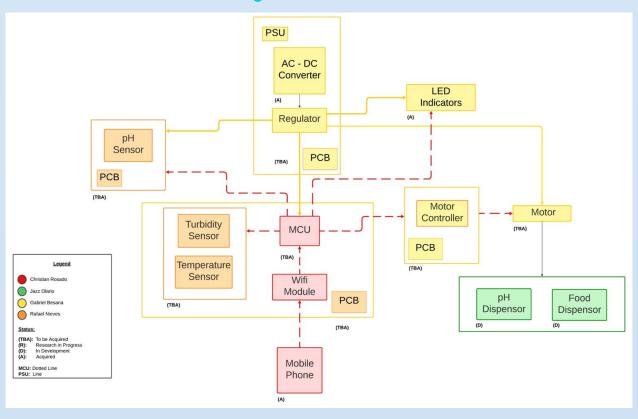


Engineering Requirements

Specification	Criteria
Power Supply	Wall outlet power
Max Power Consumption	~60 Watts
ρΗ Sensor Response time	≤ 2 min
Temperature Sensor Response Time	≤ 2 min
Temperature Sensor Accuracy	50-100°F
ρΗ Sensor Accuracy	6.5 and 8.0
Turbidity Sensor Accuracy	<5 NTU
Food Dispenser Accuracy	2 oz – 4 oz
pH Dispenser Accuracy	1 tablet at a time
Dispensers Capacity	5 oz - 10 oz
LED Brightness	Max 130 Lumens
Servo Motor Response Time	2ms
Stepper Motor Response Time	200ms
Cost	<\$500



Hardware Block Diagram







Temp. Sensor Selection

Manufacturer	Model	Price	Size	Key Features
DFRobot	DS18B20 Waterproof Probe	From \$4.50	Cable length: 1m (Sensor: 6mm diameter)	 High accuracy (±0.5°C) Operates on 3.3V or 5V 1-Wire communication
TE Connectivity	TSYS01P Waterproof	From \$12.00	Cable length: 1.5m (Sensor: 7mm diameter)	 High accuracy (±0.2°C) Operates on 5V I2C interface
TE Connectivity	HTU21D Waterproof	From \$15.00	Cable length: 1m (Sensor: 8mm diameter)	High accuracy (±0.3°C)Operates on 5VI2C interface

- The main comparison here is in the price range and interface.
- While offering similar accuracy, the other sensors come with complex interfaces and higher prices.





pH Sensor Selection

Manufacturer	Model	Price	Size	Key Features
DFRobot	Gravity: Analog pH Sensor	From \$29.5 0	Probe length: 60mm, diameter: 12mm	 Good accuracy (±0.1 pH) Response <2 min Operates on 5V Analog output
Milone Technologies	eTape Liquid Level Sensor (pH)	From \$49.9 5	Probe length: 120mm, diameter: 8mm	 Great accuracy (±0.05 pH) Response <2 min Operates on 6V - 24V Analog output
DFRobot	Gravity: Analog pH Sensor / Meter Pro Kit	From \$56.9 0	Probe length: 90mm, diameter: 12mm	 Good accuracy (±0.1 pH) Response <1 min Operates on 5V Analog output

- Analog output makes all sensors a viable option.
- Accuracy and response time don't make up for costeffectiveness





Turb. Sensor Selection

			-	
Manufacturer	Model	Price	Size	Key Features
Seeed Studio	Grove - Turbidity Sensor v1.2	From \$33.90	Probe length: 45mm, diameter: 33mm	Good accuracyAnalog outputUp to 100 NTU
DFRobot	Gravity: Analog Turbidity Sensor	From \$9.90	Probe length: 42mm, diameter: 32mm	 Good accuracy Analog output Up to 100 NTU
Vernier	Turbidity Sensor	From \$124.00	Probe length: 50mm, diameter: 30mm	Very high accuracyAnalog outputUp to 200 NTU

 High ranges of NTU are not required for measuring water clarity in aquarium standards.





CED Selection

Manufacturer	Model	Price	Size	Key Features
Adafruit	NeoPixel Digital RGB LED Strip	\$24.95	3.2 feet	 MCU compatible Operates on 5V Highly customizable Flexible Weatherproof options
HitLights	LED Strip Light	\$29.99	16.4 feet	 Remote controlled Operates on 5V Dimmable Flexible Waterproof options
BTF	WS2812B RGB ECO LED Strip	\$8.99- \$15.99	3.2- 16.4 feet	 MCU compatible Operates on 5V Highly customizable Flexible Waterproof options

 Strips required to be cuttable to fit them in our design in case in case they were too long.





Motor Selection

Manufacturer	Model	Price	VDC	Key Features
Adafruit Industries LLC	NEMA 17 Bipolar Hybrid Stepper Motor	\$14.00	12V	 Step Angle 1.8° Ease of use for general application Moderate Torque with 1.2A per phase Large Frame
BESJMYT	NEMA 17 High Torque Stepper Motor	\$10.99	3.5V	 Step Angle 1.8° Low Noise High Holding
STEPPERONLINE	NEMA8 Bipolar Microstep Stepper Motor	\$25.08	6V	 Step Angle 1.8° Precise Control Low Torque, Efficient Power Consumption Small frame

- Testing an Arduino kit sg90 servo motor with a built in motor controller.
- Further testing precision and durability between Stepper and Servo motors for each dispenser.





Criteria	TI-MSP430FR6989	Microchip-Curiosity PIC32MX470	Expressif Systems ESP32 WROOM 32E - N16
Clock Speed	16Mhz	120Mhz	240Mhz
# of Cores	Single Core	Single Core	Dual Core
Storage	128KB	128KB	16MB
GPIO	83	43	38
ADC Resolution	12-bit	10-bit	12-bit
Wireless Connectivity	N/A	Via Add-ons	Wifi & Bluetooth
Programming	C/C++/Code Composer Studio	C/C++/MP Lab X IDE	C/C++/Arduino IDE
Cost	\$20.00	\$45.00	\$5.00-\$15.00



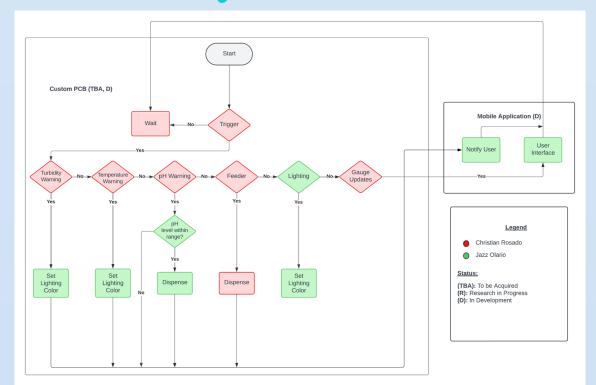




PSU Selection

Manufacturer	Model	Price	Watts	Key Features
Desvorry	B08QCBRYPT AC100-240V to DC12V	\$10.99	60W	 Smooth, flicker-free output Full protection of over voltages, over current, short circuits and over temperature
Alitove	ALT-1205 AC 100-240V input to 12V output	\$11.99	60W	 Automatic overload cut-off, over Voltage cut-off, automatic thermal cut-off, short circuit protection. Voltage consistency
Sansun	B07GFFG1BQ AC 120V to DC12V	\$9.99	60W	 Full protection of over voltage, over current, short circuits and over temperature Solderless female connector included

Software Block Diagram



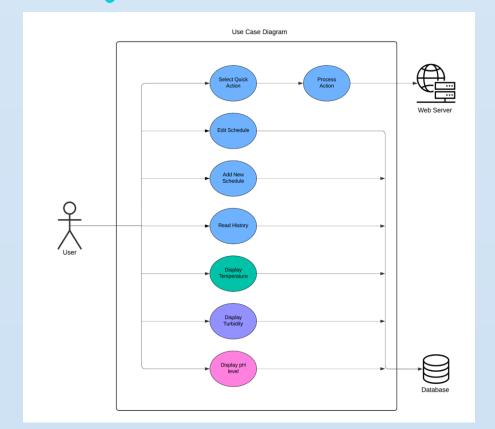






Use Case Diagram









Mobile Development

- React Native
 - Based on React
 - Cross Platform Development
 - Native Components
 - Native APIs
 - Modular Architecture
 - Hot Reloading
 - Expo Support
 - Documentation





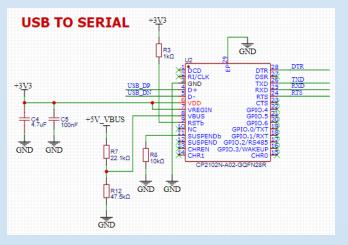


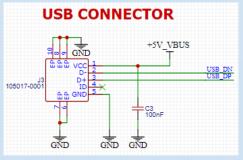
Mobile Development

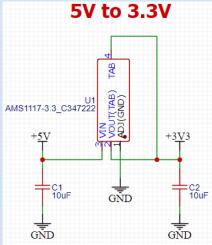
- SQLite
 - Serverless
 - Ease of use
 - Lightweight
 - Portability
 - Performance
 - Resource Efficiency



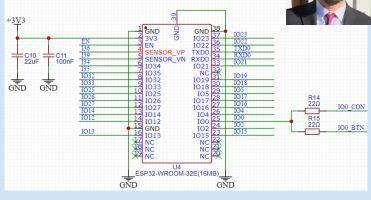
MCU Schematics



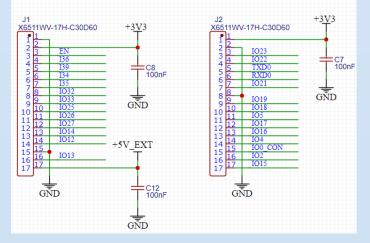




ESP32 MODULE



CONNECTORS



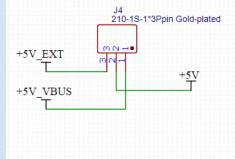


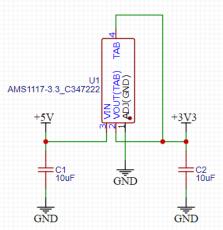
POWER INPUT SELECTION

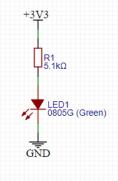
5V to 3.3V

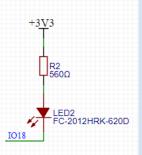
POWER LED

USER LED

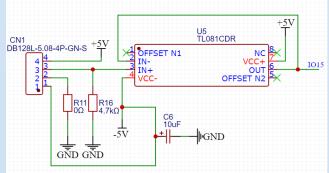




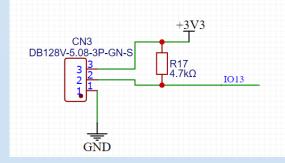




TURBIDITY SENSOR

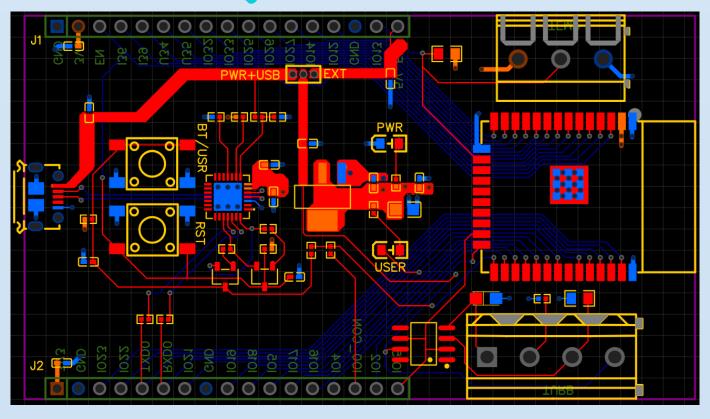


TEMPERATURE SENSOR



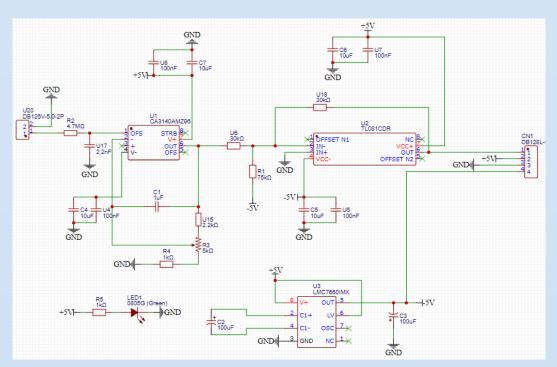
MCUPCB Design

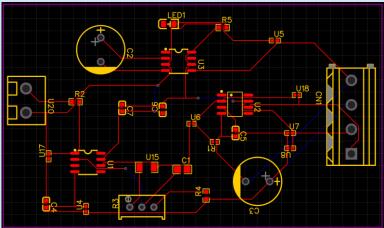




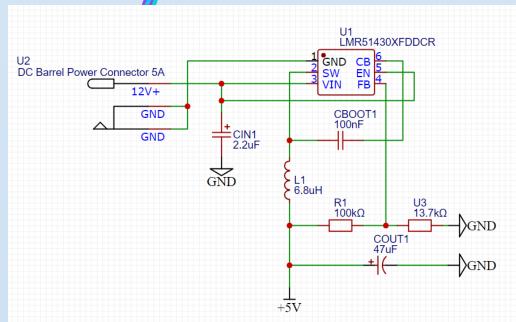




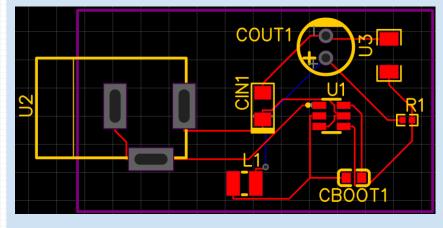




Voltage Regulator Board Design

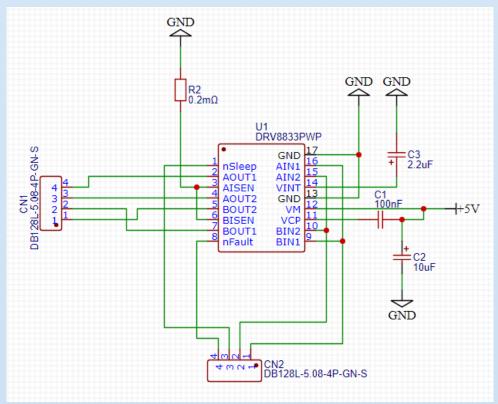


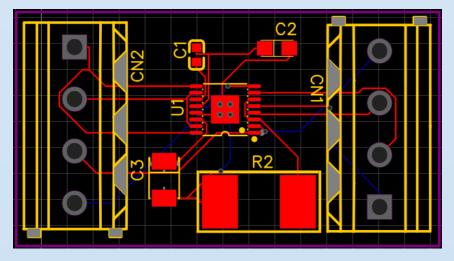




Motor Controller Board Design









App User Interface











Prototype and Testing for LEDs

Setup

- The prototype features an ESP32 microcontroller directly connected to a WS2812B RGB LED strip.
- Communication with the mobile app

ESP32 Microcontroller

ESP32 serves as a web server

Communication

- The ESP32 connects to the local WiFi network
- The app sends RGB colors and brightness levels to the ESP32





Prototype and Testing for Temp. Readings

Setup

- The prototype utilizes an ESP32 microcontroller connected to the DS18B20 temperature sensor via a terminal sensor adapter.
- The sensor provides 9 to 12-bit temperature readings over a 1-Wire interface so that only one wire (and ground) needs to be connected.

ESP32 Microcontroller

Hosts the web server.

Communication

- The ESP32 is connected to the local network.
- The mobile application can communicate either locally or remotely.
- Data is stored on the database.





Prototype for Food Dispenser

Setup

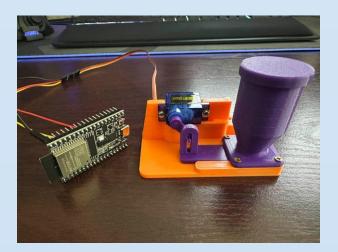
- The prototype utilizes an ESP32 microcontroller connected directly to a sg90 servo motor.
- The mobile application serves as the controller.

ESP32 Microcontroller

Hosts the web server.

Communication

- The ESP32 is connected to the local network.
- The mobile application can communicate either locally or remotely.





Budget and Financing			
Component	Estimated Price		
ρΗ Sensor	\$30		
Temperature Sensor	\$10		
Turbidity Sensor	\$20		
Dispenser(s)	\$20		
LED Lights	\$16		
Development boards	\$18		
Micro SD Card Module	\$8		
Servo Motor	Free		
Stepper Motor	\$24		
PSU	\$8		
Custom PCB	~\$79		
Total	\$251		





Christian Rosado

- Mobile Application UI
- App Logic
- Peripheral & MCU programming
- Database

Rafael Nieves

- Sensor Schematics
- MCU Schematic
- MCU PCB Design





Jazz Olario

- Mobile Application UI
- App Logic
- Peripheral & MCU programming
- Web Server

Gabriel Besana

- PCB Design
- Motor Controller Schematic
- PSU and Voltage Regulator Schematic







Project Progress

Remaining Tasks:

- Verify:
 - PCB functionality
 - PSU adapter
- 3D print the pH dispenser and enclosure.
- App Development
 - Implement scheduler feature
 - Implement the history feature
- Establish communication between sensors and mobile app:
 - Turbidity sensor
 - ρΗ sensor



Software Challenges

Challenge:

Establishing a Wi-Fi connection on the ESP32.

Solution:

Dynamically re-assign the communication port.

Challenge:

 Data synchronization problems between ESP32 and the mobile app.

Solution:

 Opting for long polling communication instead of websocket communication.





Challenge:

Communication issues with ESP board when connecting the sensors.

Solution:

 Troubleshoot the software side, otherwise make sure the sensors aren't faulty.

Challenge:

PCB troubleshooting.

Solution:

 Boards are still on the way, so we just need to make sure that all our components connecting to the PCBs are working.

Challenge:

 Analyzing and understanding the architecture of sensor boards and adapt them to our MCU.

Solution:

 We were able to adapt 2 of the smaller boards to our MCU and decided to keep the most complex sensor (pH) on a separate board.

