ECE 445

SENIOR DESIGN LABORATORY

PROJECT PROPOSAL

Schedulable Automatic Fish Feeder

TEAM #18

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1. Introduction

Problem

Fish feeders currently on the market are limited on how much convenience they give fish owners when they are away from their tank. If you want to feed your fish at a certain time, you usually have to set a timer for 12 or 24 hours in advance to feed them. There is also no reassurance that your fish is actually being fed and eating. Owners just have to assume that the machine is working as intended. This poses a major problem when gone for extended periods of time, such as winter break.

Solution

With our fish feeder, the user will not only be able to feed their fish from any location by using a mobile app, but they will also be able to schedule the exact times they want the feeder to dispense food, allowing them to customize their feeding times. In addition, the feeder will have a sensor that will detect when the food container rotates and send a notification to the user so they can ensure that their fish was fed. The feeder will be plugged into the wall to make certain that the feeder will work for extended periods of time. If the power goes out or if the feeder is not being supplied with AC power from the wall, it would switch to battery power. This solution would require a PCB, microcontroller with wireless transmitter, rotating motor, sensors, mobile app, and a power system. Other components could be added, such as a camera, water quality sensor, and indicator LEDs.

Visual Aid

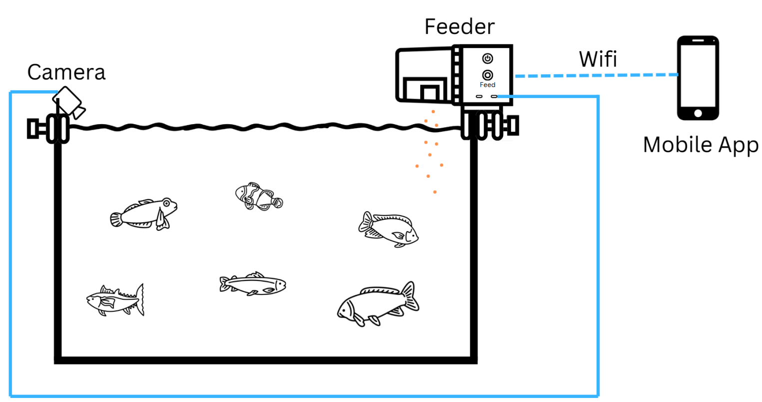

Figure 1: Visual Aid

High-Level Requirements

- Feeding via the button on the feeder and in the app works within 3 seconds of being selected or scheduled.
- The magnetic sensor detects that the food is actually dispensed into the tank and sends a notification to the app within 3 seconds of being triggered.
- When the camera icon is selected on the app, 3.3 V +/- 0.1 V is delivered to the camera and the feed is displayed in the app.

2. Design

Block Diagram

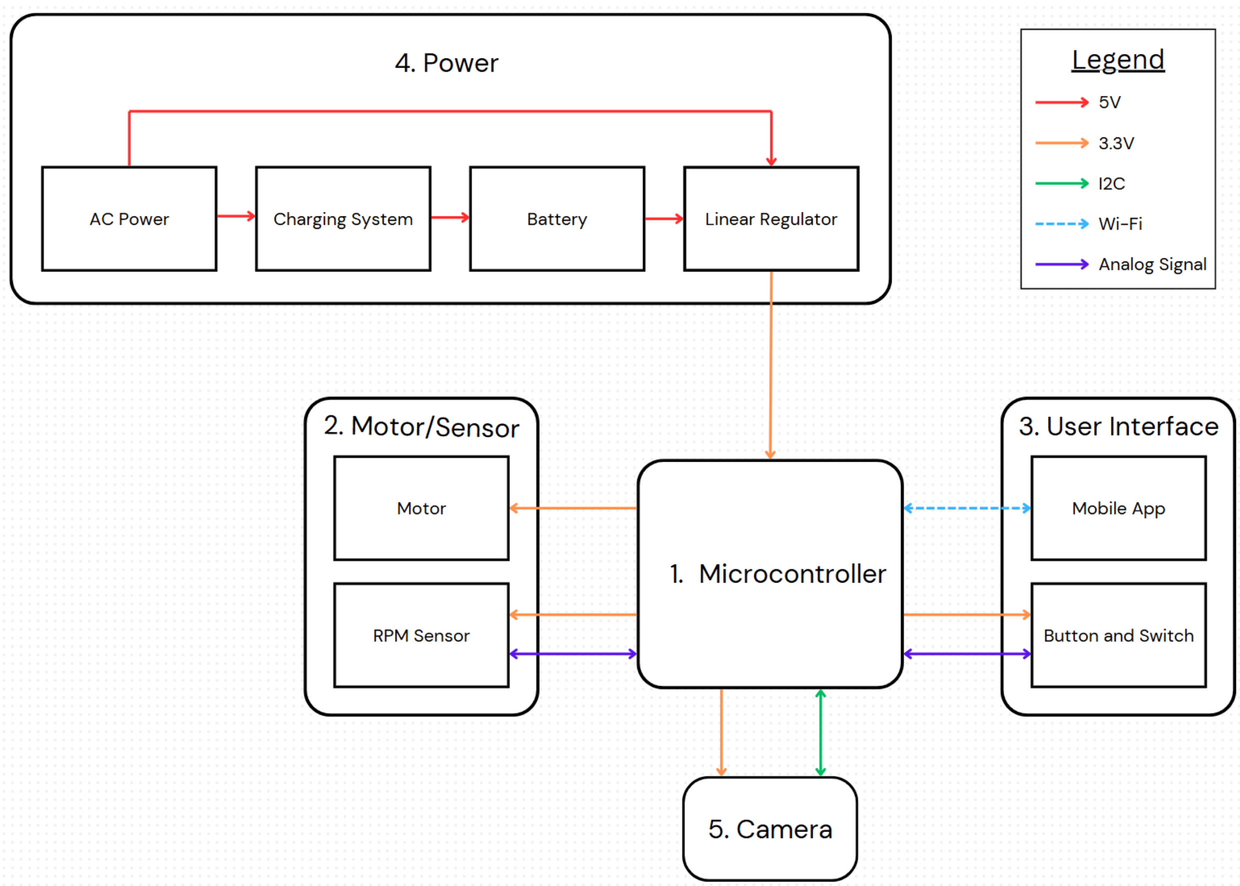

Figure 2: Block Diagram

Subsystem Overview

1. **Microcontroller Subsystem**

This microcontroller will implement the processing of the data along with triggering the circuit to engage the motor, communicate via Wi-Fi to connect to an app, and take input from sensors such as the feeder engage sensor. There will also be external ports that connect to the microcontroller for additions of other sensors, such as a possible water quality sensor.

2. **Motor and Sensor Subsystem**

This subsystem will consist of a 6V micro metal gearmotor that will be connected to the main PCB via a relay [1]. The relay will take input power from the linear regulator and a signal to switch on from the ESP32. The output shaft will hold the container of food. This container will have a magnet on the rotating section so that a Hall effect sensor can detect when it rotates to ensure that the food actually dispensed.

3. **User Interface Subsystem**

The mobile app will be programmed with multiple buttons that will communicate with the wireless transmitter on the ESP32. These buttons will manually feed the fish and allow the user to change the feeding schedule. The app will also notify the user when food is being dispensed and when the food level in the feeder is low by getting the data from the Hall effect sensor. The app would also be used to display the camera feed or the water quality add-on. In addition, there will be a power switch and manual feeding button on the feeder itself.

4. **Power Subsystem**

This subsystem will consist of an IC that will be used to switch between AC power and battery power and another IC to control the charging of the battery. The battery would be a LiPo battery that is used as a backup to AC wall power. When AC power is restored, the charge controller will calculate how much charge is needed to put 100% charge in the battery. When AC power is available, the unit will use AC power. The battery will solely be for a backup.

5. **Camera Subsystem**

This subsystem will be a separate PCB that will be used for the camera. It will connect to the main PCB with our ESP32 microcontroller through a USB-C port and use the wireless transmitter to send the camera feed to the app. The camera used will be an OV7670 which will use 3.3 V to activate the camera [2].

Subsystem Requirements

1. Microcontroller Subsystem

- The ESP32 microcontroller must be able to communicate over I^2C serial protocols to the camera, over Wi-Fi to the app, and through analog signals to the sensor, buttons, and switches.

2. Motor and Sensor Subsystem

- 3.3 V +/- 0.1 V is successfully supplied to the motor and sensor from the ESP32 when the feed button is pressed as well as when the scheduled feed times are reached.
- The motor successfully completes a minimum rotation of 360-degrees once triggered from the ESP32.
- The motor successfully stops within 2 seconds once the Hall effect sensor is triggered via the magnet inside the rotating cylinder.

3. User Interface Subsystem

- Feeder successfully activates within 3 seconds of the manual feed button press on the mobile app via Wi-Fi.
- Feeder successfully activates within 3 seconds of the scheduled time set using the app.

4. Power Subsystem

- The power subsystem supplies a stable voltage of 3.3 V +/- 0.1 V and 400 mA to the system, even with the temporary loss of AC power.

5. Camera Subsystem

- 3.3 V +/- 0.1 V is successfully supplied to the camera module from the ESP32 when the camera icon is selected on the mobile app.
- The camera feed is displayed through the mobile app.

Tolerance Analysis

One major area for concern that would be detrimental to the operation of the feeder would be heat. One major contributor to heat would be the linear regulator, which steps the voltage down to 3.3 V. If the heat dissipating off of the linear regulator is too high, this can cause the PCB to heat up other components, including the microcontroller. We will take this into consideration and find the maximum wattage that the linear regulator can handle and find the heat created from it at that state. The linear regulator we will be using is a Texas Instruments

TLV75533PDBVR. This chip will provide 3.3 V up to half of an amp, which will be a good level for what we need [3]. We know that we will not be reaching this amperage, as the ESP32 will pull a max of 250 mA [4].

First, we will find the maximum power out with the equation below:

$$P = i_{out} * (V_{in} - V_{out})$$

We also know that via the datasheet, the max current is 0.5A and the max input voltage we will be using is 5V, so let us leave some error in the wall DC adapter and use 5.1V. The output voltage will be a fixed 3.3V.

$$P = 0.5\,A * (5.1V - 3.3V)$$

$$P = 0.5\,A * (5.1V - 3.3V)$$

$$P = 0.9\,W$$

Therefore our max power produced will be 0.9W. We can now use this number to calculate the junction temperature of this voltage via the following equation:

$$T_j = P(\Theta_{jc} + \Theta_{ca}) + T_a$$

Where

$T_j(max) = 150\,°C$ via datasheet [3]

$P = 0.9W$

$T_a = 35\,°C$ ambient temperature max

$\Theta_{jc} = 34.3\,°C$ via datasheet [3]

$\Theta_{ca} = 92.5\,°C$ via datasheet [3]

Therefore,

$T_j = 0.9W * (34.3\,°C + 92.5\,°C) + 48\,°C$

$T_j = 0.9W * (34.3\,°C + 92.5\,°C) + 35\,°C$

$T_j = 149.12\,°C$

This indicates that we will meet the maximum thermal requirements for the chip itself, thus there should be no thermal issues with the design due to the linear regulator.

3. Ethics and Safety

Ethical Concerns

One ethical concern with our fish feeder is that it takes away the hands-on interaction between the owner and their fish. When people feed their fish manually, they are not just giving them food. They are also checking in on their health, noticing any changes in behavior, and building a sense of responsibility. This fish feeder removes that connection, allowing oversight when it comes to issues like illness or poor water conditions. Also, feeding fish can be a calming, enjoyable routine for the owner that alleviates feelings like anxiety or stress [5]. However, the implementation of the camera in our design will hopefully mitigate some aspects of this concern as the owner will be able to check in on the fish when they are away.

Safety Concerns

One safety concern is overfeeding, which can harm the fish’s health and disrupt the balance of their environment. Overfeeding can lead to excess waste and water contamination which would lead to ammonia and nitride buildup that would contaminate the ecosystem of the fish tank [6]. However, if the owner properly schedules the feeding times via the app, they should not have to worry about this concern since our design will ensure that the fish is fed on time. Another safety concern is that electronics will be near the water of the fish tank, but the feeder will be fully enclosed to ensure that no water comes into contact with the inner circuits. Also, we will make sure that the clamps that we use are strong enough for the weight of the feeder and camera so that there is no concern of them falling in the water.

References

[1] “Pololu - Micro Metal Gearmotors,” *www.pololu.com*. https://www.pololu.com/category/60/micro-metal-gearmotors

[2] “Advanced Information Preliminary Datasheet OV7670/OV7171 CMOS VGA (640x480) CAMERACHIP TM with OmniPixel ® Technology,” 2005. Accessed: Feb. 13, 2025. [Online]. Available: https://www.olimex.com/Products/Components/Camera/CAMERA-OV7670/resources/OV7670.pdf

[3] “LM3940 1-A Low-Dropout Regulator for 5-V to 3.3-V Conversion Input Voltage Range: 4.5 V to 5.5 V • Output Voltage Specified over Temperature • Excellent Load Regulation • Specified 1-A Output Current • Requires only One External Component • Built-in Protection against Excess Temperature • Short-Circuit Protected 2 Applications • Laptop and Desktop Computers • Logic Systems 3 Description.” Accessed: Feb. 13, 2025. [Online]. Available: https://www.ti.com/lit/ds/symlink/lm3940.pdf?ts=1739371712085&ref_url=https%253A%252F%252Fwww.mouser.es%252F

[4] “ESP32C3MINI1 ESP32C3MINI1U Datasheet Smallsized 2.4 GHz WiFi (802.11 b/g/n) and Bluetooth ® 5 module Built around ESP32C3 series of SoCs, RISCV singlecore microprocessor 4 MB flash in chip package 15 GPIOs Onboard PCB antenna or external antenna connector ESP32C3MINI1 ESP32C3MINI1U.” Available: https://www.espressif.com/sites/default/files/documentation/esp32-c3-mini-1_datasheet_en.pdf

[5] H. Clements *et al.*, “The effects of interacting with fish in aquariums on human health and well-being: A systematic review,” *PLOS ONE*, vol. 14, no. 7, p. e0220524, Jul. 2019, doi: https://doi.org/10.1371/journal.pone.0220524.

[6] “PetCoach - Ask a Vet Online for Free, 24/7,” *Petcoach.co*, 2019. https://www.petcoach.co/article/why-overfeeding-fish-is-a-problem-and-how-to-avoid-it/