ECE 445

SENIOR DESIGN LABORATORY

PROPOSAL

Automatic Intelligent Fishing Rod

Team #40

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1 Introduction

1.1 Background and Overview

Fishing is a popular activity and way of life with a rich history in cultures around the world. However, traditional fishing methods require anglers to invest a lot of time, patience, and skill. They often have to wait for hours for a fish to take the bait, which can be unpredictable and frustrating. With the advancement of technology, there is growing interest in developing automated solutions to simplify the fishing process and enhance the overall experience. By accurately identifying fish species, anglers can make informed decisions about which fish to keep and which to release, helping to protect aquatic ecosystems and maintain fragile species populations. Our project uses sensor technology, mechanical structures, automated control systems, and machine vision to design and implement a device that can automatically detect, capture, and identify fish. This innovation aims to reduce the burden on anglers and improve fishing efficiency and convenience. By combining modern technology with traditional fishing methods, we hope to offer a new fishing experience to enthusiasts, making it easier for them to enjoy this ancient and wonderful activity.

1.2 Overview of the Solution

Our solution introduces an innovative approach to fishing by developing an automated fishing rod system. The system seamlessly integrates advanced sensor technology, mechanical construction, automation, and machine vision to revolutionize the fishing experience. The automated rod system simplifies the fishing process and greatly reduces the time and effort required by the angler. By utilizing micro-tension sensors and micro-water level sensors, the system can accurately detect fish bites, eliminating the need for continuous monitoring of fishing rods. This increased efficiency allows anglers to engage in other activities while the system handles the fishing process autonomously. A key feature of the system is the ability to accurately identify fish species using machine vision technology. After the catch, the system activates the camera to visually inspect the caught fish, providing real-time species identification.

1.3 High-level Requirement List

The pod's mechanics are designed for ease of use, featuring an automatic baiting system and a responsive rod lifting mechanism.

1. Bite-detecting Subsystem: The accuracy rate of catching fish is higher than 80%.
2. Identification System: An identification system is used to identify fish species with accuracy over 90%.
3. Mechanical Subsystem: Successfully catches fish from 0.03 to 1 kilogram.
4. Power Supply Subsystem: Successfully supply the whole system.

1.4 Visual Aid

This is what our intelligent fishing rod looks like. The entire system is wired as shown in the diagram. An Arduino board is used to control and power all the sensors and motors. The Raspberry Pi is used to store the trained machine learning model for the identification subsystem. Additionally, the power supply subsystem powers both the Arduino and Raspberry Pi in a wired way. The pluggers on the two sides of the diagram are used to fix the whole system on the ground.

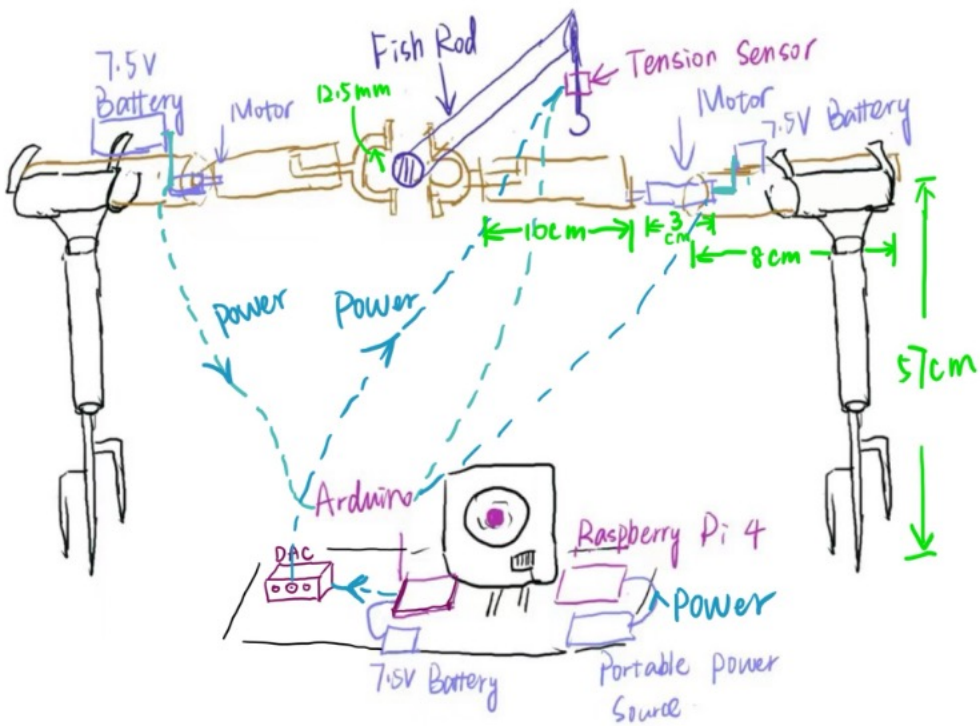

Figure 1: Visual Aid for the whole system

2 Design and Requirement

2.1 Block Diagram

As shown below, our project contains four parts: Bite-detecting subsystem, Mechanical subsystem, Identification Subsystem, and Power Supply subsystem.

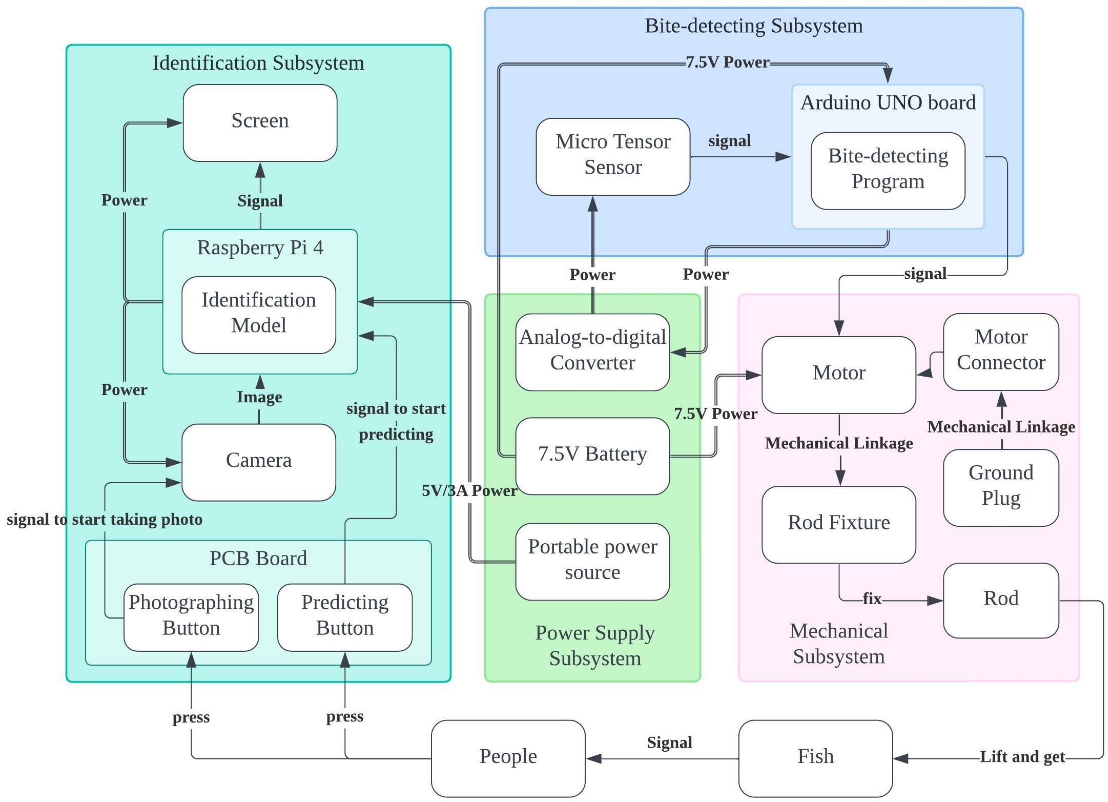

Figure 2: Block Diagram for Automatic Intelligent Fishing Rod

2.2 Subsystem Overview

Bite-detecting System: The bite-detecting system is used to detect the movement of the fish. We can use this feature since the hooked fish will struggle to escape. This subsystem will be deployed on Arduino Uno. The applied sensor is a force sensor on the fishing wire. We also need an analog-to-digital converter between the sensor and Arduino Uno. Therefore, the data collected in real-time will be transmitted and analyzed in the program to determine the movement of the mechanical subsystem. Thus, once

Identification System: An identification system is to be implemented to identify the species of fish caught by taking photos and analyzing them. Users are supposed to activate it when a fish is caught. They are supposed to take a picture of the fish by pressing a button and start predicting the species by pushing another button. The power system will power the identification system.

Mechanical System: The overall mechanical structure is achieved in the form of modified fishing rods. When a fish is identified, the signal system sends a signal to the electronic control system of the control motor. Then, with a speed of 2rpm, the fishing rod rises slowly near the human position through the linkage mechanical structure to get the fish.

Power Supply Subsystem: A power system supplies the power of each subsystem, including the linkage between each subsystem and independent parts such as the buoy's power. We use batteries to provide a stable power supply. In the rod lifting device, we will use the battery to drive a motor with a speed of 2 to lift the rod.

2.2.1 Bite-detecting Subsystem

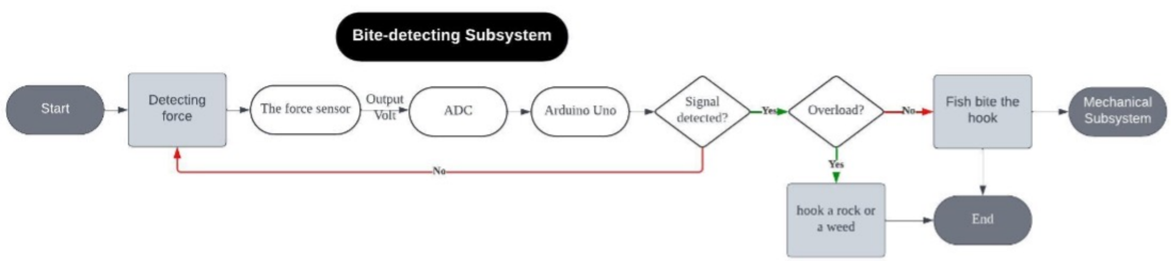

Figure 3: Flowchart for bite-detecting subsystem

Firstly, there will be great tension on the fishing wire when a fish gets caught. To catch fish from 0.03 to 1 kilogram, we need to prepare a tension sensor with specific precision and capacity. Besides, we also consider the condition when the hook catches a weed or a rock, which may lead to overload if the capacity is limited. Moreover, the sensor should have minor errors to guarantee high accuracy in catching fish. When the sensor is activated, a fish likely bites the hook. Secondly, an analog-to-digital converter is needed for weighing scales since the output voltage from the sensor might be too small. It can change the sensor's output voltage from analog to digital so that the MCU can use it. As for the Arduino Uno, we will write a program to analyze the signal and control the movement of the mechanical subsystem. We will consider the problem of getting the bite stuck in a rock or a weed to avoid breaking the fishing rod.

2.2.2 Identification Subsystem

The identification system implemented for the fishing process has a crucial objective: to accurately identify the species of the fish that has been caught. To achieve this, a high-resolution camera captures an image of the fish, which is then sent to a large-scale fish dataset created by a team of experts, including O. Ulucan, D. Karakaya, and M.

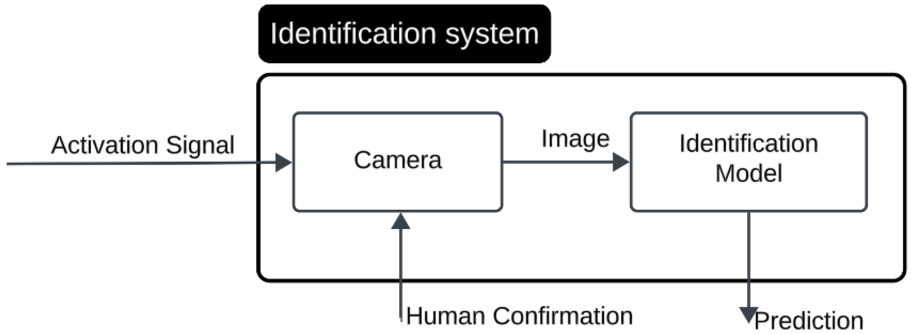

Figure 4: Block diagram for identification system

Turkan.[1]This dataset comprises a vast collection of images of different fish species, which the system uses to classify and predict the caught fish species.

The classification process uses a Convolutional Neural Network (CNN), a deep learning algorithm that can automatically detect image patterns[2]. Before the fishing process begins, the CNN will be trained using a subset of the dataset to optimize its performance. This training enables the neural network to learn the distinguishing features of each fish species, which it can then use to classify and predict the caught fish species.

The classification problem is challenging due to the many different fish species available and the similarities between some of them. However, the model is designed to achieve an accuracy of at least 90%, which is a high level of precision. Moreover, the results are expected to be provided within a few seconds, enabling the fishermen to identify the fish species quickly.

2.2.3 Mechanical Subsystem

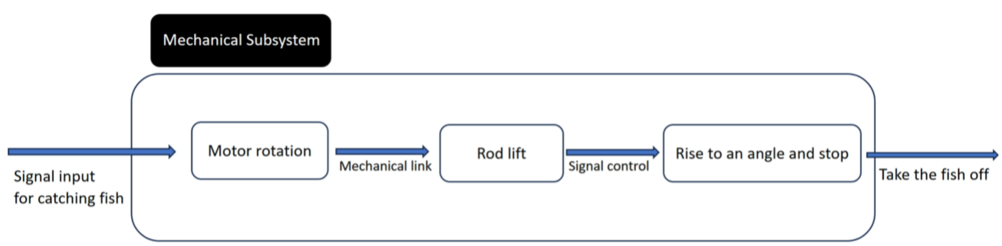

Figure 5: Block diagram for mechanical system

When the two sensors reach the critical value, the signal of catching the fish is simultaneously transmitted to the mechanical device, which is transmitted to the motor through a microcontroller similar to Arduino so that the engine starts to turn. Considering the fish's bite time, the motor turns about three seconds after the sensor reaches the critical time.

We use two vertical rods inserted into the soil to better fix the mechanical device. The two motors are welded to the rods used for fixation. When the motor starts to rotate, the fixture drives the rod to rotate to achieve the purpose of lifting the rod. Considering that the length of the fishing line is about 1.8m, to prevent the fishing line from swinging or winding, we will take a slow closing method. After investigation, we found that the 2rpm motor on the market was in line with our prediction of the lifting speed of the rod, so we tentatively decided on this speed.

Through the control of the single-chip computer, we can lift the fishing rod to a vertical Angle with the ground to stop lifting. Then, the process of raising the rod is completed. We just need to wait for the line swing to decrease and then remove the fish from the hook.

For the other part of the mechanism, the scan recognition device, we take a camera-like shape structure, and the scan results can ideally be viewed with a mobile app.

2.2.4 Power Supply Subsystem

A power system supplies the power of each subsystem, including the linkage between each subsystem. We use batteries and a portable power source to provide a stable power supply. We will use Arduino UNO to control and supply power for the sensors and motors in the rod-lifting device. The battery we use to provide the Arduino board is a 7.5V battery. We load the trained model into berry Pi for the Identification subsystem to identify the kind of fish. The power supply we chose for Raspberry Pi is a 5V/3A portable power source. The camera and screen we use in the identification subsystem connect directly with Raspberry Pi and get power from the board.

2.3 Tolerance Analysis

2.3.1 Feasibility Analysis

The whole system will be tested in a relatively more stable environment in the lab. A water tank is supposed to simulate the climate of peaceful open water, which is a better choice for fishing than in fierce waves. Also, it is easier for the fishing process to be triggered because the density of fish can be controlled in this case. In this testing process, fish can be attracted to our system much more efficiently than in open water. Overall, the proposed testing plan enables us to show the functions of our design more conveniently. Several factors still need careful consideration in cases of natural open water and our proposed testing plan.

2.3.2 Factors Analysis

Although the model's accuracy is expected to be high for the identification subsystem, the prediction can still be incorrect due to factors such as fish size, pose, and environment.

The motor's driving force may not be sufficient to lift the rod steadily. If the driving force is insufficient, we consider using multiple motors.

The device may disengage from the ground when catching a fish that exceeds the weight. If so, we will replace the design with the ground fixed. Due to the fish's weight and the hook's resistance, we must analyze whether the fragile 3D-printed part can withstand these forces. When the fishing line pulls up the fish, the maximum force is the resistance of the water, and the formula is:

$$F_{drag} = \frac{1}{2} \times drag\ coef \times A \times \rho \times \upsilon^2$$

The range of drag coefficient is generally 0.1 to 0.2. We chose the maximum resistance coefficient to calculate whether the 3D printed part can withstand the force of the fish bite. The weight range of our target fish is 0.03 1kg; here, we choose a maximum of 1kg. After calculation, the fish's resistance weighing about 1kg to the hook is around 3.6N. In addition, the gravity of a 1kg fish is 9.8N; we use these two primary forces to sum up the torque of the fish.

$$\tau = F \times r$$

3 Ethics and Safety

3.1 Ethical Considerations

Our automated fishing process prioritizes animal welfare and conservation principles. Our system promotes responsible fishing practices by ensuring the humane treatment of fish and adherence to fishing regulations and quotas. Accurate identification of fish species enables anglers to make informed decisions, contributing to sustainable fishing practices and the protection of vulnerable species.

3.2 Safety Measures

Safety is a top priority in the design and operation of the automatic fishing rod system. The system has various safety features to mitigate risks and ensure user protection.

Robust construction: The fishing rods and components are constructed from durable materials to withstand the rigors of fishing environments.

Automatic shutoff: The system is equipped with automatic shutoff mechanisms to deactivate the motor and prevent accidents in case of malfunction or entanglement.

References

[1] D. O.Ulucan and M.Turkan. "A large-scale dataset for fish segmentation and classification." (2020).

[2] K. O'Shea and R. R. Nash, "An Introduction to Convolutional Neural Networks," *arXiv (Cornell University)*, Nov. 2015. DOI: https://doi.org/10.48550/arxiv.1511.08458.