Aquatic Identification and Sorting System

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Introduction

In many parts of the world, populations of non-native species are growing at a rate faster than humans can actively remove them. The pursuit of the Aquatic Identification and Sorting System (A.I.S.S.) capstone project is to provide a self-contained deployable architecture that utilizes digital image processing and artificial intelligence (AI) to collect data and successfully sort out a desired classification of species.

Objectives

This project has three primary objectives:

1. Safely sort artificial marine wildlife (lures) using a modular design.
2. Accurately classify a target specimen above 50% accuracy with artificial intelligence.
3. Implement an off-grid power system.

Significance

- Commercially harvest fish based on size to reduce the inefficient fish harvesting practices of accidental early harvesting, which amounts to a yearly $50 billion loss according to The World Bank.
- Control a population of invasive species like Asian Carp, which is estimated by the Army Corps of Engineering to cost at least $15 billion over 20 years to stem the epidemic using man-made barriers.

Sorting Architecture

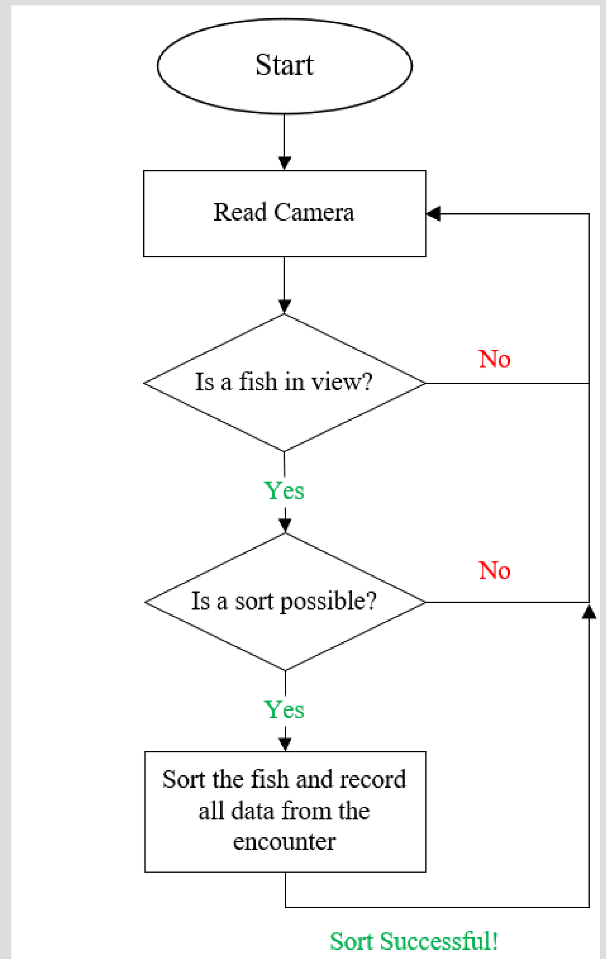

Figure 1. Sorting Process

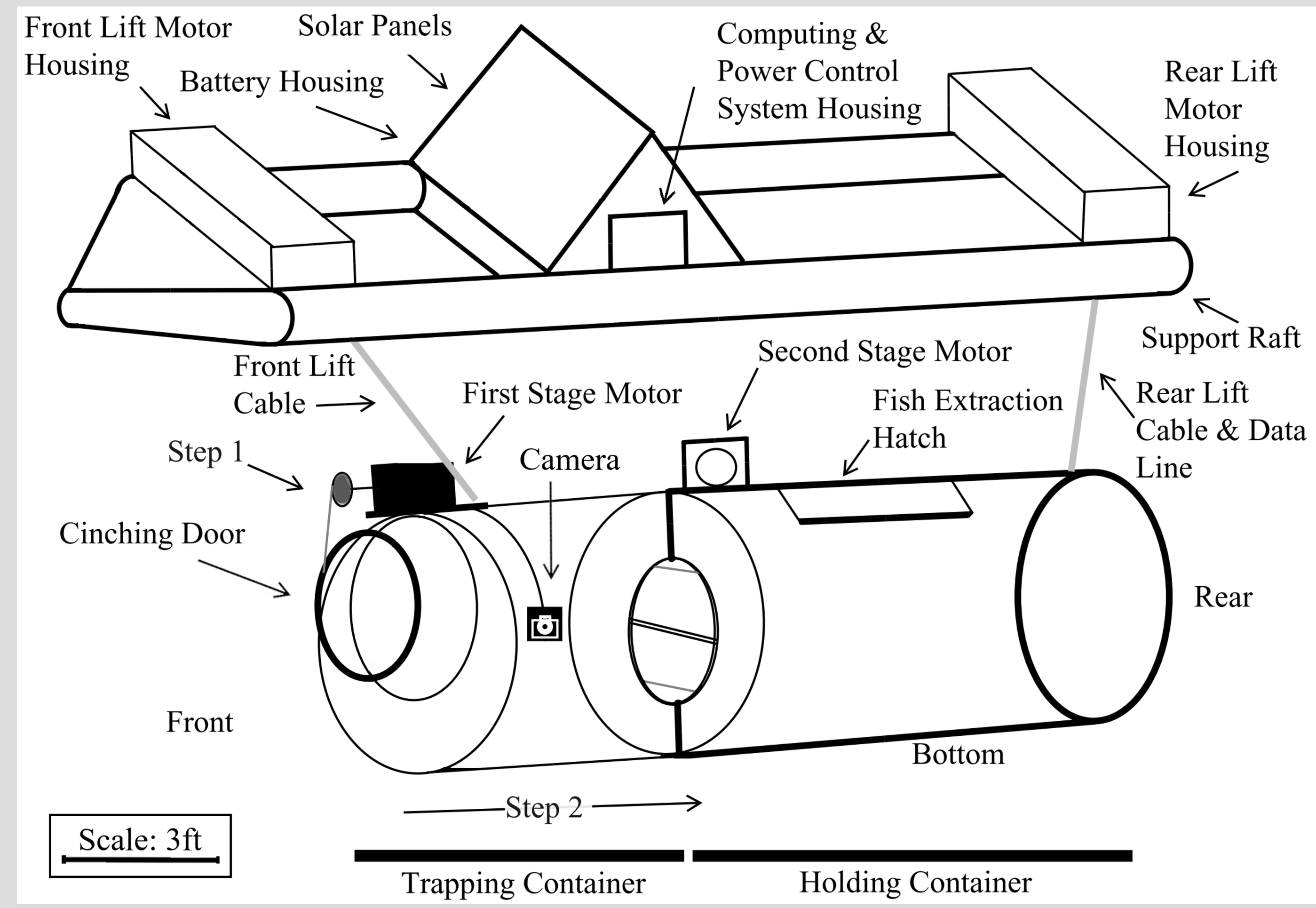

Figure 2. Sorting Architecture

Design

To simulate different aquatic species, 20 different fishing lures are filmed in a simulation container to create 800k images of training data.

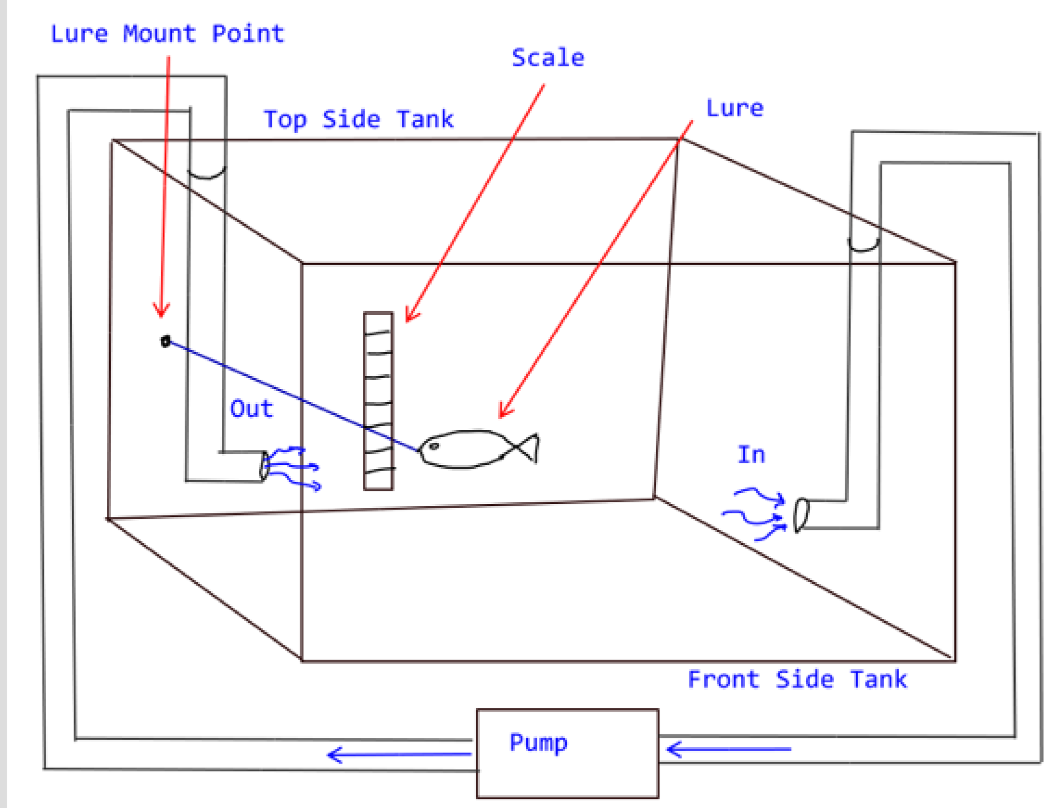

Figure 3. Simulation Container

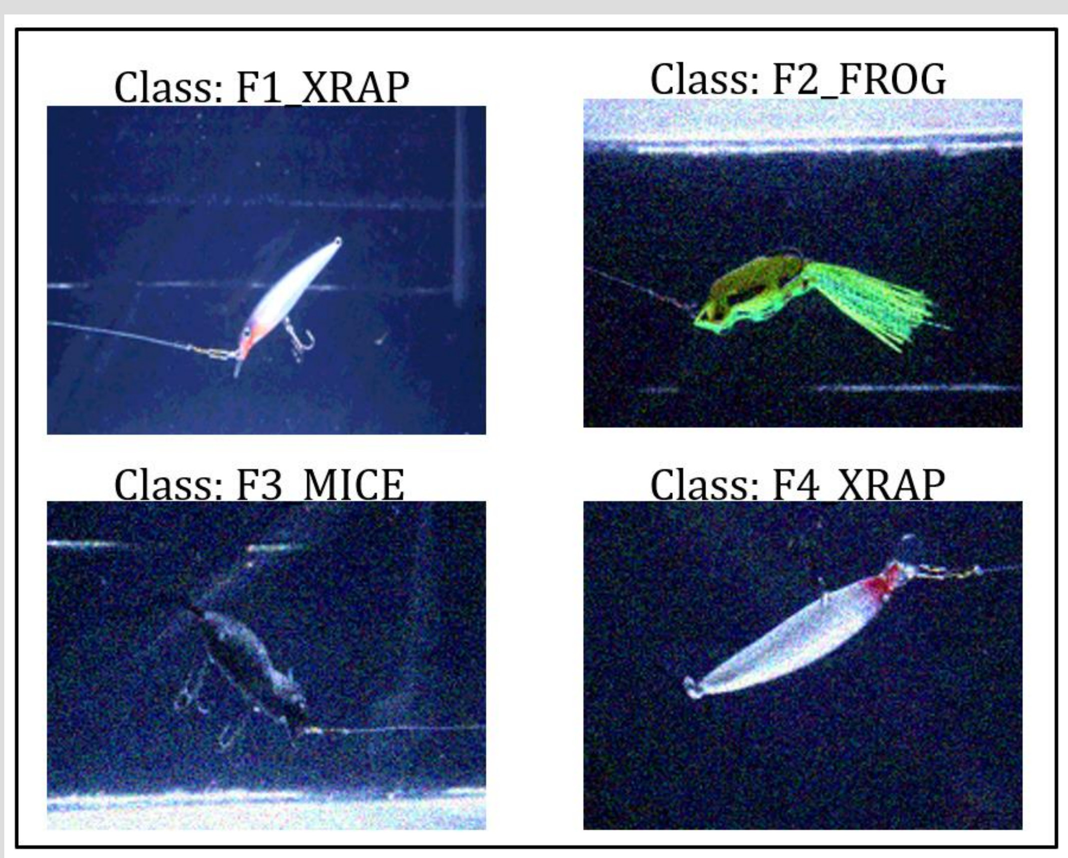

Figure 4. Training Data

The system decides on the lures using a convolutional neural network running on a graphics card or FPGA that receives imagery data from an external camera. The computer interfaces with a microcontroller to implement the motor control functionality for AI based sorting.

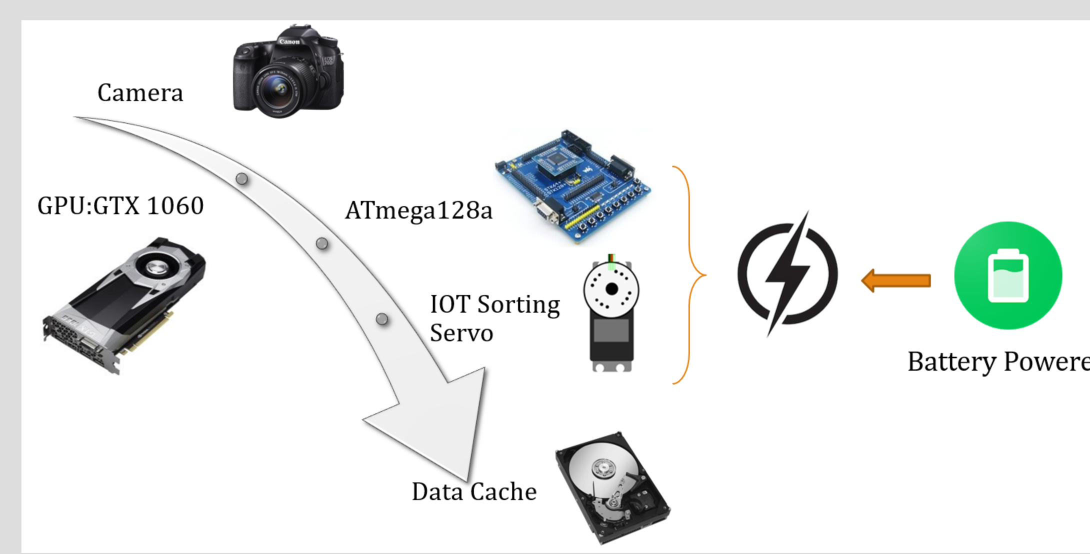

Figure 6. Hardware Pipeline

Powering the pipeline of electronics is a BP350 50[W] max output solar panel combined with a 42,000[mAh] lithium battery storage system that can output a max 150[W]. The entire system can be powered for 24-hours a day if the system is in its sub 5[W] idle state for at least 93% of the time. The entire power supply system should aim to weigh under 50 pounds.

Results

The embedded neural network:

- Trained on 17 of the 20 lure classes.
- Used 3 convolutional layers and only two dense layers of 500 nodes each.
- Training accuracy exceeded: 99%
- Real-world accuracy averages: 82%

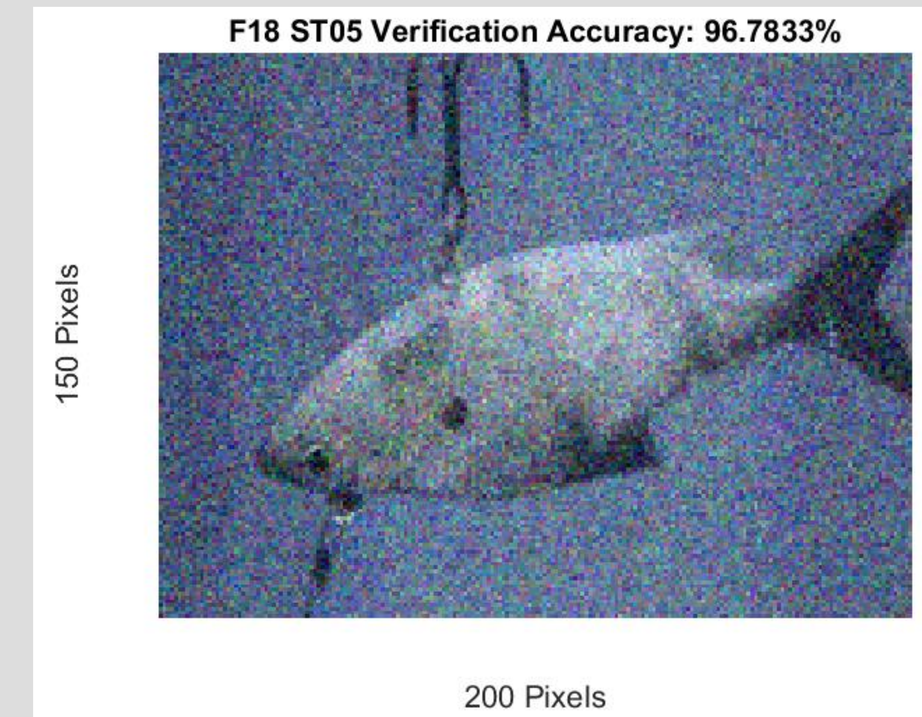

Figure 7. Real-World Accuracy on Unknown Lure

The resulting deployable power supply implements:

- Two BP 350 solar panels.
- A charge controller to keep one 12[V] deep cycle Li-Ion automotive grade battery charged.
- Two regulated and electrically isolated 5[V] DC rails:
  - One rail dedicated for onboard electronics
  - Second rail for submerged electronics. The submerged electronics include: the camera and two DC stepper motors.

Conclusion

- Low latency predictions made in milliseconds.
- Accurately sorts three untrained lures.
- Neural network can exceed 90% inferencing accuracy
- The power system meets the electrical load of the A.I.S.S. in a 30.8 pound package.