Smart Light Trap: Intelligent Crab Monitoring

W ELECTRICAL & COMPUTER ENGINEERING

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Introduction

Many government agencies and researchers are interested in tracking and collecting data on Dungeness crab populations in the Pacific North West (PNW). Specifically, many researchers are interested in the effects of global warming and ocean acidification on Dungeness crab populations. Researchers have used traps to collect Dungeness crab megalopae, but current tools for collecting and counting crab are laborious and lack any additional sensors.

In this project, we present progress towards automated counting of Dungeness crab megalopae and a more versatile data collection and control system.

Requirements

- Integrate technology into existing crab trap design
- Control the illumination of a 12v LED light to attract crab at specific times/intervals
- Collect focused 720p 30 frames per second (fps) video of <0.5-1cm objects
- Classify and track Dungeness crab in video for counting
- Collect environmental data on water temperature, internal/external luminance, and trap accelerometer
- Implement power monitoring system to track power usage
- Minimize power consumption, cost, and size

Specifications/Results

1. Arduino based sensor control and logging system on custom PCB with OLED GUI written in C
2. Raspberry Pi 3 + Pi Camera + M12 Lenses
3. Custom 3D printed lens mount and linear rail camera mounting system
4. 3000+ hand labeled images of Dungeness crab
5. Darknet YOLOv3 based detection algorithm rebuilt with Tenserflow + Keras for cross-platform use
6. Python + PyQt based GUI for data visualization

Implementation

Sensor Control System
- Custom easily printable PCB
- Sensors + Logging
- 12v LED Timing

Camera System
- 12MP Raspberry Pi v2 Camera
- M12 Lens Mount
- 720p 30fps video

Custom Software
- 3000+ Labeled Megalopae
- Detection/Visualization GUI
- C based embedded OLED GUI

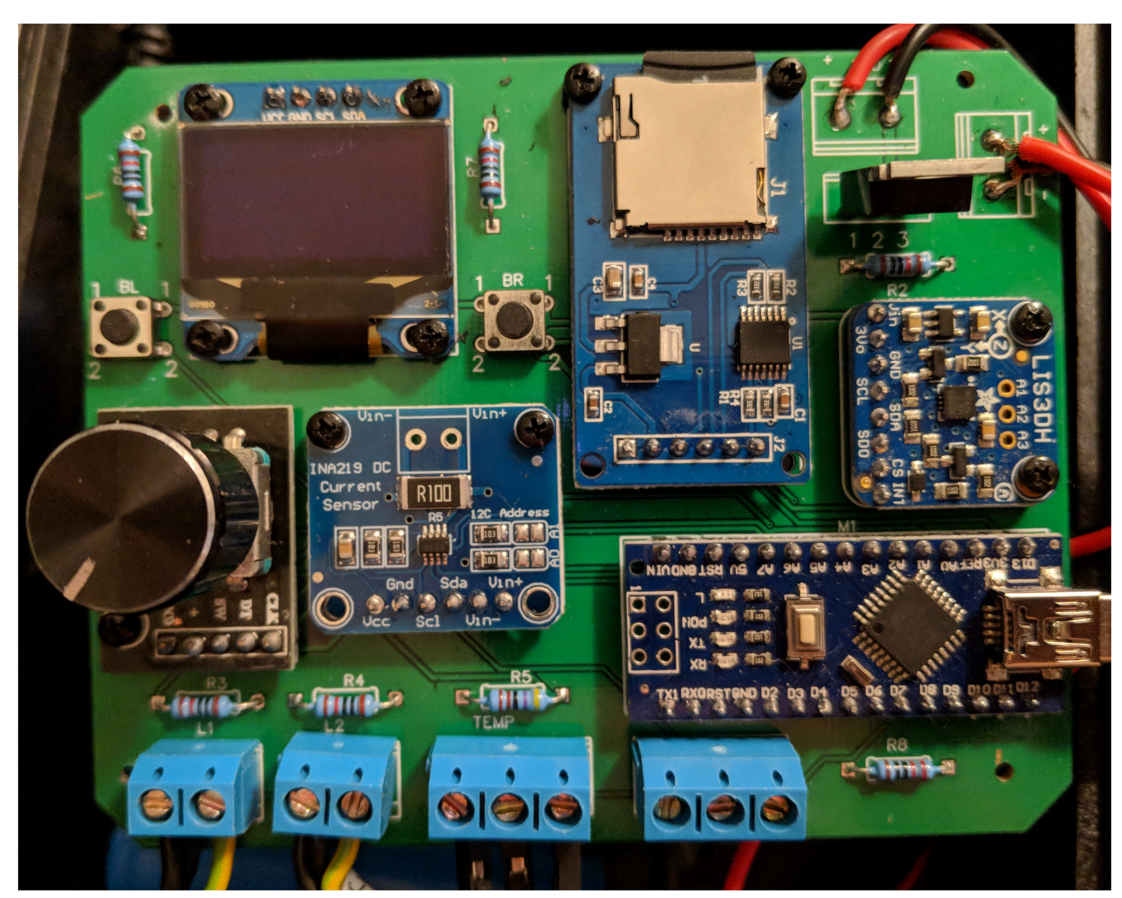

Figure 1: Custom PCB sensor control system. Includes 2 light sensor hook-ups, 1 temperature sensor hook-up, 1 I²C connector for communicating with the camera system, current/voltage monitor, accelerometer, SD card reader/writer, Arduino Nano, buttons/encoder, and an OLED display

Figure 2: Dungeness crab trap. Top section includes the sensor control unit housed in a enclosing float. Middle section houses LED light and funnels for crab.

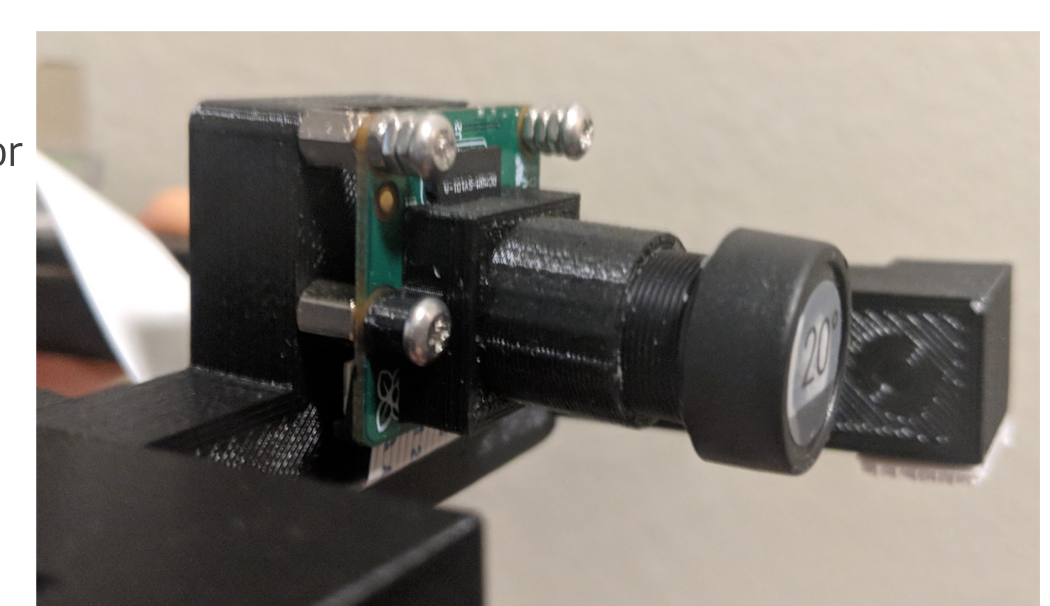

Figure 3: Raspberry Pi v2 camera board mounted on rail system with M12 20° lens mounted with 3D printed lens holder.

Figure 4: Two Dungeness crab megalopae captured by our camera system

Figure 5: Screenshot of our visualization software showing detection of 4 megalopae

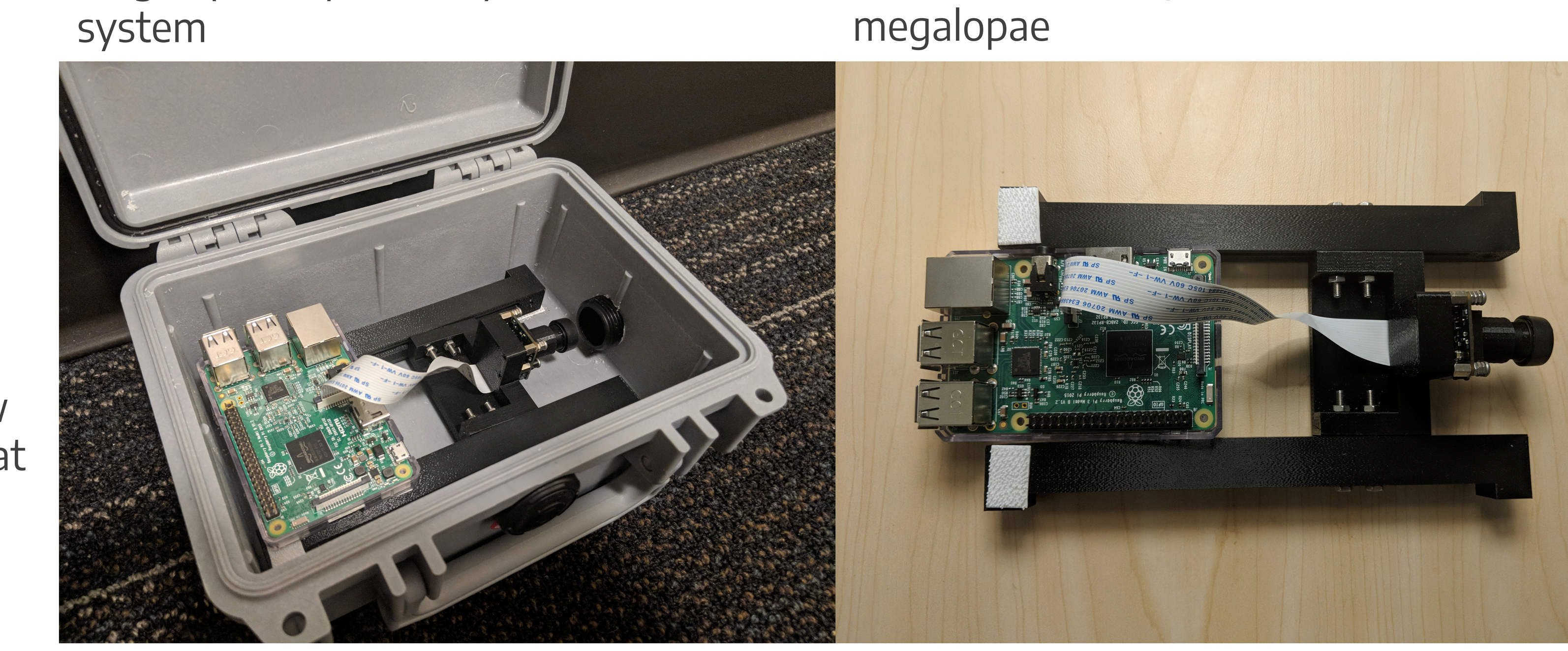

Figure 6 & 7: Camera system housed in a waterproof case with Raspberry Pi (Left). Different view of 3D printed linear rail system that allows for adjustment of working distance of system within waterproof enclosure. (Right)

Conclusion

Our project expands on past work to improve the process of collecting and counting megalopae: our sensor control system will help gather additional data points about the crabs' environments, our camera system will allow groups to clearly record megalopae, and our labeled data and detection model will make it easy for other groups to expand on our work.

Future Work

- Label more data to increase accuracy of the detection model
- Label data for tracking and implement tracking algorithm
- Mount camera system into existing trap
- Build custom battery for longer deployments
- Implement system to calibrate light sensors

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