Using AI Enabled Robotic Fish to Combat Environmental Waste

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Agenda

- Introduction & Project Relevance
- Literature Review
- Project Requirements
- Methodology
- Preliminary Results
- Final Results

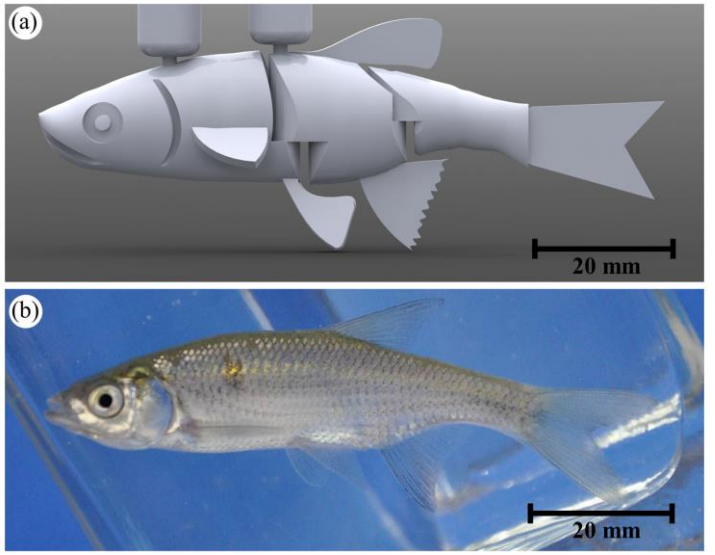
Project Relevance

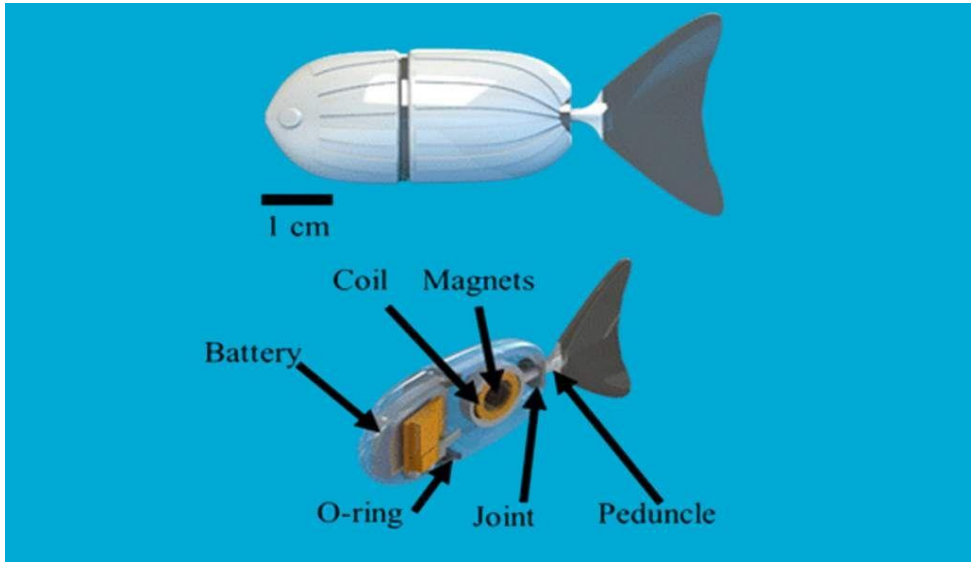
- Pollution over the years has endangered underwater life across the globe
- Estimated 4.8 - 12.7 million tonnes of plastic in today's oceans [1]
- Several different methods have been tested to help fight waste in the world's ocean
- Find a way to combine AI and waste collection in the world's oceans

Introduction

- Examining different ways underwater drones are being used today
  - Oil leak detection, environmental monitoring, etc.
- Goal is to determine how to best implement AI into robotic fish to help detect and clean waste in large bodies of water
- Team to suggest robot hardware and software for the AI enabled robotic fish
- Use open source tools like TensorFlow, Keras, and OpenCV for Deep Learning & Image Classification.
  - MatPlotLib for data analysis & visualization

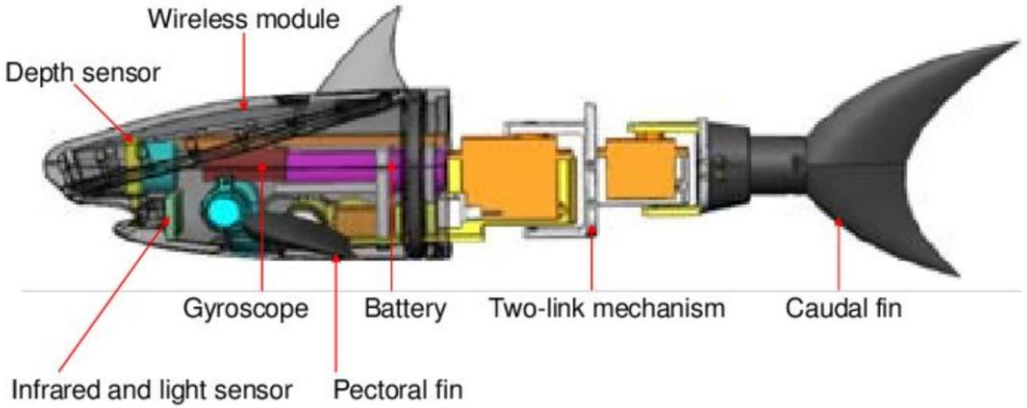
Literature Review





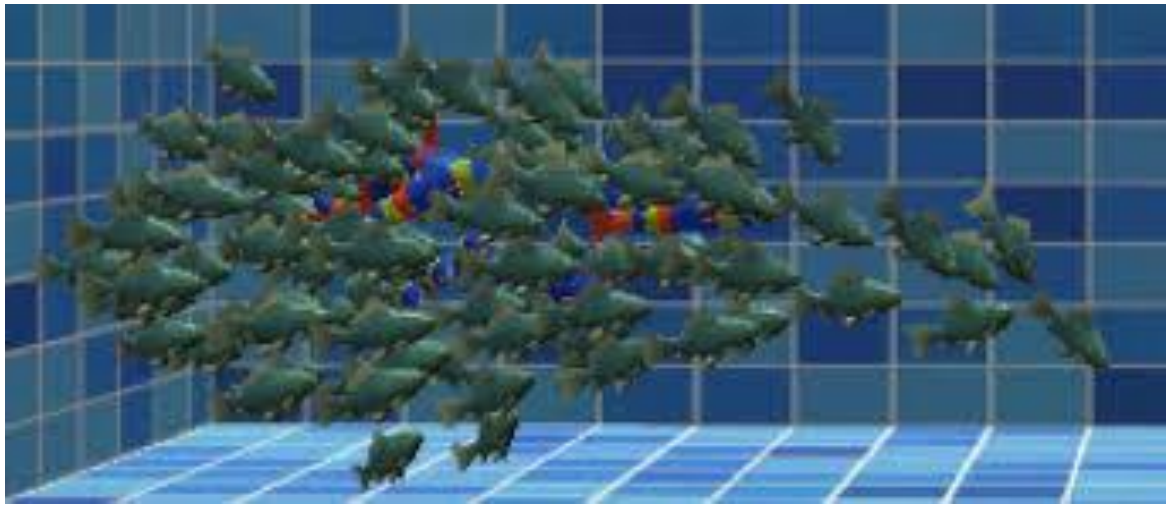
Literature Review

Experimental Modeling and Motion Control for Underwater Robotic Fish



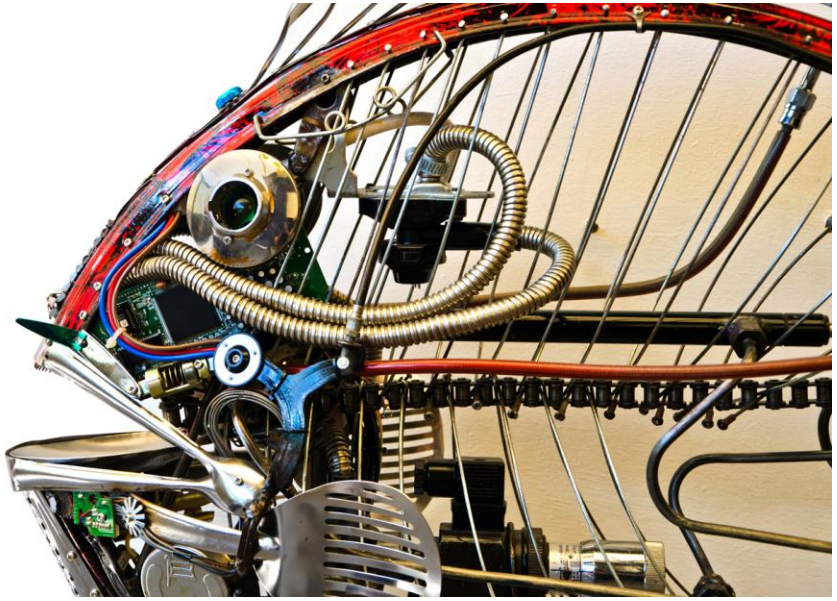
Literature Review

Analysis of Robotic Fish Using Swarming Rules with Limited Sensory Input



Literature Review

Insight of a Six Layered Neural Network along with other AI Techniques for Path Planning Strategy of a Robot



Project Requirements

- With the methods of code and algorithms that we have implemented in the project, the robotic fish will be given the artificial intelligence to move as a real fish and clean the environment.
- The Robotic fish is being used to monitor and remove the waste is in the water.
- By placing the Robotic fish underwater, the data shows how much waste there would be collected due to the natural fish habitat being polluted
- The Robotic fish sorts the waste into categories to enable the vacuum from its mouth in order to cleanup it up.

Project Tools

1. Microchips
2. Sensors
3. Mini camera
4. GPS
5. Microprocessor
6. Peripherals
7. Wireless Microphone
8. Computer
9. Batteries
10. Wiring
11. Mini suction Vacuum
12. Silicon Exoskeleton
13. Remote
14. Silicone exoskeleton head and body
15. Gas Tube Chamber
16. Five motors
17. Two fins and a tail

Robotic Fish Dimensions and Specs

- The Robotic fish has a measurement of a 13 inch length, 3 inch width, and a 5 inch height.
- It has 6 joints including two oscillating fins and one oscillating tail.
- The Robotic fish is powered by batteries, wiring, and a remote. It can last up to 10 hours underwater with a maximum speed of 1m/s and a maximum torque of 44.1 psi.
- Robotic fish has an silicon exoskeleton for a head and body, a built-in vacuum, gas tubes for the breathing chamber, sensors, and five rotating motors.

Methodology:
Robot Fish Functionality

- AI functionality for the robot fish are implemented programmatically; the code is written to a chip and executed through a microprocessor.

- Various algorithms and machine learning techniques are used:
  - Mimic real fish behavior and movement.
  - Teach robot fish to seek out and identify “ocean garbage”.
  - Train robot fish to distinguish between trash and recyclables.

Methodology: “Practice Makes Perfect”

- The robot fish will go through multiple trial runs:
  - Compare the movement of the robot fish against that of a real fish.
  - Evaluate the effectiveness and timeliness of the garbage clean up performed by the robot fish.

- The robot fish must be able to adapt so that it can survive the harsh environment of the ocean and also thrive on its purpose which is to help rid the ocean of decades worth of pollution created by humans.

Open Source Libraries & Dependencies

- Keras
- TensorFlow
- OpenCV
- PIL
- Matplotlib

Preliminary Results

- We want to enable our robot fish to classify garbage based if it is an organic material or recyclable
- CNN Model used performs a binary classification: is the garbage organic or recyclable?

Dataset

- A total of 100 images were used to test and train the model
- Compiled dataset using kaggle and google images
- Converted the images to appropriate formats
- 70% of the images are used for training
- 30% are used for testing

CNN Model

- Resize the images and pass them to a ImageDataGenerator
- Used vgg16 to train our classifier
- Max pooling,dropout and dense layers are also used
- Accuracy of 91% was achieved

```
[ ]  model = Sequential()
     model.add(conv_base)
     model.add(Flatten())
     model.add(Dense(512, activation='relu'))

     model.add(Dense(64, activation='relu'))
     model.add(Dense(2, activation='softmax'))
```

```
[ ]  model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
vgg16 (Model)                (None, 4, 4, 512)         14714688
_________________________________________________________________
flatten (Flatten)            (None, 8192)              0
_________________________________________________________________
dense (Dense)                (None, 512)               4194816
_________________________________________________________________
dense_1 (Dense)              (None, 64)                32832
_________________________________________________________________
dense_2 (Dense)              (None, 2)                 130
=================================================================
Total params: 18,942,466
Trainable params: 18,942,466
```

Final Results

- With our CNN model we were able to achieve a testing accuracy of 93%
- This is our contribution towards building a robotic fish that can help keep our oceans clean

Thank you!

Questions?

Sources

1. @misc{natural history museum, title={How much plastic is in the ocean?}, url={https://www.nhm.ac.uk/discover/quick-questions/how-much-plastic-is-in-the-ocean.html}, journal={Natural History Museum}, publisher={Natural History Museum}}
2. https://github.com/techSash/Waste-classification