Spines and (Population) Spikes: Optimizing Pacific Purple Sea Urchin Population Control

Team 547

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Abstract

Pacific purple sea urchins (*Strongylocentrotus purpuratus*), while native to the California coast, have experienced a population explosion due to the decline of their natural predator, the sunflower starfish — a species heavily impacted by rising ocean temperatures. This rapid increase in urchin numbers has led to the overgrazing of kelp, their primary food source, resulting in the formation of "urchin barrens" — vast underwater areas stripped of kelp. The loss of kelp forests not only disrupts the balance of the marine ecosystem but also threatens the biodiversity that depends on them. Our project explores the use of technology to aid in managing this imbalance by developing a vision-based system to detect and track urchin populations, supporting more efficient ecological intervention.

Background and Motivation

While human divers remain the most effective method for removing Pacific purple sea urchins, the process of locating urchin patches is time-consuming and physically demanding. Divers typically rely on manually searching the seafloor or encouraging local fish to feed on urchins — both of which require extended underwater time, increasing oxygen use and limiting efficiency.

Additionally, current efforts prioritize removal over long-term tracking, leading to inconsistent data on urchin spread. Implementing a system to monitor distribution and growth over time would provide valuable insight into the development of urchin barrens, help predict future spread, and highlight areas of ecological concern. Our project aims to enhance these efforts by integrating image recognition technology to support data collection and improve response strategies.

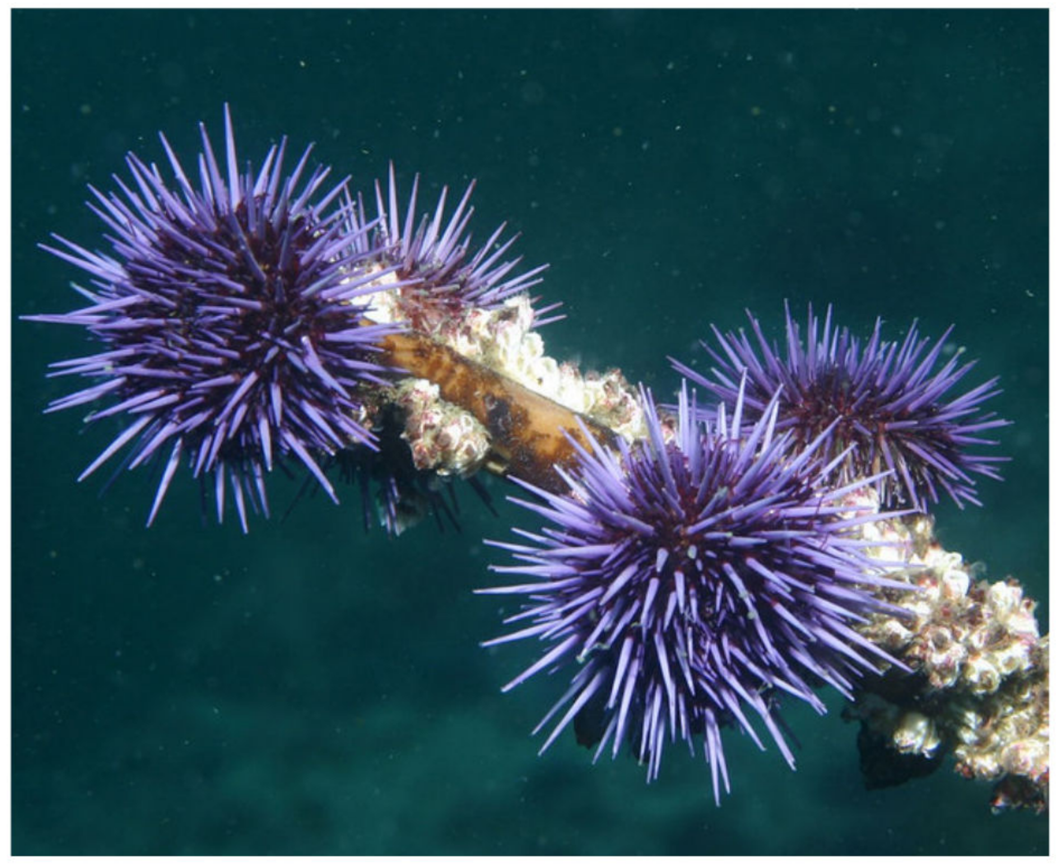

Photo credit: Steve Lonhart/NOAA

Hypothesis and Goal

The idea is to create a ROV that can track and map urchin spread, as well as mark locations of large patches so the divers can spend less time looking and more time on removing.

Methodology

Optimizing removal and tracking spread through digital means may not only help increase efficiency and help better manage control, but also provide valuable data in population spread and areas of concern. Will also save money on refilling scuba tanks and save time for divers. An ROV equipped with recognition software and automatic mapping can help lessen the workload by automatically locating, recognizing, and accurately marking urchin patches.

Working with our competition perch and brainstorming as a team, we realized the following modifications were necessary:

- Underwater camera
- Underwater light
- Longer battery life
- Image recognition and mapping software

Due to severe budget limits we focused on creating the software and creating a mount for a small, cheap, underwater camera.

To build the software we used OpenCV, which is the simplest way to code for an object recognition software. We attempted to use Google Teachable Machine and CoLab but unfortunately they were not suited for this. Because we are not located on the California Coast, we could not source our images first hand. Through OpenCV we were able to train the software to recognize purple sea urchin patches, but were unable to test in a real-life scenario due not being in California.

For our camera mount, we recycled an earlier failed prototype to reduce plastic waste. The mount is printed in carbon fiber and altered to fit the 20$ waterproof camera.

OpenCV Code Samples

Stream the image directly to the host computer

```
 s=0
if len(sys.argv)>1:
    s=sys.argv[1]
source=cv2.VideoCapture(s)
win_name = 'Camera Preview'
cv2.namedWindow(win_name, cv2.WINDOW_NORMAL)
// this example displays camera input on the HostPC in window
```

Process the Image

```
Imgproc.putText(
frame, Detected: " + result,new Point(10, 30),
Imgproc.FONT_HERSHEY_SIMPLEX, 1.0,
new Scalar(255, 0, 255),2
```

// This example of code resizes the camera frame, so that OpenCV can process it easier, next it processes the image to determine if it is looking at a Sea Urchin.

Photo credit: Ed Bierman

Photo credit: Steve Lonhart/NOAA MBNMS

Images such as these were used to train the algorithm after decreasing visibility to mimic underwater conditions

Results and Conlusion

Although our software is successful at recognizing images that were sourced from the internet, we unfortunately are unable to test its recognition abilities on real-life urchin patches due to environmental limitations. With severe lack of budget we had to focus on creation rather than implementation. With funding, we hope to greatly improve the capabilities of both this ROV and its efficiency.

Future Changes

Investing in a better quality camera, an affordable underwater tracking and mapping system, a processor mounted on the ROV to increase reach, and stronger motors would deeply benefit this project. With these changes this ROV could be a key component of managing urchin populations.

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Citations

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