OSTRACAM

Underwater Stereo Imaging

Oliver Thio, Paul Killam, Christina Lim, Caio Motta

Objective

To aid Dr. Oakley and his team in their study of Ostracods by providing 3D video data of their bioluminescent displays

What are ostracods?

- Ostracods are small, bioluminescent shrimp, about the size of a sesame seed.
- Ostracods use bioluminescent displays to ward off predators and attract mates only at night when there is no moon.
- This results in impressive displays seen in warm, shallow waters around the world.

Why Ostracods?

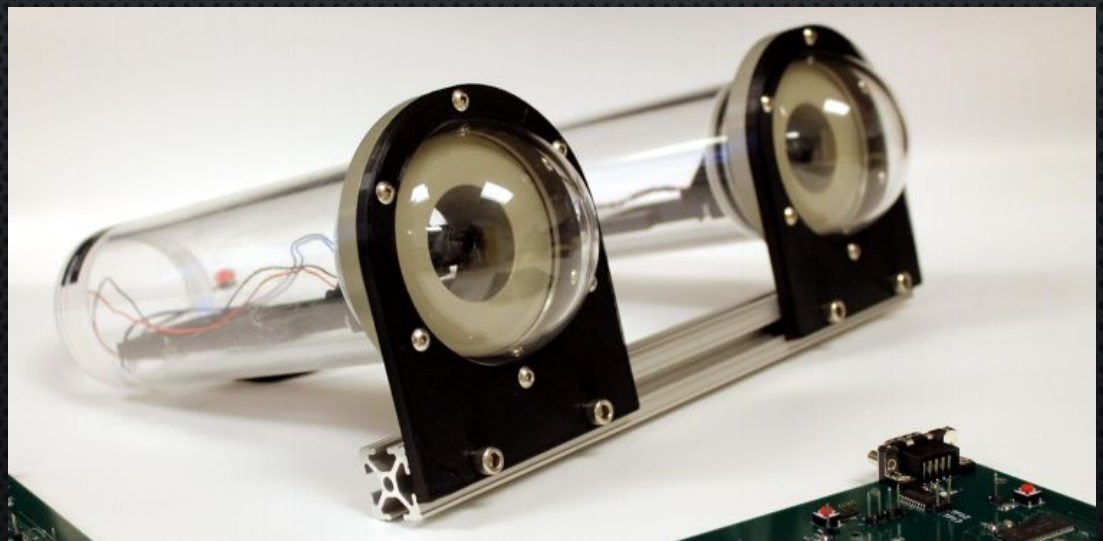
- There are around 200 species of bioluminescent Ostracods, many having distinct differences in their bioluminescent displays
  - Intensity
  - Duration
  - Size
  - Coordination
- By cataloguing these displays and matching them with the genetic differences between Ostracod species, we can:
  - Further our knowledge of bioluminescence
  - Learn how to utilize bioluminescence in future genetic engineering experiments

Adverse Conditions

- System must:
  - Be submerged in salt water
  - Be protected against salt water corrosion
  - Be operated in a full diving suit
  - Handle differentials in pressure as it is brought deeper
  - Gather visual data with no ambient light
  - Gather high enough quality data to perform 2D -> 3D Stereo mapping
  - At 30 FPS

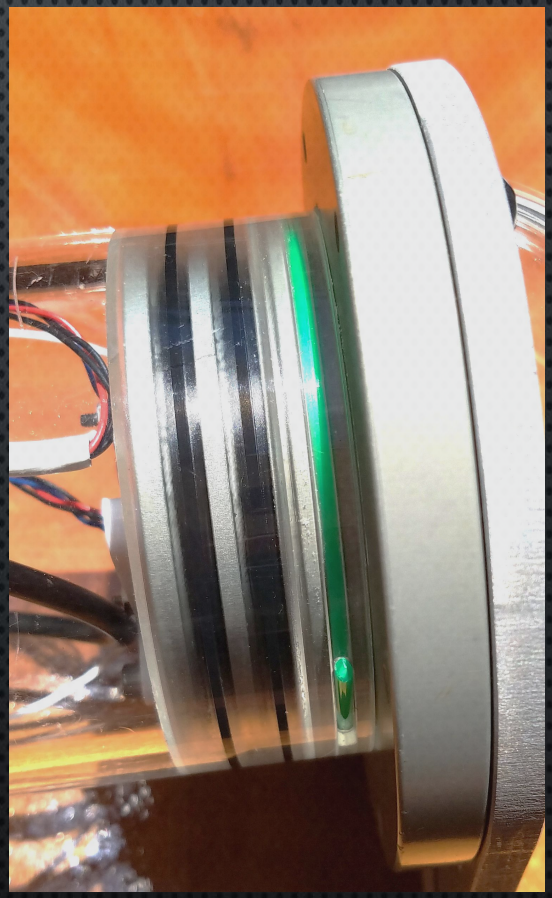
The Camera System

- Two ultra-low-light Watec 910h cameras in a stereo configuration
- Contained within custom-made waterproof "camera tubes"
- 3D-Printed camera mounts
- waterproof connectors to the main box
- Video data is sent to a MobileMule™ 2100 2-channel Mobile DVR



WATERPROOFING

- O-RING SEALS ON THE CAMERA TUBES
- O-RING SEALS ON THE MAIN BOX
- WATERPROOF CONNECTORS FOR THE CAMERAS AND FUTURE ADDITIONAL INSTRUMENTATION



Hardware Improvements Delayed to Year 3

- New board using a lower-footprint decreased complexity microcontroller
- New Instrumentation:
  - GPS Tracking
  - Temperature
  - Water Pressure
  - pH
  - Salinity

VIDEO RESULTS

POSTPROCESSING

1. Correct for the fishbowl effect generated by the spherical aperture of the waterproof camera tube
2. Search for identifiable features from both cameras and map them together
3. Generate a rectified frame
4. Create a disparity map using the Rectified images
5. Use the disparity map to generate a depth map

Example

DISTORTION CORRECTION

- Using a calibration checkerboard, identify the checkerboard pattern
- Use Checkerboard intersections to estimate the camera parameters

Rectification

- Identify surface features
- Map them together

RECTIFICATION

- Overlay corrected frames from both cameras to generate a rectified frame, using the stereo parameters

Disparity Map

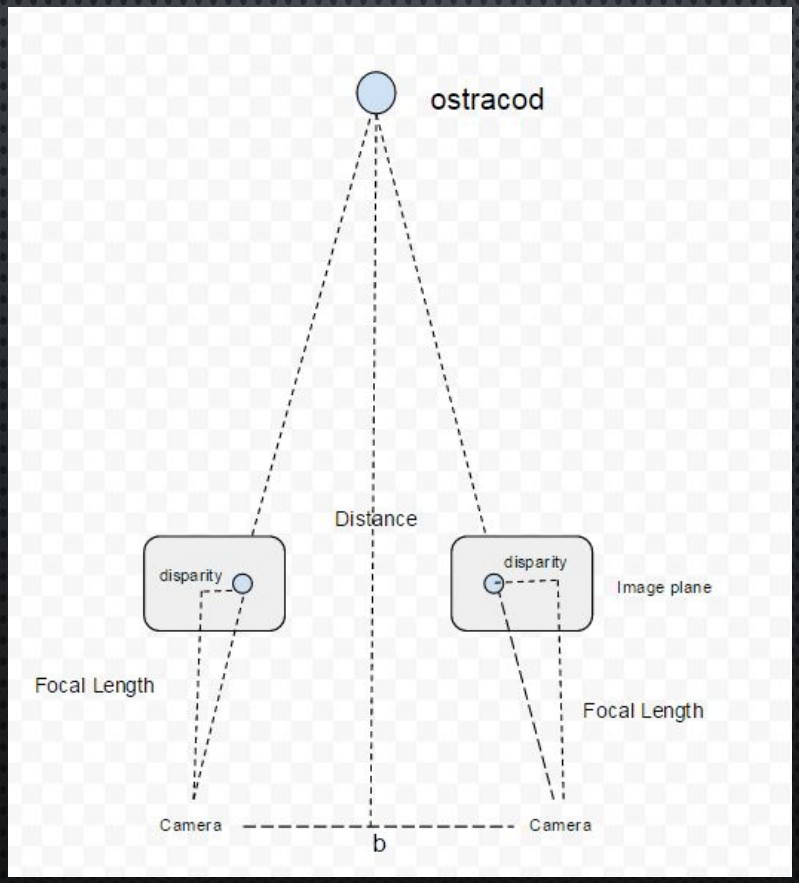
- Apply block matching to the rectified images to generate a disparity map

Disparity Map

- Apply block matching to the rectified images to generate a disparity map

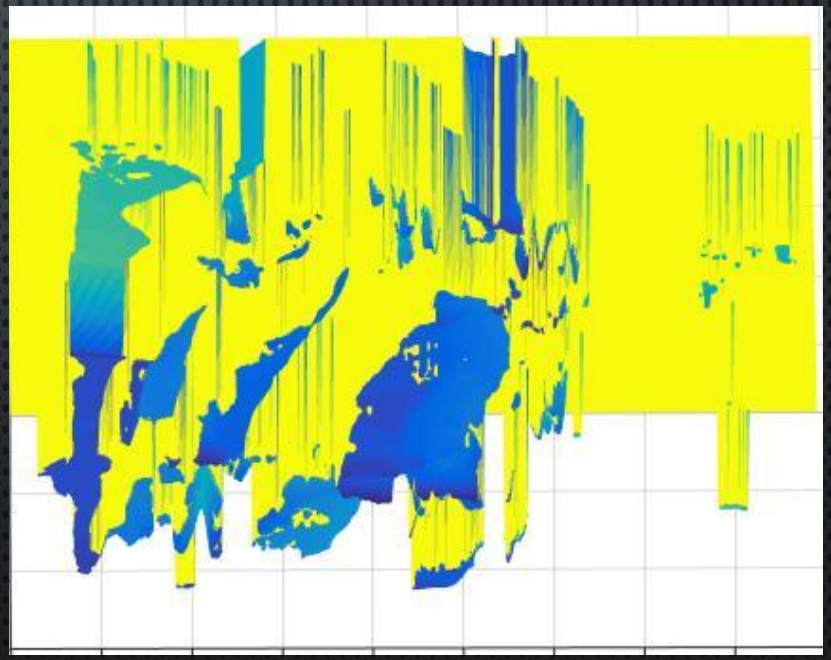
GENERATE DEPTH MAP

- GENERATE A DEPTH MAP USING THE DISPARITY MAP USING GEOMETRY
- DISTANCE = BASE_OFFSET * FOCAL_LENGTH / DISPARITY



GENERATE DEPTH MAP

- GENERATE A DEPTH MAP USING THE DISPARITY MAP USING GEOMETRY
- DISTANCE = BASE_OFFSET * FOCAL_LENGTH / DISPARITY



BLUE IS CLOSER, YELLOW IS FURTHER

DE-NOISING

QUESTIONS?