Capstone Project

Ocean Sediment Collection Drone

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OVAC

Abstract

The purpose of our project was to prototype an autonomous ocean sediment collection device to be used by researchers and industry professionals to assist them in gathering important data about the health of our environment. Once launched into the water, the device will act autonomously to sink to the bottom of a lake or ocean, collect floor sediment, and float back to the surface for retrieval. With the sediment and data collected researchers will be able to determine past ocean conditions, oceanic circulation patterns, as well as the nutrient content of the surrounding area.

Design Factors

This project was developed with the intent to prioritize ease of use as well as accessibility by minimizing the extent to which additional equipment is required for operation.

Features

- Vacuum and lift bag powered by standard scuba tank
- Controlled via smartphone
- Easily disassembled for transport
- Adaptable to changing environments
- Quick operation time allows for multiple tests

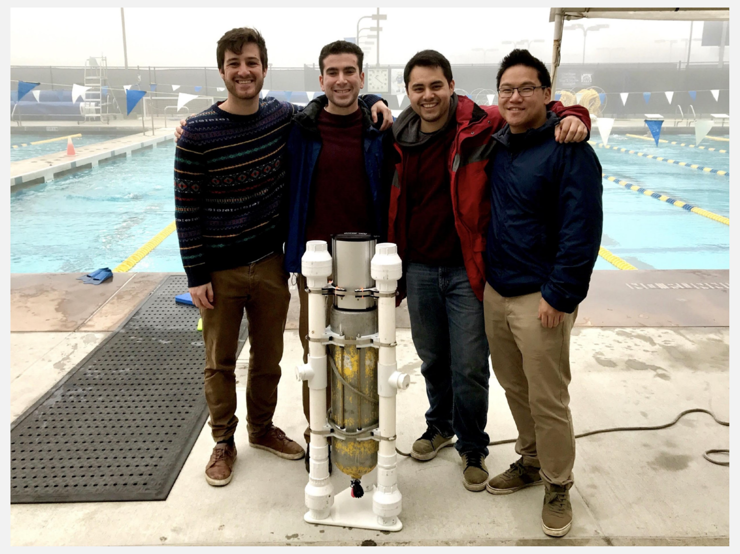


Fig. 1 – Team OVAC testing at OPERS pool

Sediment Collection

Exploring depths from 200 to 1000 feet prove to be difficult due to being out of range for scuba divers. There are devices that can reach this depth, but they are made to explore much deeper waters and are very expensive.

Current Industry Method

- Grab Sampler
  - Claw like device that is expensive, time consuming and requires up to five people to operate
  - Not reliable, as claw is lifted to the surface ocean currents erode away most of the sediment collected

Air Lift System

- Method OVAC utilizes
  - Compressed air is fed to the bottom of a long tube, creating a vacuum as it rises up through the tube and expands
  - The vacuum at the bottom lifts water and sediment into the tube
  - When the air is turned off a check valve located at the bottom closes, trapping the sediment

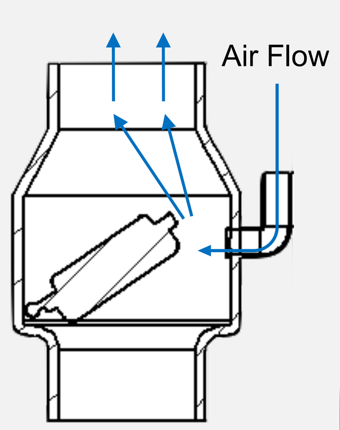


Fig. 2 – Check valve with air flow

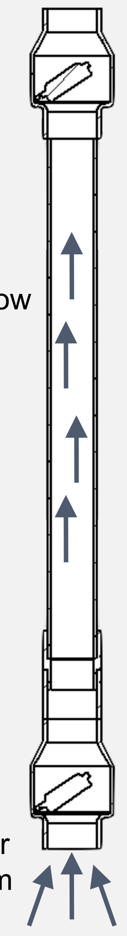


Fig. 3 – Air Lift System

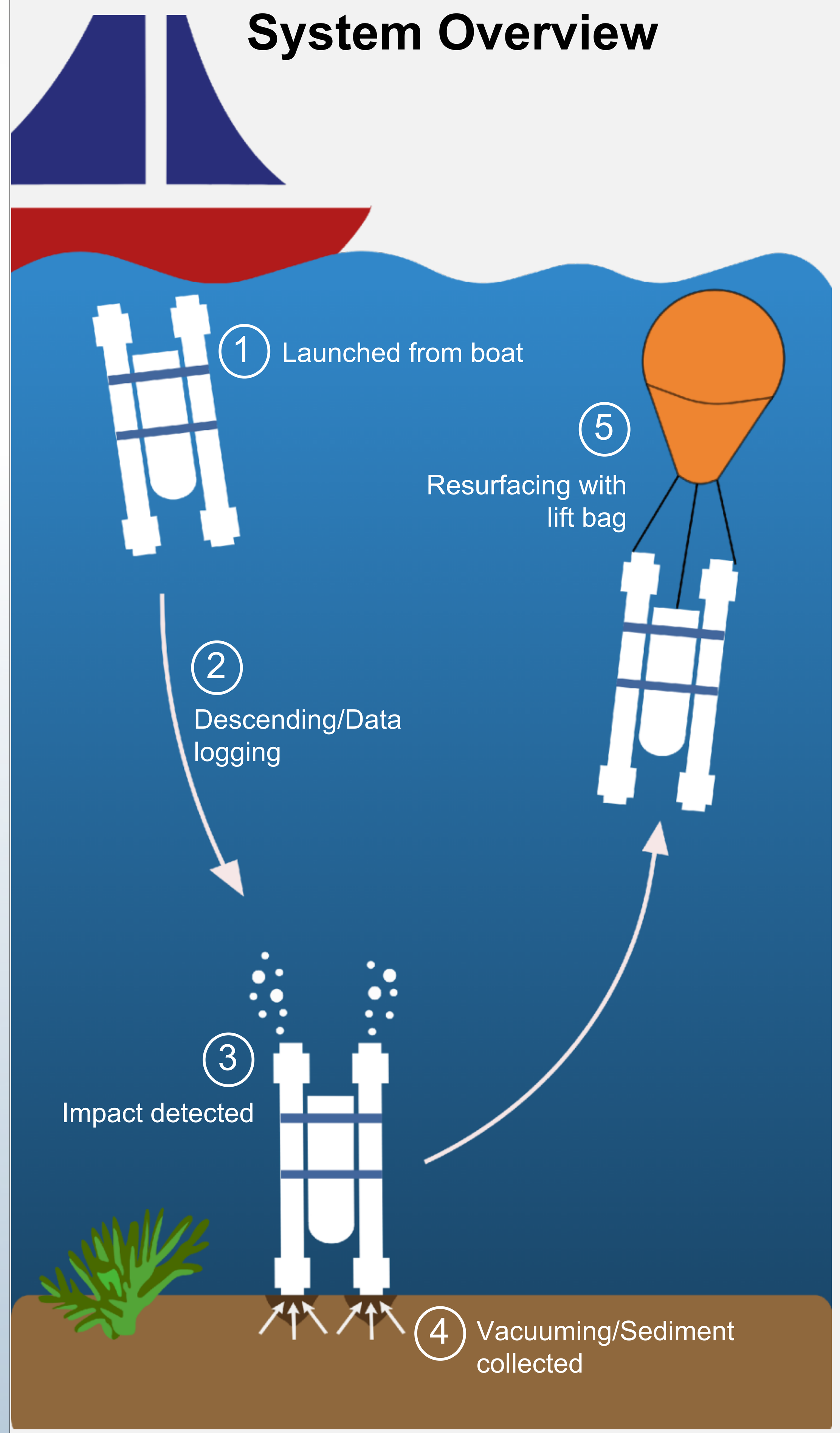
Data Collection

Various sensors can be used to collect data during descent and resurfacing. With its modular design, researchers can have a number of sensor arrangements to collect the data they need.

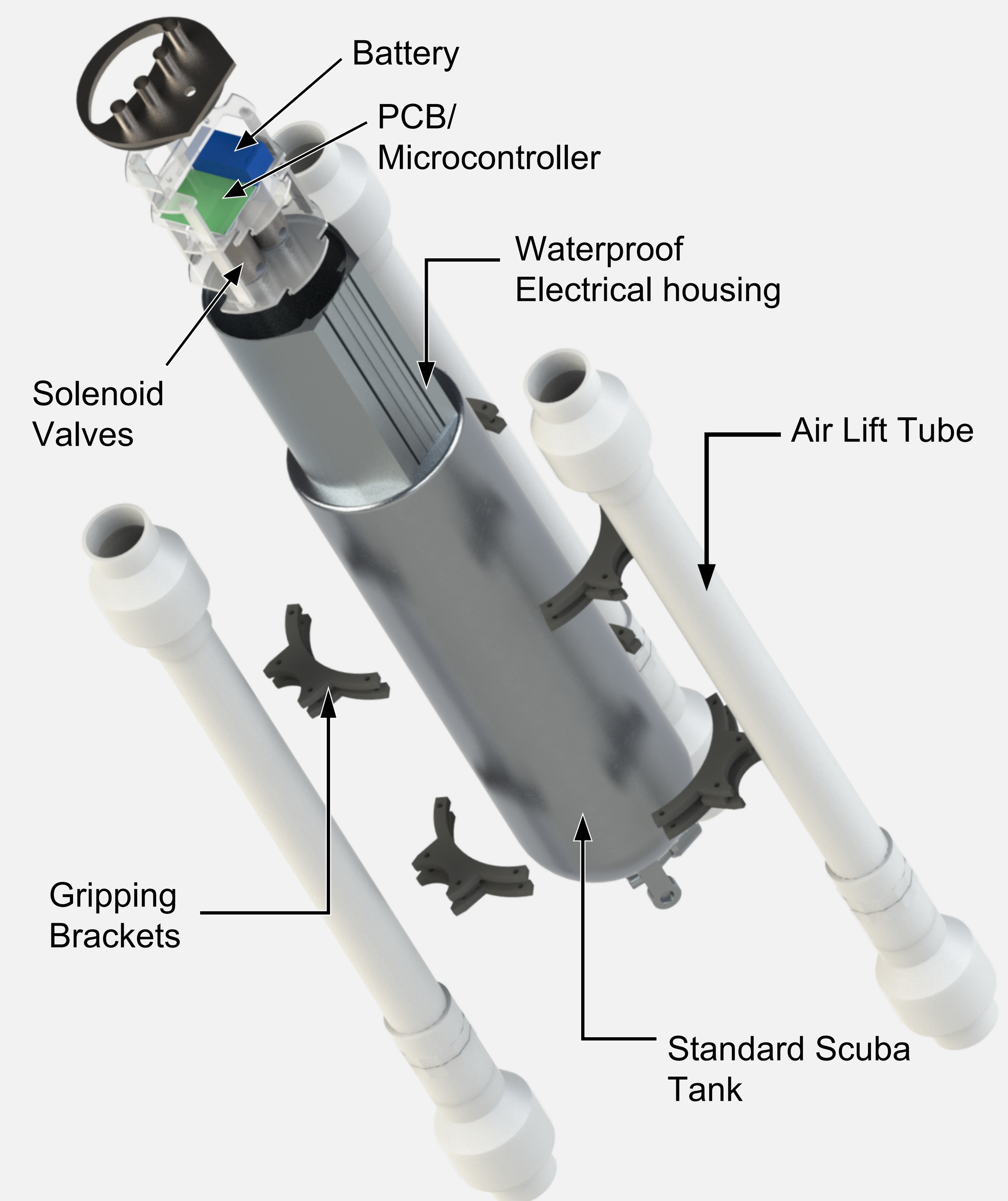
- Current Sensor Integrations
  - Accelerometer/Gyroscope
  - Pressure
  - Moisture (leak detection)
- Future Sensor Integrations
  - Temperature
  - Salinity
  - pH
  - GPS

Overview

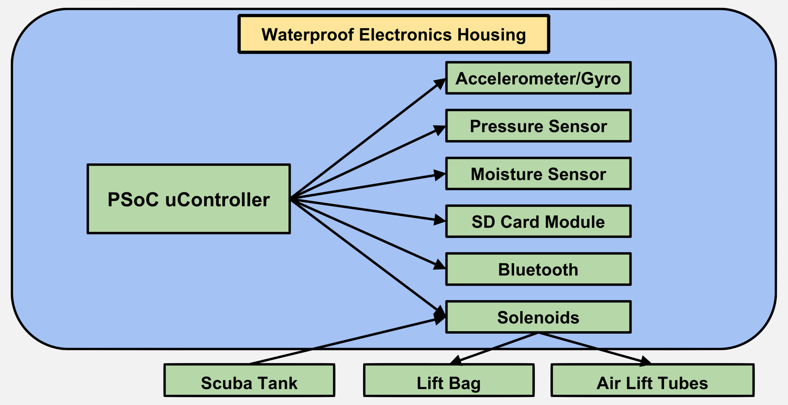
System Overview



Exploded View



System Block Diagram



Components

Electrical Housing

Our waterproof housing stores all of our electrical components including the PCB, microcontroller, sensors, battery and solenoids.

Solenoids

Control air flow to the vacuum systems and lift bag

- The black tubes seen in Fig. 4 carry air through the housing to and from the solenoids
- Brass fittings on top are used to connect the air lines to the outside of the housing

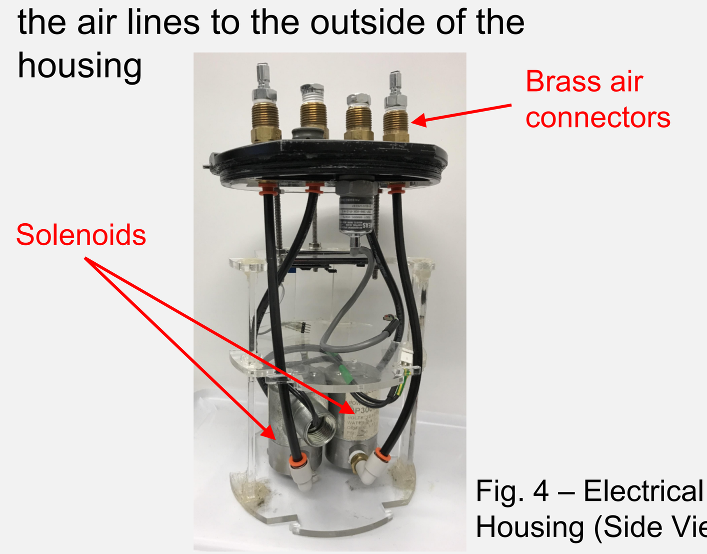


Fig. 4 – Electrical Housing (Side View)

Housing Lid

- Secures pressure sensor, pressure relief valve, and brass air connectors
- Glass window allows for visibility of LCD screen
- LCD screen used for device status and state changes

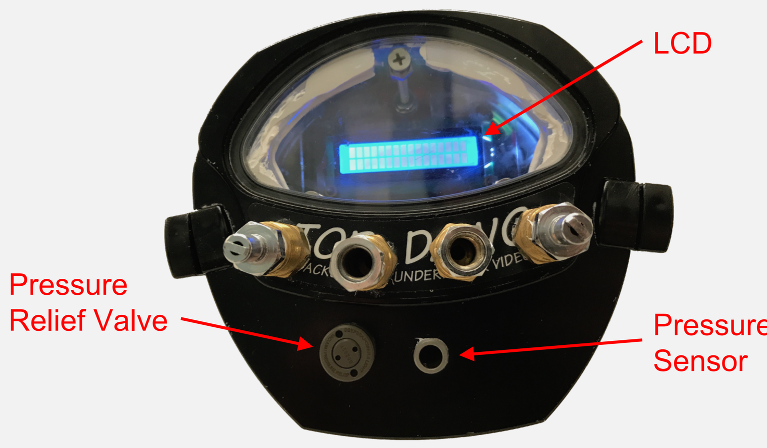


Fig. 5 – Electrical Housing (Top View)

PCB

Unifies all of the components of the system to the Microcontroller. Includes connections for:

- Accelerometer/Gyro
- Voltage Regulation
- Solenoid Drivers
- Differential Amplifier
- SD Card module
- Moisture Sensor
- Bluetooth
- Battery

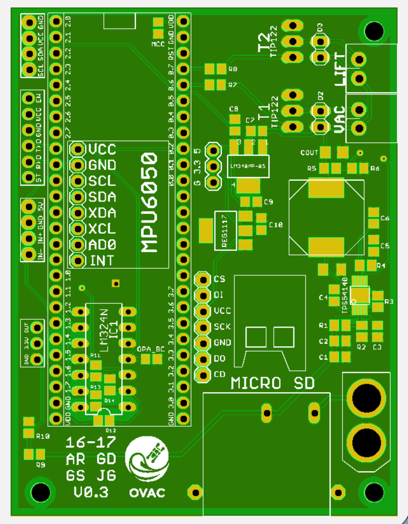


Fig. 6 – PCB Layout

Sensors

Accelerometer

The accelerometer enables us to detect a sudden change in velocity which indicates when the device impacts the sea floor. Once an impact is detected the device will transition from descent into the sediment collection state.

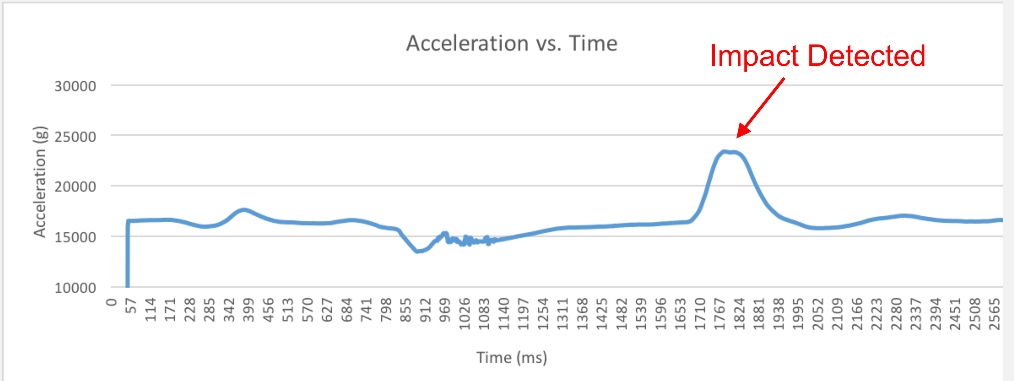


Fig. 7 – Accelerometer data throughout a single sampling run

Pressure

As the device descends ambient pressure increases linearly; knowing this we can use a pressure sensor to determine the current depth and state of the device.

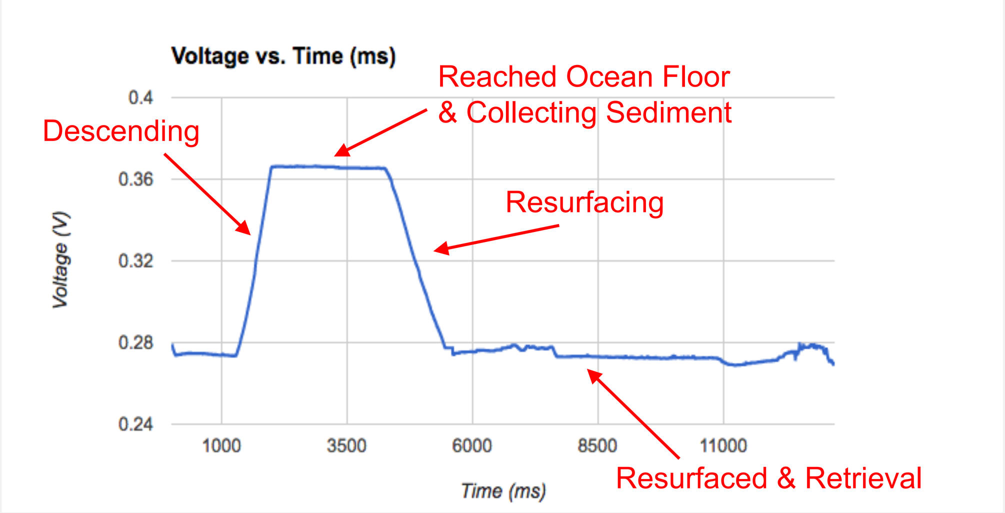


Fig. 8 – Pressure data throughout a single sampling run

Conclusion

Our project was successful in proving that the device can autonomously collect sediment and important data. The device is able to descend up to 200 feet and reliably return to the surface with samples. We hope that our design will continue to increase the efficiency of the sediment collection process and enable researchers to draw important conclusions about the health of our environment. The prototype will be deployed with the Long Marine Lab and act as a more efficient replacement to their current methods.

Future Work

Now that our prototype has proven to be effective we are looking to improve our design in future iterations. An improvement that we are interested in pursuing would be to make a miniature version of the device that can be deployed in groups in areas such as coral reefs or in oil spills, to collect multiple sources of data. This could also be used to quantify the temperatures and pH levels of various parts of a coral reef as well as the effects of oil spills on biodiversity.

Acknowledgments

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