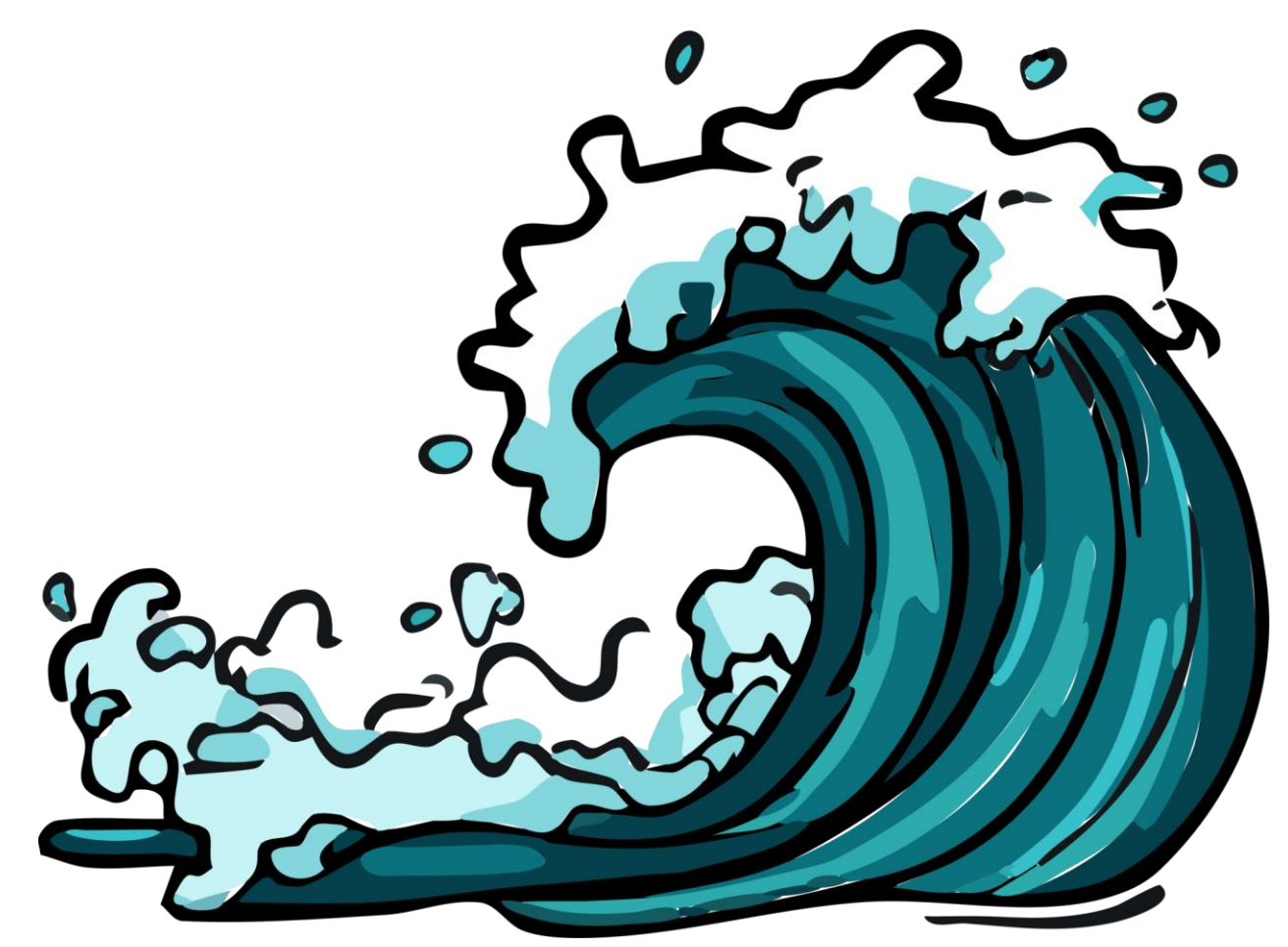


Enhancing Coastal Preparedness: A Device for Earthquake Detection and Community Supply Cache Access



Camden Galen - Adrian Mobley - Drummond Wengrove - Tracy Crews

Background

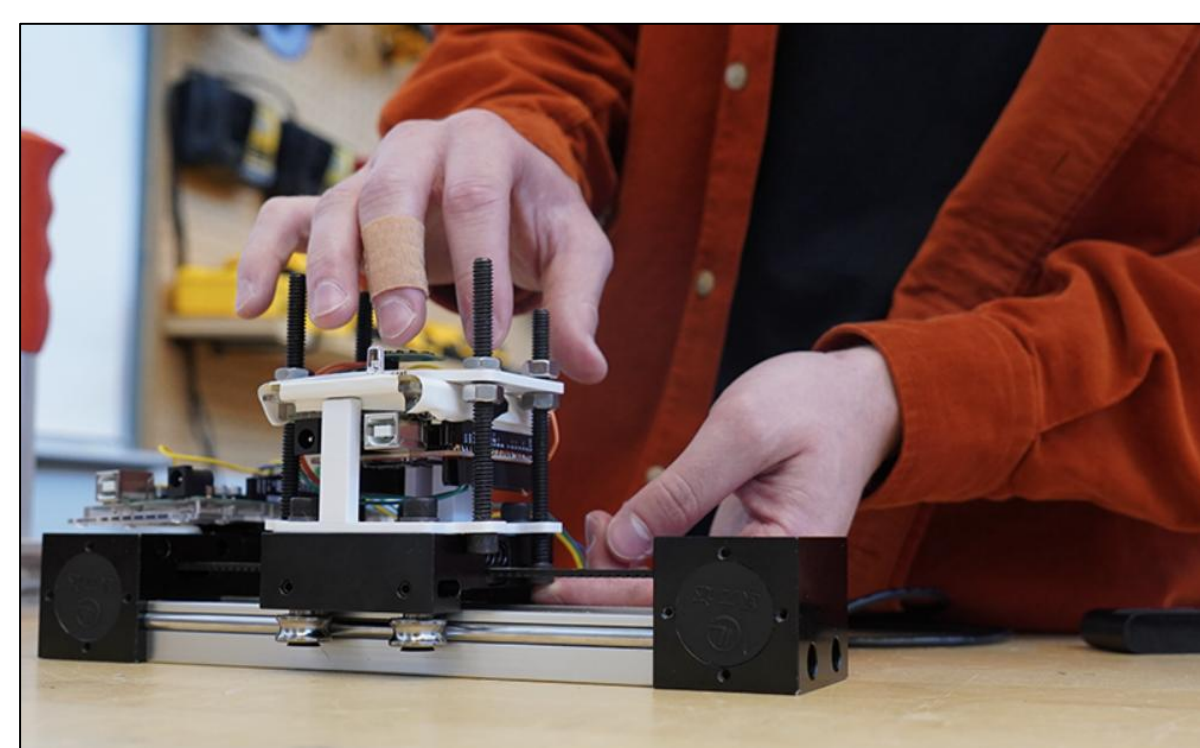
Historically the Cascadia earthquake happens every 200-500 years. The last major event was in 1700, meaning one could happen at any moment. Newport, along with other coastal towns, have prepared for this with several dedicated evacuation zones and supply caches with food, water and shelter at these locations. Though with lack of education and limited access to the caches, several groups of people are left susceptible to the earthquake and tsunami.



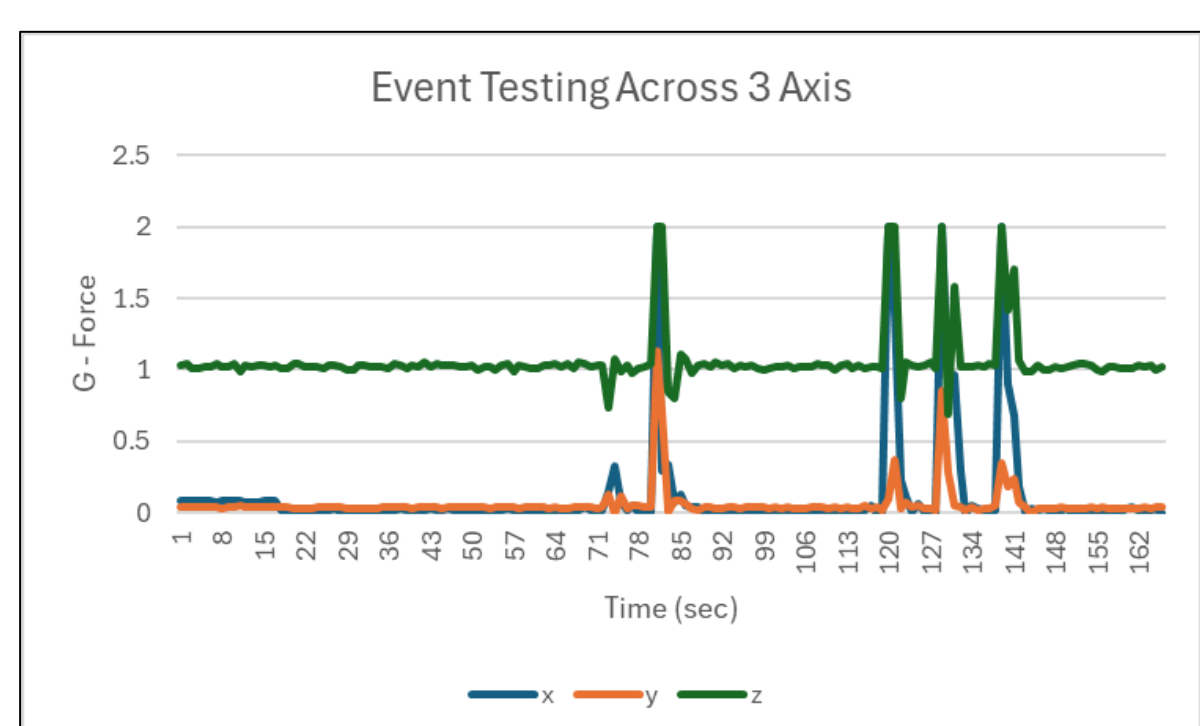
How Can We Help?

Develop a device that attaches to community supply caches/ assembly areas to detect major earthquakes and provide a warning system to lead the public to safety, while also ensuring timely access to the supplies within.

We can accomplish this with the use of a programmable Adafruit ESP microcontroller, a 3-axis accelerometer to collect seismic data, a LED beacon to direct the public where to evacuate, a solenoid to actuate a locked key box door, and use the Wi-Fi compatibility of the microcontroller to send an email to staff, all in a weather tight housing.



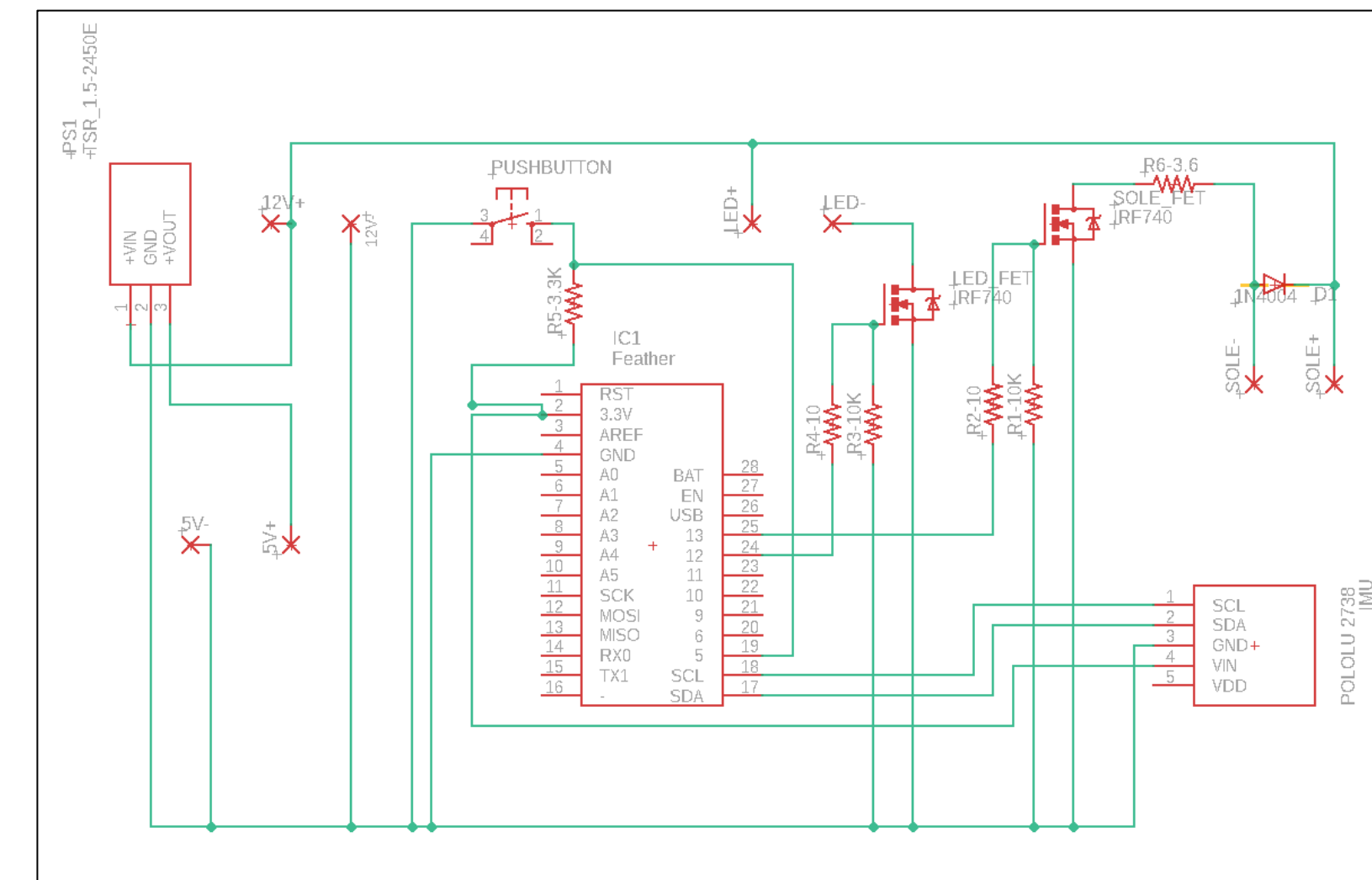
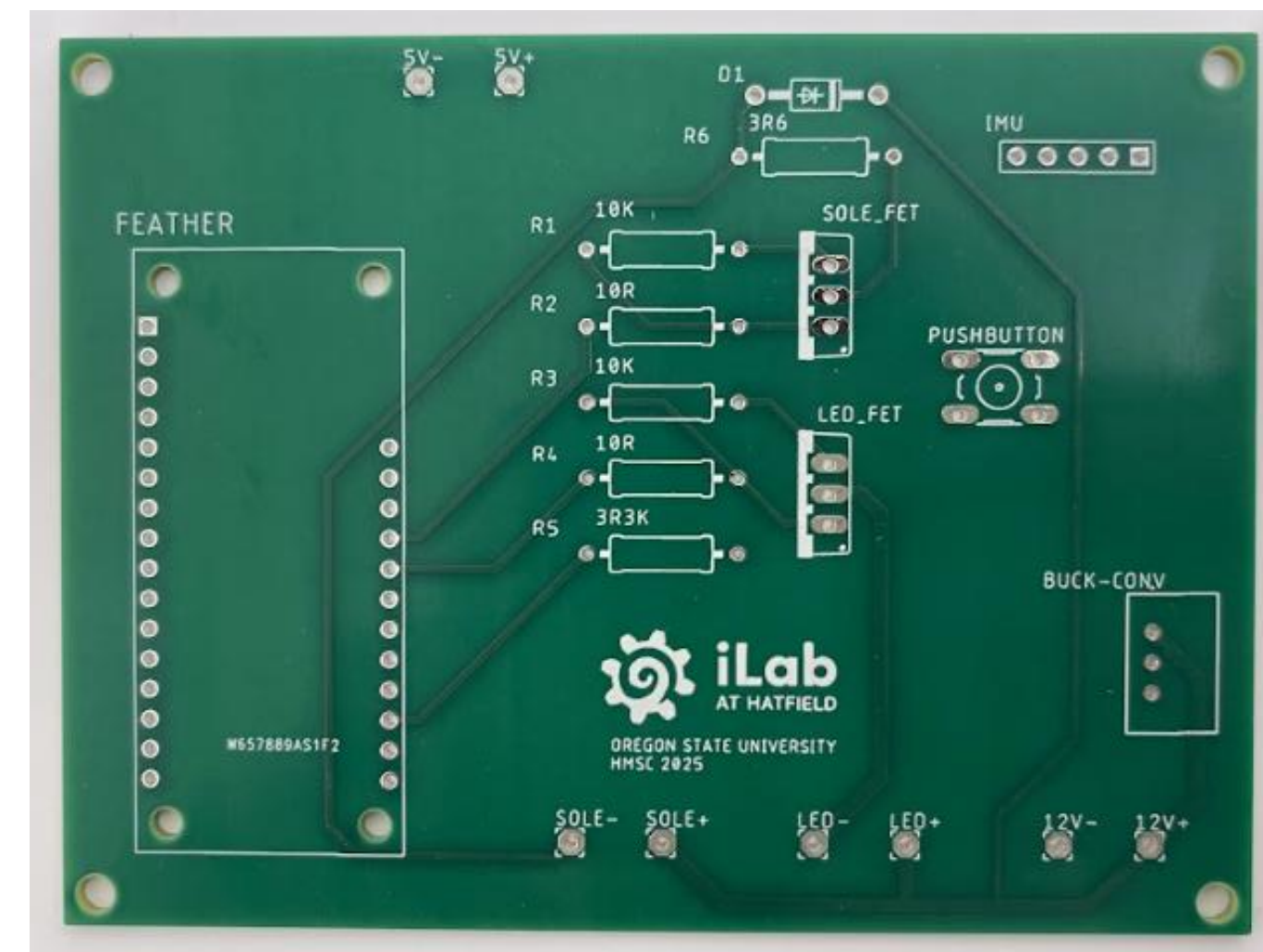
On the left is the testing of a Pololu 3-axis accelerometer with a stepper motor turned makeshift shaker table to do event testing.



The graph results are as expected with a large spike when the shaker table is simulating an event then going back to about 0.00 g-force after the event.

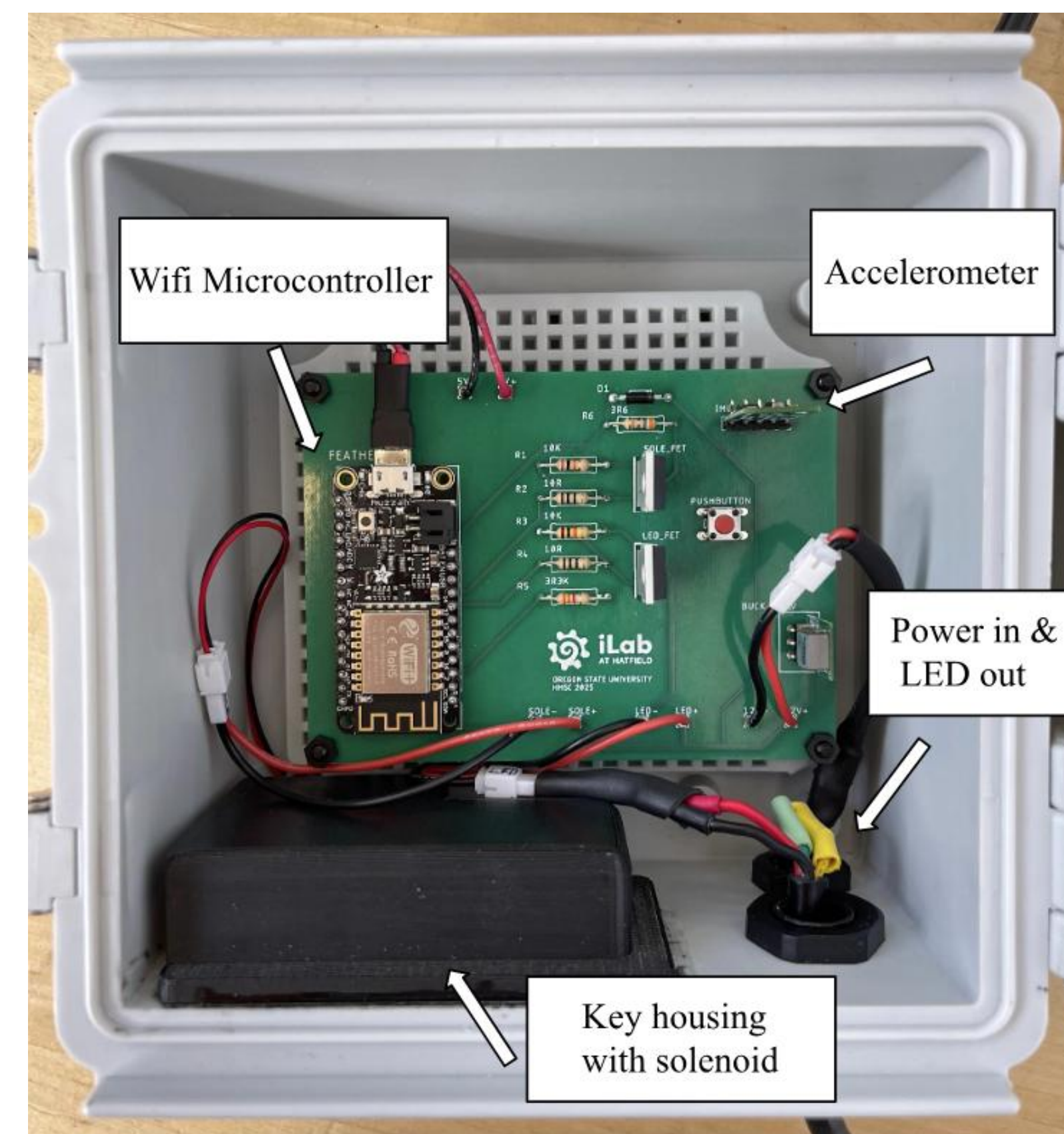
Currently

To the right is the circuit schematic made in Autodesk Eagle. This has all the components, and their paths to ensure accuracy of the device. The circuit is then converted to a printed circuit board and externally manufactured for mass deployment of the device.



To the left is the printed circuit board. The only post-processing step necessary is to solder the components, upload the code to the microcontroller, and mount the board to the housing.

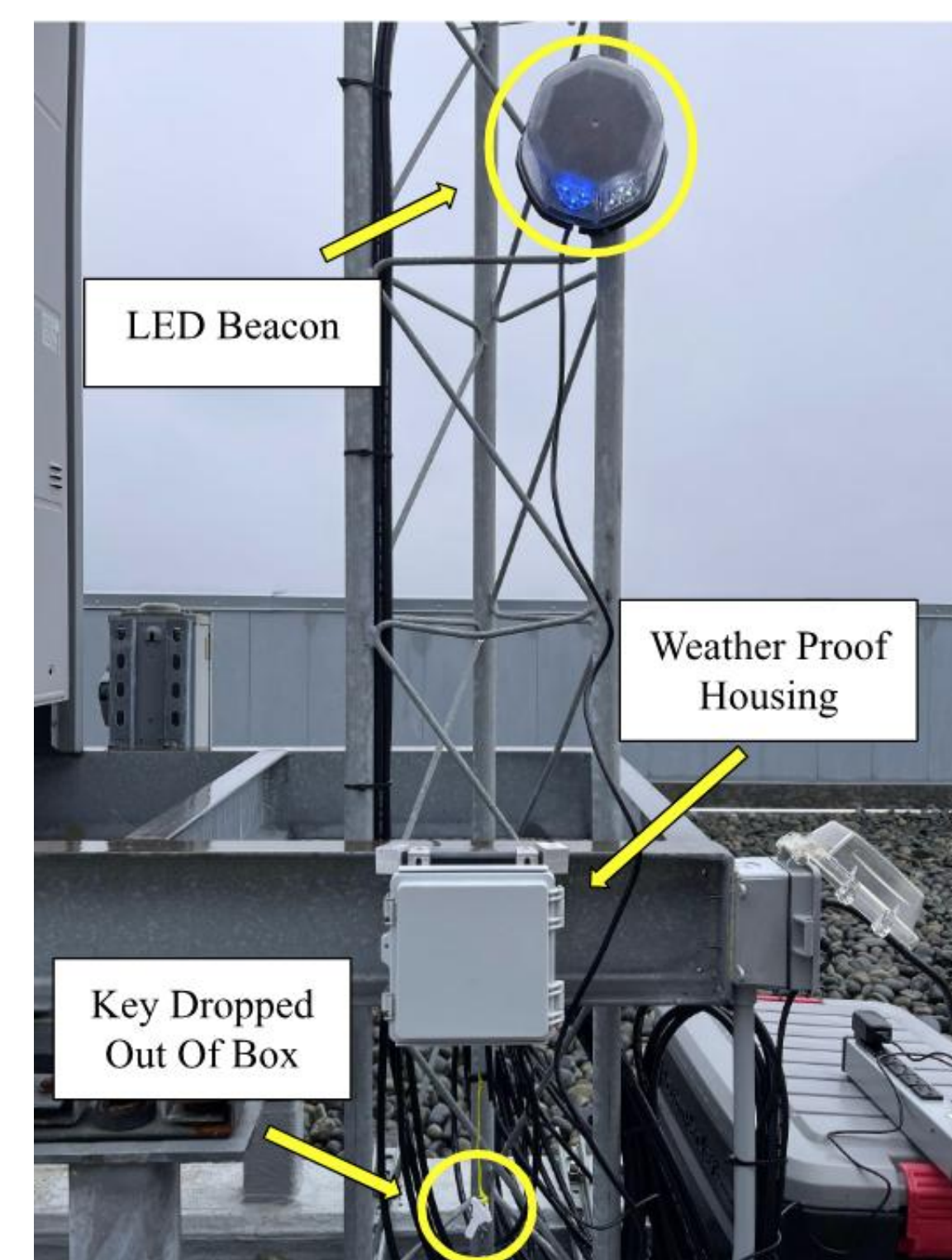
To the right are the internal components of the device. At its core is the board above with all the necessary transistors, resistors, and sensors to run the system. On the bottom left of the image is the key box housing with a solenoid actuated door. On the bottom right are two grommets with the 12 Volts DC input and the LED output wires.



```

86 void loop()
87 {
88   float x_threshold = 0.4;
89   float y_threshold = 0.4;
90   float z_threshold = 1.4; // Adjust if necessary
91
92   imu.read();
93   float x_accel = abs((imu.a.x*0.061)/1000);
94   float y_accel = abs((imu.a.y*0.061)/1000);
95   float z_accel = abs((imu.a.z*0.061)/1000);
96
97   // Add IMU data to runningAverage objects
98   rax.addValue(x_accel);
99   ray.addValue(y_accel);
100  raz.addValue(z_accel);
101
102   // Get smoothed values
103   float x_avg = rax.getAverage();
104   float y_avg = ray.getAverage();
105   float z_avg = raz.getAverage();
  
```

The code running the device uses C++ and creates a running average of the acceleration data. If it goes over a variable threshold, the device triggers.

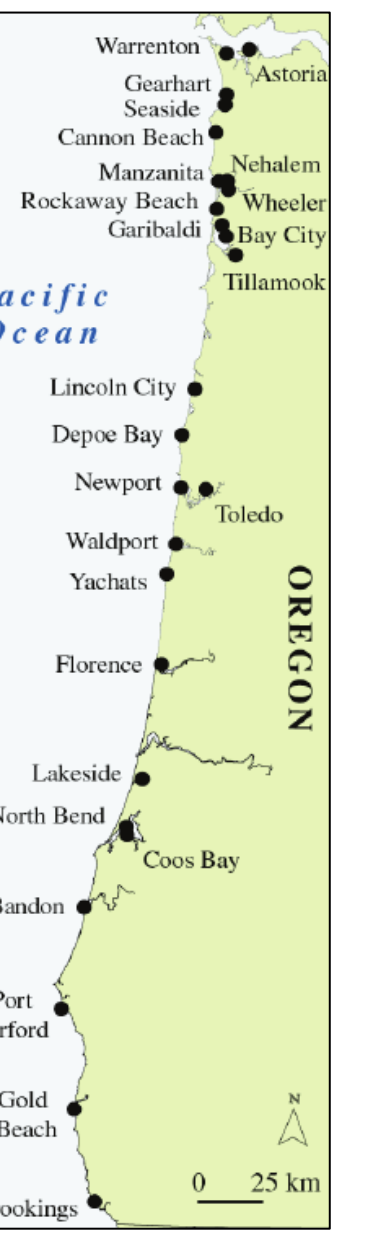


An 8.0 magnitude earthquake is predicted to cause a destructive tsunami. When we convert this to the Mercalli scale it equals about 1.39 g-Force or 13.6 m/s². We use this value as our threshold for the device. To prevent false triggers, it must be a sustained duration of time over this threshold. After 10 seconds of continuous ≥ 1.39 g-force of acceleration in any direction (N,E,S,W or vertical) the device activates. The LED beacon spirals blue and white lights at about 5000 lumens. Bright enough for tourists to see at night and know where to evacuate. The key box door opens and drops a key to unlock the supply cache. For extra security, an email gets sent to staff in case it false triggers and needs to be deactivated.

Future

The entire Oregon coast is susceptible to the Cascadia earthquake and the only thing we can do is prepare and educate.

There is still one term of funding remaining for this project. The goal is to refine the current prototype and work on a large-scale deployment along the Oregon coast at no cost to them.



Improvements

One major consideration in our hopes to deploy this device along the coast is access to power. Our system relies on 12 volts and many supply caches along the coast are based in rural areas lacking utility/power. These considerations raised a strong desire for renewable energy and its ability to provide systems with a level of energy autonomy.

We were able to design and develop a small, cost effective, solar module that could easily be attached to any device at any cache/assembly area regardless of the power available. Given the weather we experience in Newport and along the coast we realize there are inherent draw backs to relying on solar power year-round. Testing and development show promise in this regard.



Acknowledgments

We want to express our gratitude to Oregon Sea Grant, NOAA, Tracy Crews, and Drummond Wengrove for this incredible opportunity. Working on such a unique project presented many challenges and learning experiences, but it has left us well-prepared for our future endeavors. We are excited to continue this project and feel grateful for the chance to contribute to our hometown and the local community of Newport, Oregon.