



instru-MEN-tation

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Project introduction:

Dr. Chun-Hsing Ho:

Associate Professor in Civil Engineering, Construction Management, and Environmental Engineering.



Motivation:

- Detect Obstacles on the bike trail
- Help the bikers know the location of each obstacle to avoid it
- Making biking safer by making an app that is accessible to everyone

Dr. Kyle Winfree

Associate Director for Undergraduate Programs, School of Informatics, Computing, and Cyber Systems.



Most important requirements:

- GPS sampling frequency at least 1 Hz.
- Accelerometer sampling frequency at least 100 Hz.
- It needs at least 3 hours battery life to collect data.
- At least 100MB of memory to store multiple trips.
- Must be able to locate other obstacles in the trail.



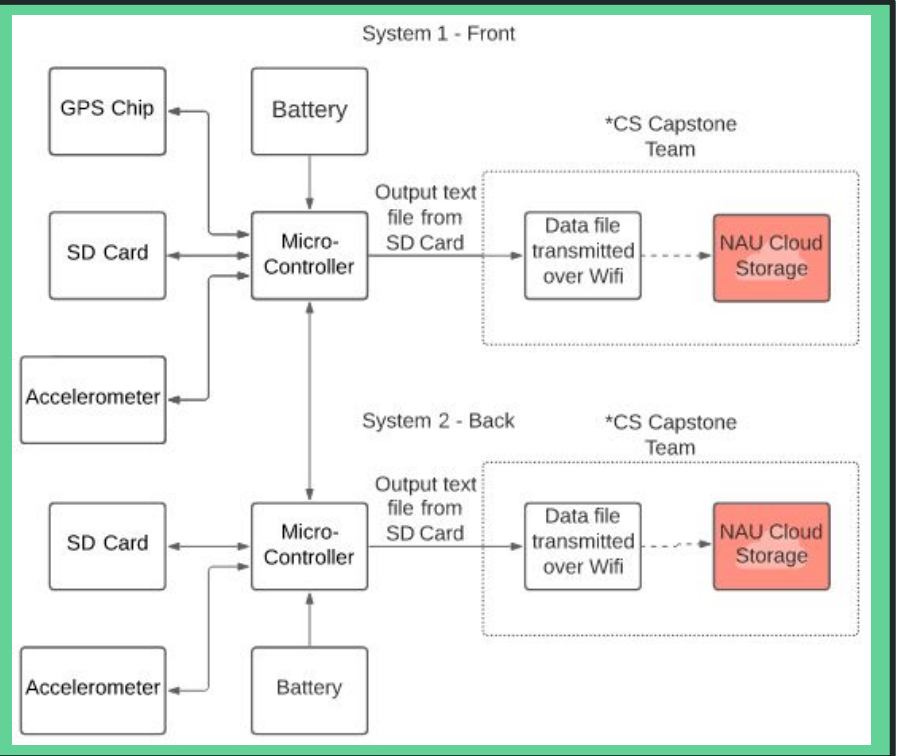
System Architecture:

System 1 - Front:

- GPS
- SD Card
- Accelerometer
- Battery

System 2 - Back:

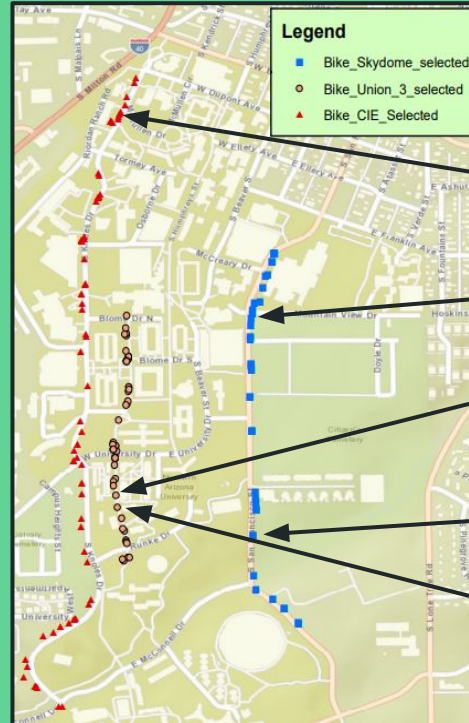
- SD Card
- Accelerometer
- Battery



Testing Results:

Bike trails tested:

- **Red triangles:** From *W. A. Franke College of Business* building to *Center for International Education* building
- **Yellow dots:** From *Skyview Apartments* to *University Union*.
- **Blue squares:** From *Skydome* to *Health and Learning Center*



Analysis of Results:

Raw data output:

Every 1 second:

time (in ms), latitude, longitude, date, and time

Every ~0.1 seconds:

time (in ms), x, y, and z values

```
37300, 35.18880, -111.65507, 2022-3-23-13-32-41
374171, 35.18878, -111.65507,
374192, -0.1196, -0.0605, 1.0287
374221, -0.1213, -0.0595, 0.5916
374244, -0.0914, -0.0798, 1.0046
374267, -0.0662, -0.1233, 1.0239
```

Sudden change in the z value indicates that there is a hole at this location

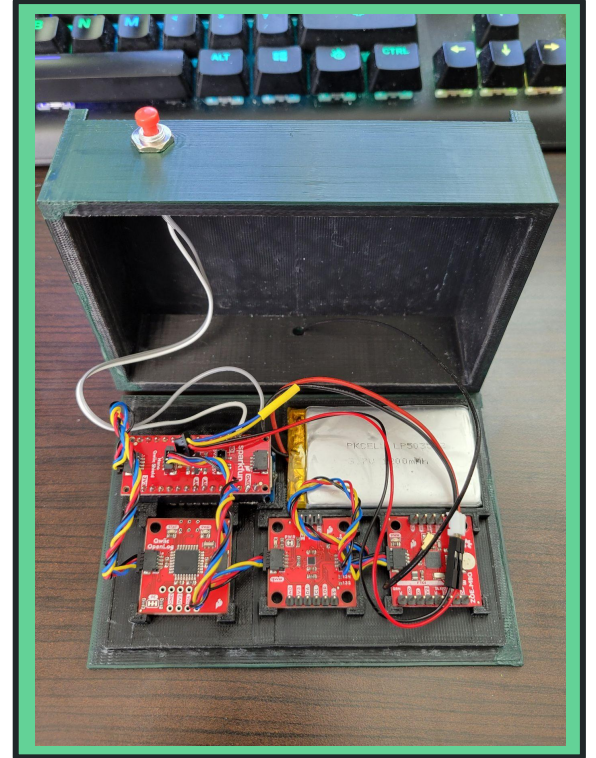
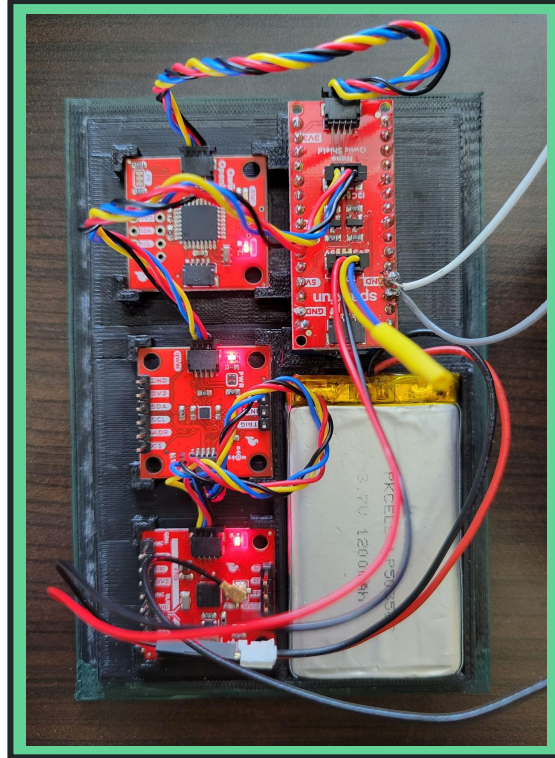
A sudden change in a z value indicates that there is an obstacle in the latest printed GPS coordinates.

A gradual change in an x value indicates that the bike is on an incline or decline

Summary of Technical challenges:

- **Missing Characters:** Inability to change the baud rate of the Arduino (due to using I²C communication) caused missing characters in the output data file, as the OpenLog was running slower than the accelerometer.
- **Using two accelerometers:** The Arduino was only reading one accelerometer. And changing addresses did not resolve the issue.
- **Using a second subsystem on the back of the bike:** was impractical, challenging to implement, and caused more trouble than it was worth.
- **Using NAU WiFi:** was impossible to connect the Arduino to the NAU WiFi due to the two-step verification.
- **System container:** 3D-printing, warping due to temperature fluctuations

Final Product Pictures:



Ibrahim

Conclusion:

Although the important requirements were satisfied, we feel that the project could have been done in a more practical way such as developing it in a smartphone app. Nonetheless, this was a very valuable experience and the team has learned a great deal from this project, as it introduced us to real-world problems and challenged the team to think creatively and effectively throughout the entire project.

Thank You for Listening

Any Questions?