Radio propagation digital twin to evaluate pedestrian localization in smart streetscapes

REU Scholar: Alyssa Falcon
Advisor: Dr. Georgios Sklivanitis
Lehman College, City University of New York

FLORIDA ATLANTIC UNIVERSITY
Institute for Sensing and Embedded
Network Systems Engineering

NSF | CENTER FOR SMART STREET SCAPES

About

- I-SENSE has sensors deployed that detect RSSI values from Wireless emissions and can be found on Mobile Intel (wifi, phones, cars etc.)

- For the project we use 14 emitter locations and focusing on 4 sensors

- Digital Twin would help eliminate collecting data in person and help generate additional RSSI values

- Pedestrian finding on Clematis Street

- Mobility pattern of pedestrians or cars
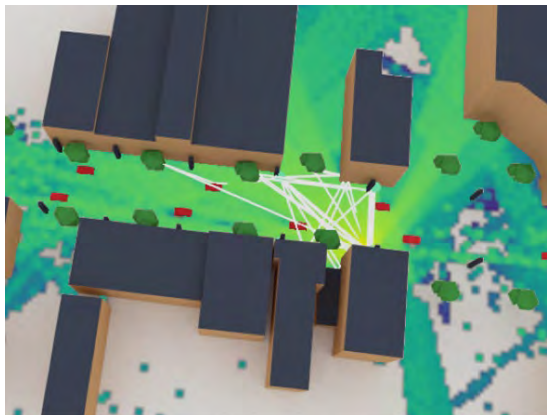
Allow wireless access
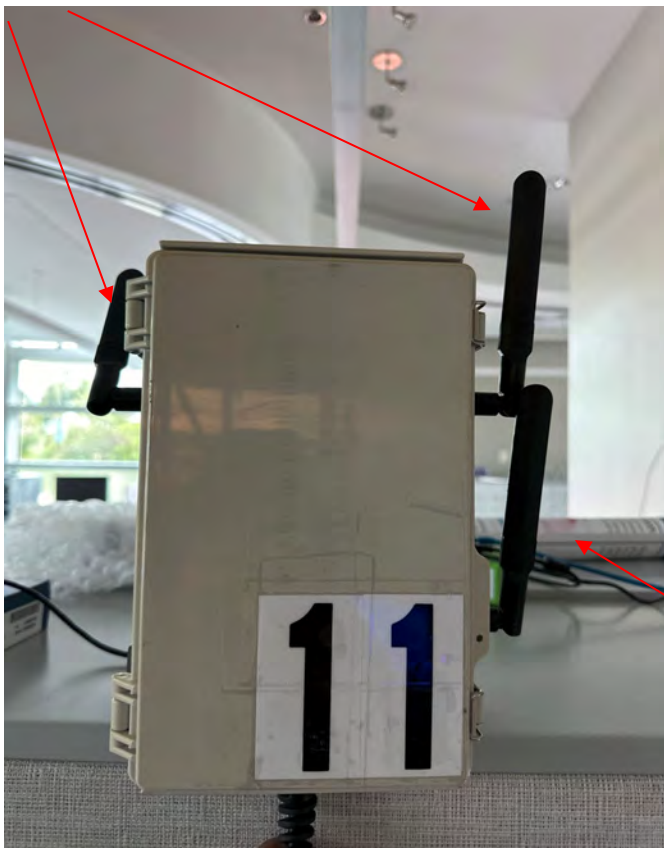
Detects RSSI

Tools Used

Sionna Ray Tracing

- Simulates how radio signals travel through an environment as they bounce off objects

Blender

- Tool that supports 3d modeling and animation

Open Street Maps

- Map of the world and you can get coordinates of an area you want to focus on

Research Goals

- Create a Digital Twin of Clematis Street using Blender

- Gather RSSI values using Sionna Ray Tracing

- Apply localization methods to the Digital Twin
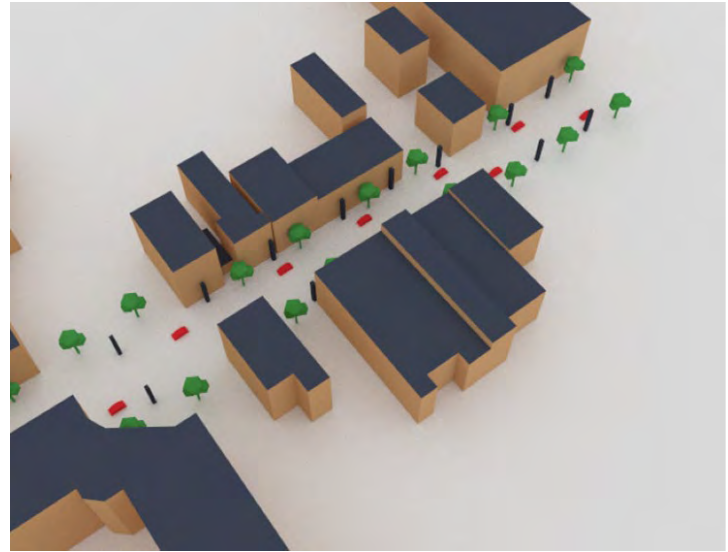
How RSSI collection is done?

- Get coordinates from OSM and import the 3d map into Blender

- Add in materials for objects and additional items in scene

- Export the .xml file needed to import into Sionna

- place receivers and transmitters in Sionna at specific coordinates from Blender

- Set up cars to move in the scene and updated coverage map
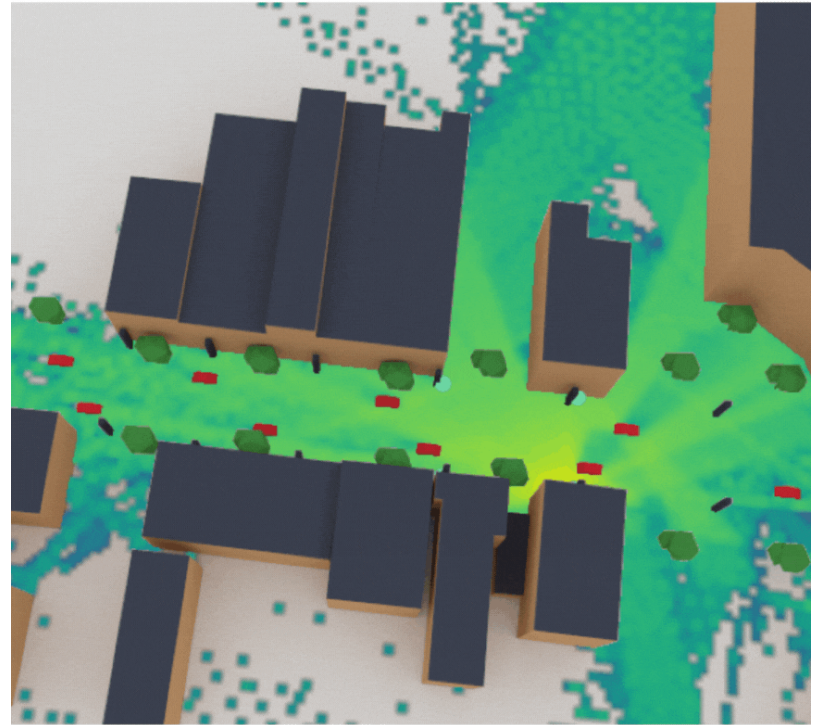
Trilateration

- Localization method which uses three known points to find an unknown point

- RSSI values from each known point were applied to the Friis Equation to find the Distance to the actual location

$$d = d_0 10^{\frac{p_r - p_0}{-10v}}$$

- Tested with different v values to see if that would help our accuracy

$$v = \frac{p_r - p_0}{-10 \log_{10}\left(\frac{d}{d_0}\right)}$$
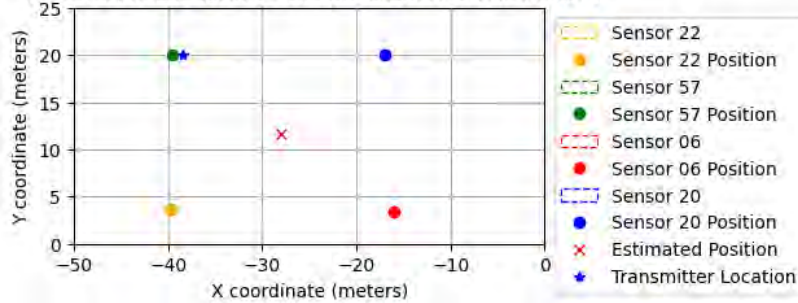
RSSI Collection Variance
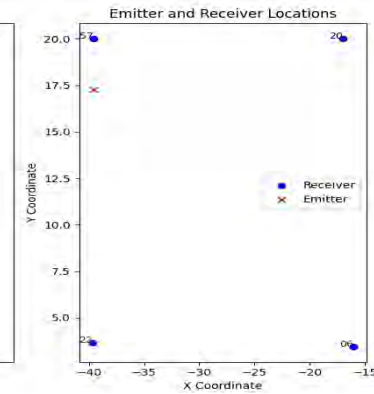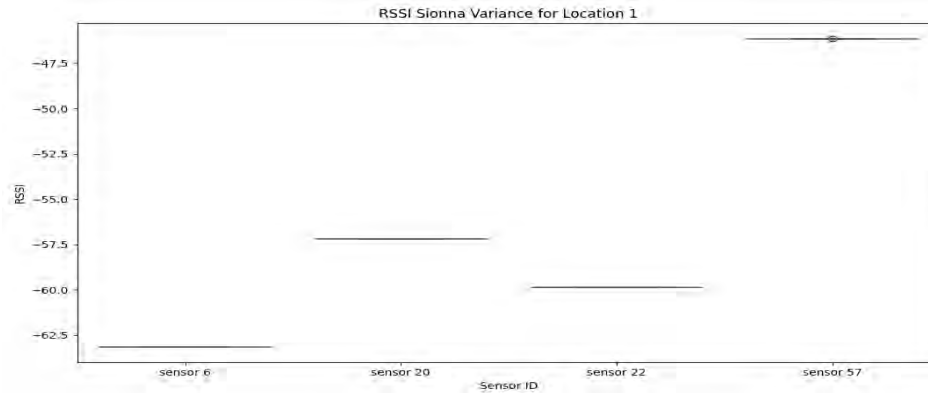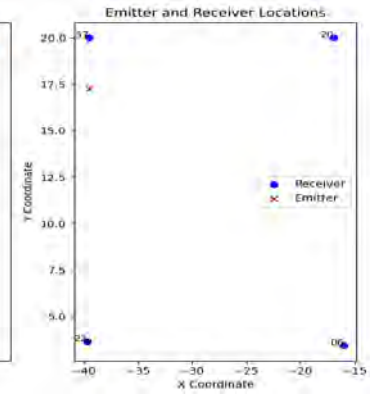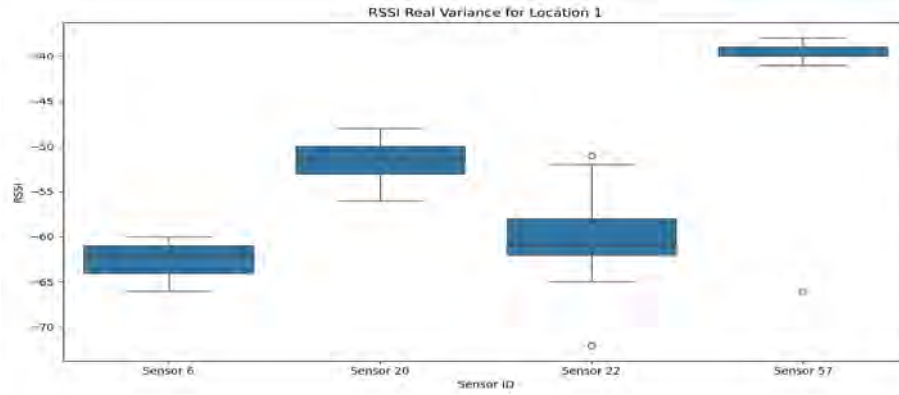
Real Data

$$d = d_0 10 \frac{p_r - p_0}{-10v}$$

$$v = 2 \qquad d_0 = 1 \qquad p_0 = -39$$

Digital Twin Data

$$p_0 = -38 \qquad d_0 = 1$$

$$v = 2$$

Real Data

$$d = d_0 10 \frac{p_r - p_0}{-10v}$$

Digital Twin Data

$$p_0 = -38 \qquad d_0 = 1$$

$$v = 2$$

Trilateration Location 2 - Distance Error: 12.85 meters
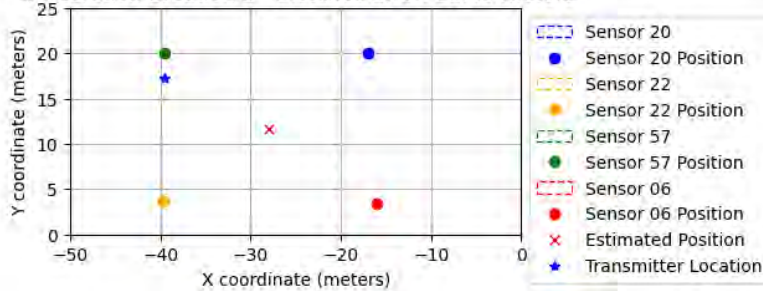
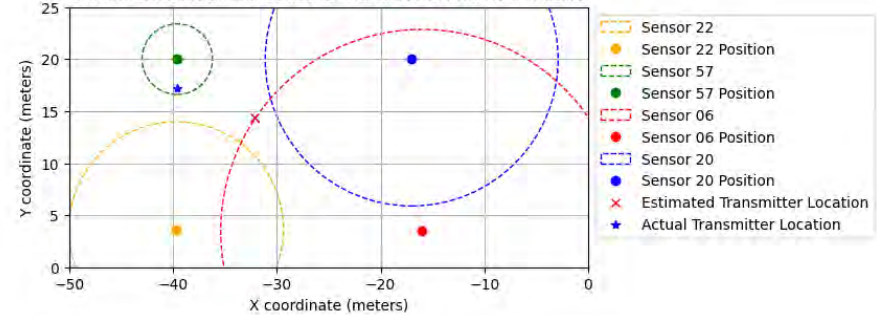Sionna Trilateration Location 2- Distance Error: 7.93 meters

Estimation Comparison

Estimation error difference
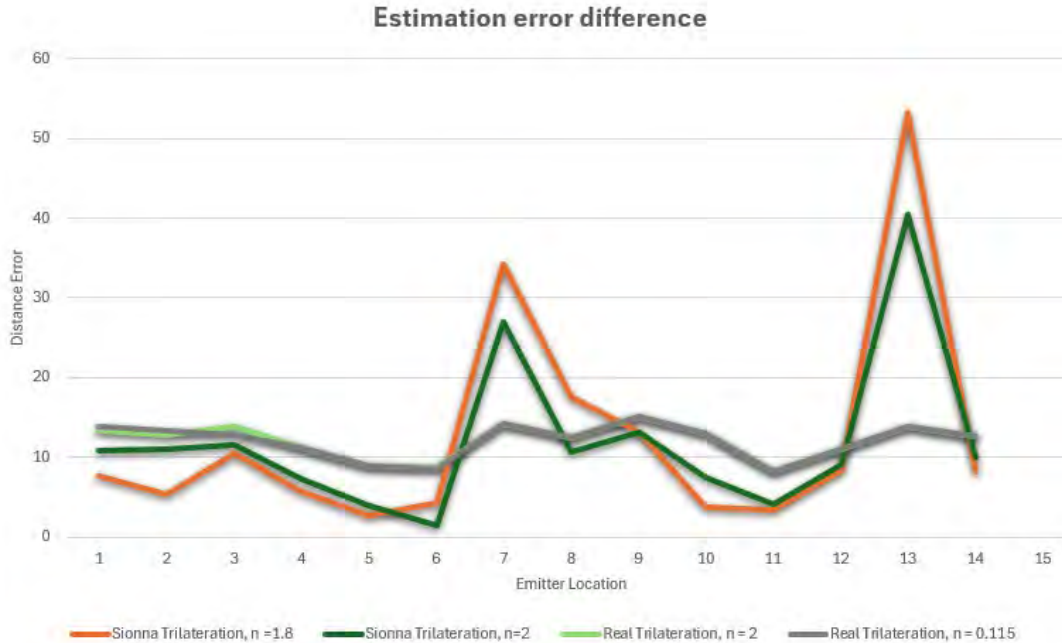
- Distance error between the estimated location and actual location of emitter

- Similarities in distance errors

Conclusion

- Digital Twin helps with the what if situations since it allows you to control the environment

- Tool that provides efficiency, ability to make informed decisions, and an easy to implement simulation

- Future work to be added on to this Digital Twin can be implementing a fingerprinting localization method

Acknowledgment

Mobile Intel

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References

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