Wireless Client Location Determination

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Introduction

In this project, our team has prototyped an IEEE 802.11 (WiFi)-based wireless location determination system. Our goal was to create a system that can locate a sensor with an accuracy of less than 1 meter in 2 or 3 dimensions. This system utilizes ESP8266 wireless modules which act as “nodes”. Nodes can detect wireless sensors and report signal and sensor information to the server. The server then computes the location of the wireless sensor.

Development of our system was split into three main steps: distance determination, trilateration/localization, and creation of a server.

Distance Determination

Finding a universal, accurate method of distance determination using wireless signals is not a new problem. Distance calculations can be affected by the transmitting device, receiving device, weather, interference, and more.

For our purposes, we ran dozens of tests comparing the signal strength between devices as a function of distance. Using a logarithmic regression (r^2=0.94), we determined a signal strength to distance function, accurate to about 1.5 meters.

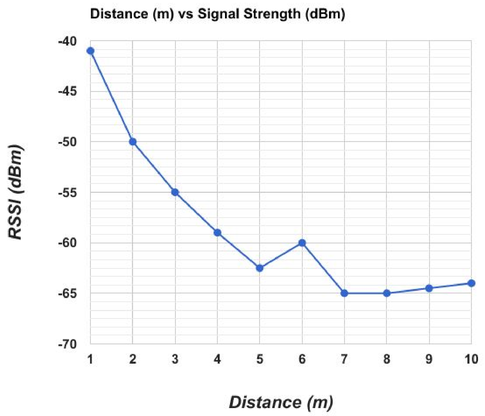

Figure 1. Test results of median signal strength as a function of distance.

Trilateration

Trilateration is the method by which the known locations of several nodes as well as their distances from the sensor are used to determine the location of the sensor. This project uses a weighted gradient method to find the position of the sensor.

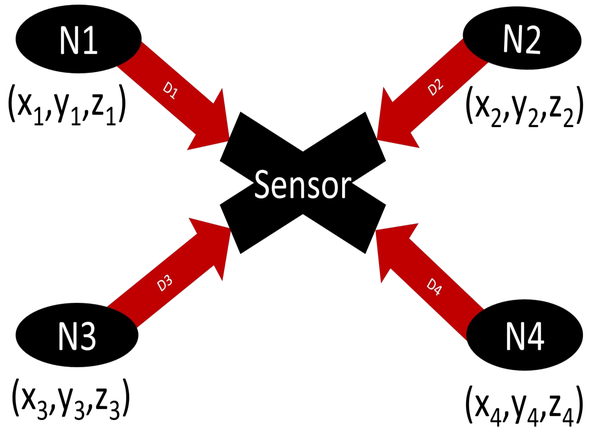

Figure 2. A visual diagram of the information being used to calculated the position.

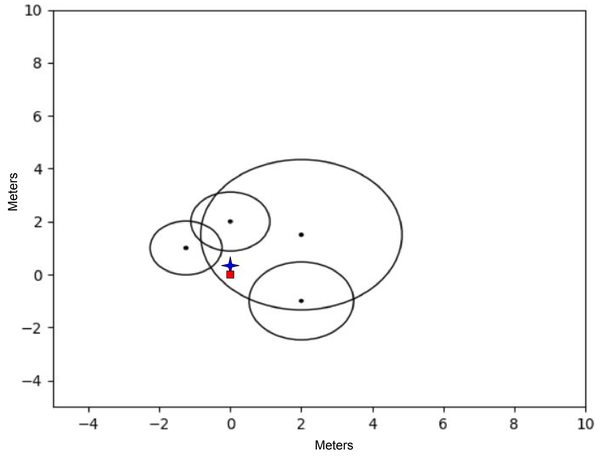

Figure 3. An example of localization using actual nodes. The error for this test was 31.6 cm. The red square shows actual sensor location, and the blue star shows the localization calculation.

Server

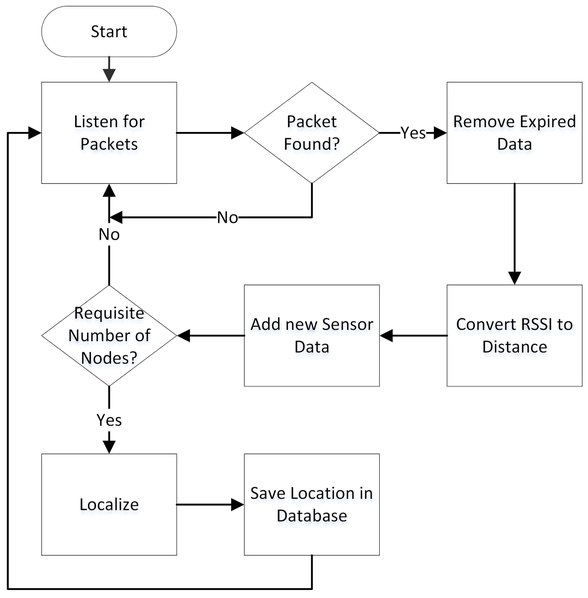

Figure 4. Server flowchart.

Server Features:

- Low overhead connectionless protocol-based communication
- Database backup
- Real time plotting of sensor locations

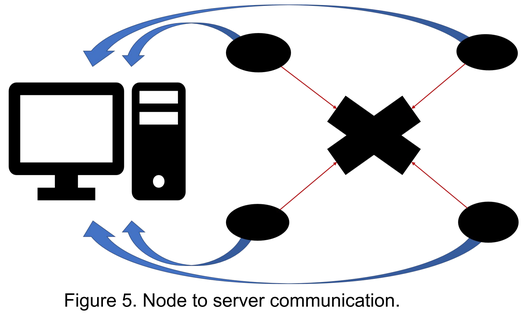

Figure 5. Node to server communication.

Conclusions and Future Work

Current Accuracy:
0.3 to 1.2 m (2D and 3D) in an open environment

Price for Deployment:
~$5.00 / node ($0.01 / m^3 wireless coverage)

Update Frequency:
Dependent on wireless sensor up to every 2 seconds

Node Range:
Each node covers a sphere of a 5 m radius

Next Steps: Mesh network, send sensor data to server, use sensor data to 3D map data

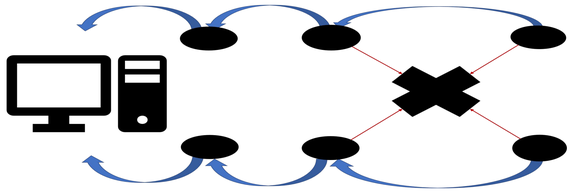

Figure 6. A basic diagram of a mesh network.

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