Teaching Ranging and Localization Using Bluetooth on Android Devices

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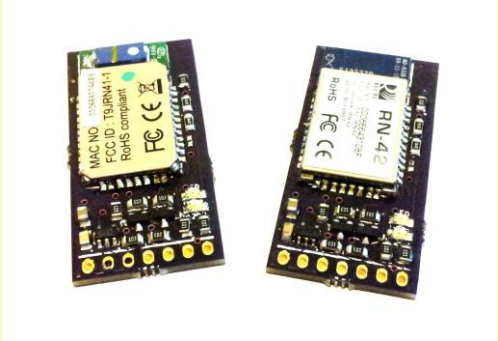
April 23, 2021

Final NSF IUSE Workshop
Collaborative Research: Integrated Development of Scalable Mobile Multidisciplinary Modules for STEM

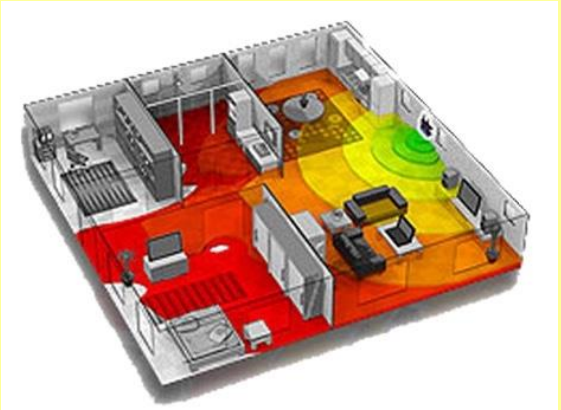
Clarkson University

The work at Arizona State University is supported in part by the NSF DUE award 1525716 and the SenSIP Center.
The work at Clarkson University is supported in part by the NSF DUE award 1525224.

Agenda



1. Localization Concepts
2. Target Audiences
3. Teaching Approach
4. Assessment Details
5. Android App Exercises
6. Results
7. Future Work



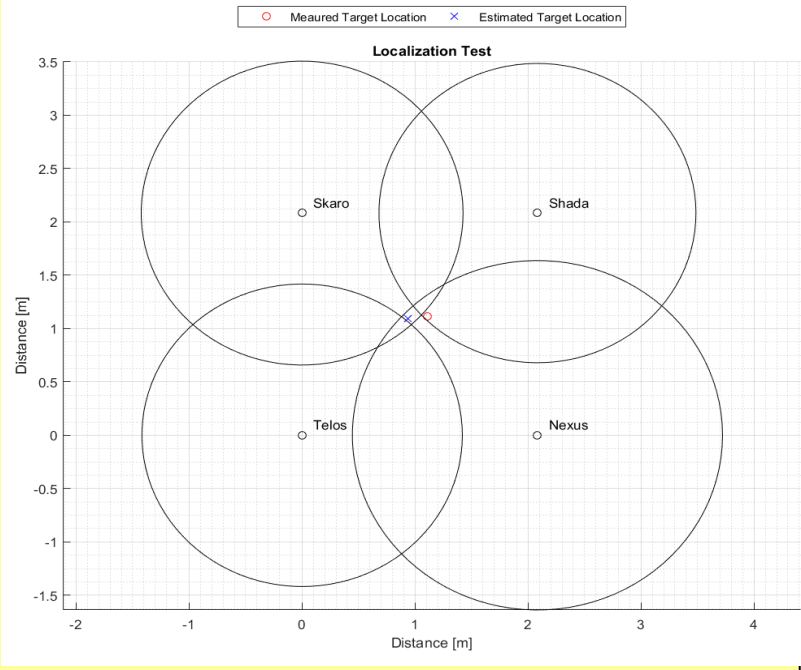
WHAT IS LOCALIZATION?

Goal: Estimate the location of a target object (think GPS)

Two types of nodes: Targets and Anchors

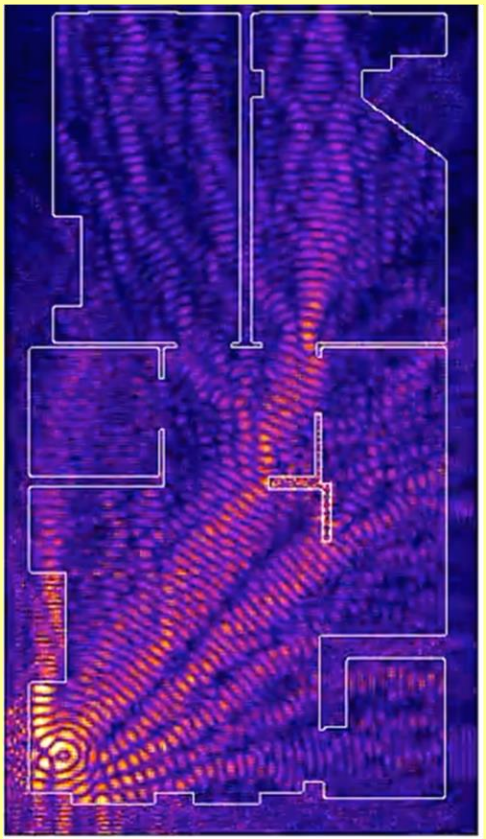
Different types of ranging: Received Signal Strength Indication (RSSI), Time of Arrival (TOA), Time Difference of Arrival (TDOA), Angle of Arrival (AOA), Large Aperture Array (LAA), etc.

RSSI is available through Android Bluetooth and Bluetooth Low Energy stack



Concepts in Localization

- Localization (Engineering)
- Matrix algebra (Mathematics)
- Behavior of Radio Waves (Physics)
- Android devices and Programming



Target audiences

- Upper Level Engineering Classrooms (DSP):
  - Students come from a technical background
  - Most likely familiar with smartphones and tablets
  - Programming knowledge

- Adult Learning Classrooms (SOAR):
  - "The **400+** members of SOAR are "Third Age" adults, post-family and career people who are actively enjoying their lives." [1]
  - Students not necessarily from a technical background
  - May not be very familiar with smartphone technology
  - May not have programming knowledge

http://www.soarnorthcountry.com/about/

Workshop format:

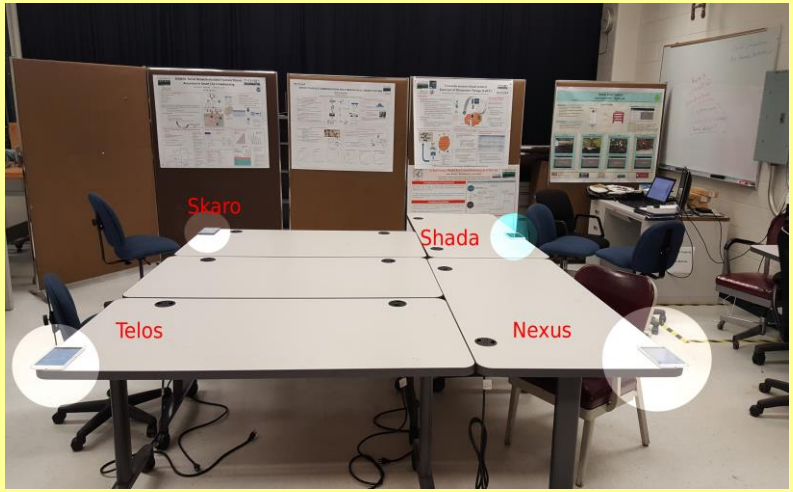
- Pre-Quiz Assessment
- Lecture: Localization on Android
- Ranging and Localization Exercises
- Post-Quiz Assessment

Assessment Questions

Main Concept	Question Summary
Terminology	A terminology question that asks the participant to correctly assign definitions to the terms “anchor” and “target”.
# of Anchors	This question gives the setup for several localization experiments and asks which is likely to be more accurate. The participants were given one choice that had the most anchors and the least number of targets, which is the best case.
Triangulation	Participants are asked where the localization estimate will be when given three ranging circles with one intersection point.
Accuracy I	Participants are given several localization experiment outputs, with ranging circles included, and are asked to choose which one is most likely to be more accurate. The perceived accuracy is based on how closely all of the ranging circles intersect at one point.
Accuracy II	This question asks whether or not ranging estimates need to be perfect in order to get accurate localization estimates. The question is designed to reinforce that noisy range estimates can still be useful when used in the localization algorithm.

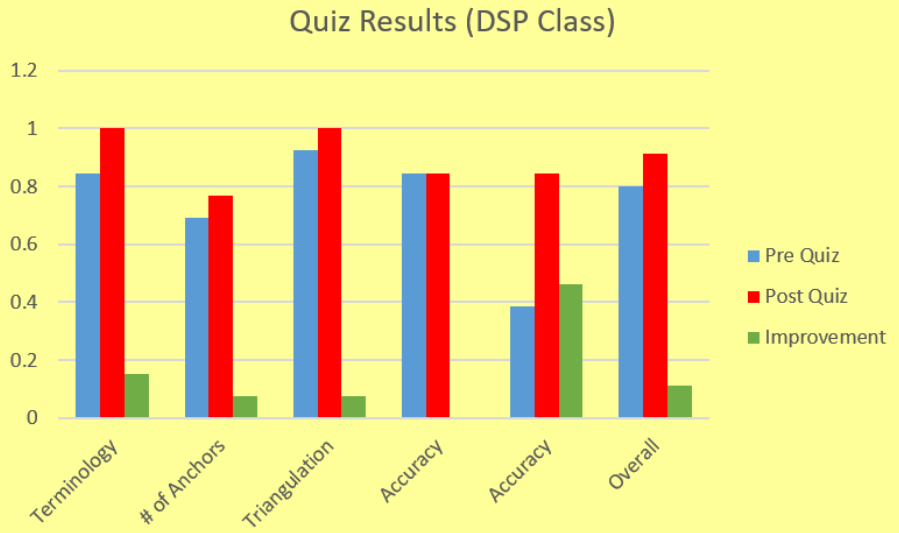
Localization Exercises

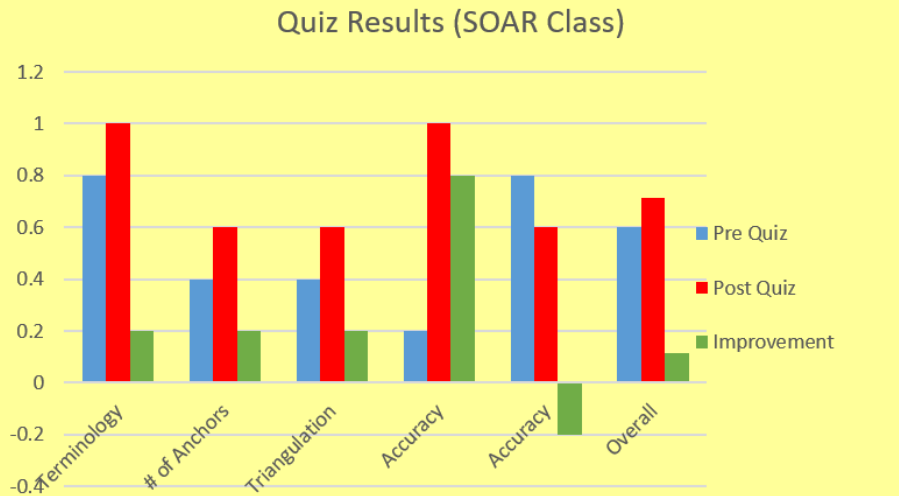
- First Exercise: Test Signal attenuation with a partner
- Second Exercise: Take RSSI samples and compute a ranging estimate
  - Each pair of students calculates an average RSSI and a ranging estimate
  - The ranging estimates are reported to the proctor, and added to the localization estimate (circles on the graph)
  - Once all ranging estimates are finished, a localization estimate is produced



Assessment Results

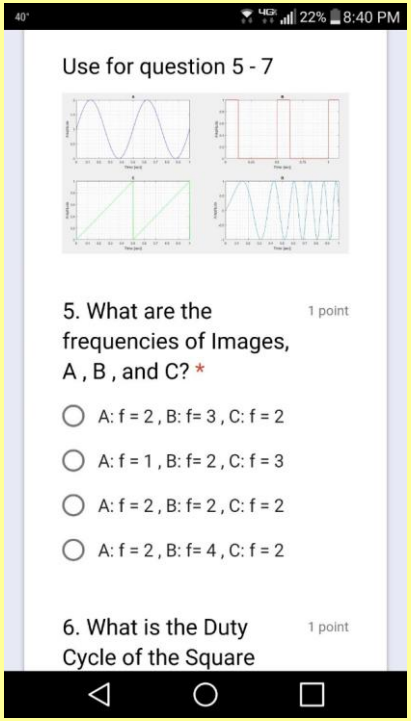
- Results show improvements in both target audiences
- Questions were the same for each target audience
- Those with technical backgrounds did better on the pre-quiz assessments
- Results suggest it may be better to tailor activities to the target audience, in order to improve learning value

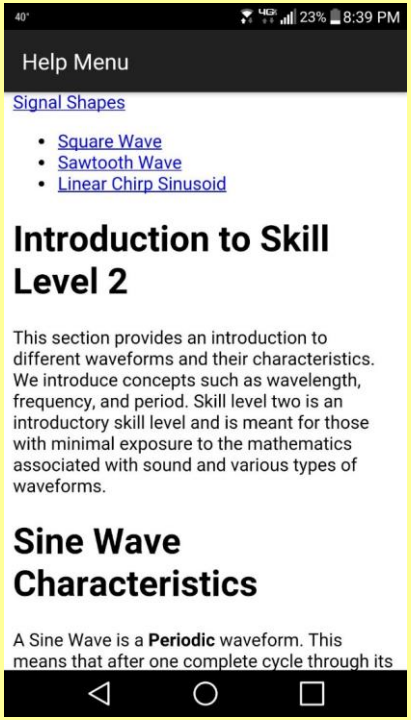




Future Work

- Teach and assess effectiveness in a high school environment
- Include more topics from physics, mathematics, and programming
- Tailor assessments to target audience
- Include learning material in the app (Similar to Reflections App)





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