Augmented Reality Visualizations for Software-defined Radios

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Introduction

- Software-defined radios (SDRs) leverage the power of general-purpose processors to transmit and receive a wide range wireless protocols

- These wireless communications and interactions are invisible to the naked eye
- Augmented reality (AR) may have potential in making wireless communications education and research more accessible and intuitive to students

Augmented Reality Tools

- Vuforia — AR software development kit
  - Identifies and tracks image targets
  - Establishes virtual objects in real space
- Unity — Game development tool
  - Creates 3D models for augmentation
  - Manages scripts that animate 3D models

Backend Infrastructure

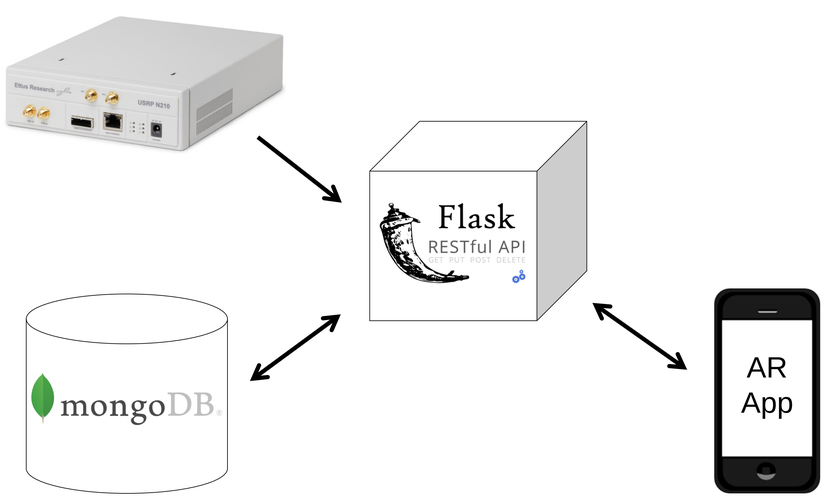

Figure 1. Diagram of Backend Infrastructure. SDRs send information about their current state using a Python script to an Application Programming Interface (API). The API then pushes that data into a Mongo Database. When the mobile application is started, it begins making requests for the data through the API, and the data is returned to the application where it can be visualized.

Figure 2. Example Image Targets Image targets create a point of reference in real space for the mobile application. Using this point of reference, the mobile application is then able to place virtual objects relative to the marker.

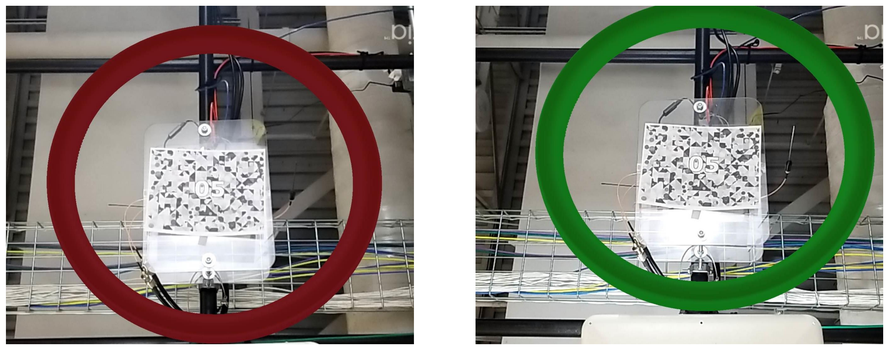

Figure 2. Individual Node Availability. Individual markers have been placed on each SDR to help find where the virtual object should go. In this demo, the color of the rings correspond to whether an SDR is in use or not.

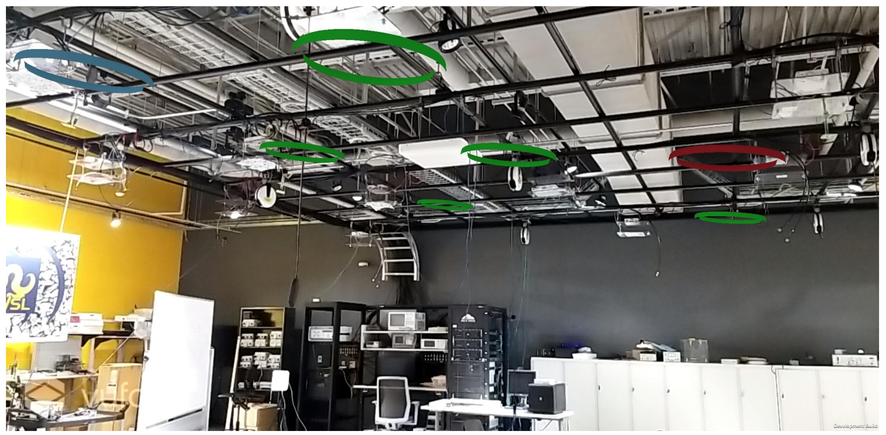

Figure 3 Wide Vide of Demo Application. The application can identify and track the DWSL image target near the back of the lab to create a reference point for AR visualization of the entire grid of SDRs. The 3D ring models represent the SDRs and are used to display the current status of the radio they hover beneath.

Conclusion

- AR has the potential to impact wireless communication education and research by making invisible phenomena observable
- Further development on this application would allow more exploration on how to make wireless communications education and research more engaging for students
- Further development would also allow us to explore how we can take advantage of AR within classrooms to improve learning outcomes

Future Work

In the future, further animations and visualizations could be developed for the grid of SDRs housed at the Drexel Wireless Systems Laboratory. For example:

- Displaying radios transmitting and receiving data
- Animating interference phenomena
- Animating reconfigurable antennas being modified in real-time
- Tracing paths of RFID tags using XYZ information from localization technology

As wireless communications technology evolve, this framework aims at being robust and extensible enough to allow visualizations for any future innovations.

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[1] D. H. Nguyen, J. Chacko, L. Henderson, A. Paatelma, H. Saarnisaari, N. Kandasamy, K. R. Dandekar, “Demo: WiArt – Visualize and Interact with Wireless Networks using Augmented Reality,” *MobiCom*, pp. 511-512, Oct. 2016.