Localization Using Digitally Steerable Antennas

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ABSTRACT

We propose to demonstrate real-time localization using digitally steerable antennas. The antennas implement Electrically-Steerable Parasitic Array Radiator (ESPAR) design that is digitally steerable from a microcontroller. We discuss the operation and the needs of the proposed demonstration.

1. INTRODUCTION

The approach is to use several localization nodes that are equipped with a digitally steerable ESPAR antenna each [1, 2]. Thus the nodes can act as either transmitters or receivers with controlled directionality. The direction can be changed over time thus improving the localization accuracy. The objects for the localization may or may not be equipped with active transmitter or receiver tags. The data received from or by the directional antennas is used for signal processing that calculates the most likely positions of the objects to be localized.

The operation of the localization is possible in three configurations:

1. The localization nodes act as receivers scanning the area for objects with simple transmitters, then submit their data to the processing server that estimates the location of the objects.
2. The localization nodes act as spatial pattern transmitters and the objects to be localized are supplied with the receiver tags. The tags collect information coming from the transmitter nodes and annotate it with timestamps. Then the information is sent to the base station that collects and processes the data, and estimates the location of the objects.
3. The objects to be localized are tag-free, and their location is determined from the interference patterns created by some of the localization nodes. The patterns are received by the other localization nodes and the captured data is eventually analyzed by the server.

The first case is better for small number of objects to be localized. When the number of objects increases, the probability of interference between the transmitters increases, unless TDMA or similar protocol is used.

The second case scales better to a large number of objects, especially when the localization needs to be time-synchronized among the objects. The tags still need to transmit their data, using CSMA protocol or queried by the server to transport the received data for processing.

Finally, the third approach requires no instrumentation of objects, however is less exact with respect to their locations, and does not scale well for many objects due to multipath, reflections, and the complexity of data processing.

We expect to focus on the first or the second case for the competition, depending on the on-site performance and requirements, while leaving the third for demonstration should the opportunity arise.

1.1 Demo setup and the requirements

We expect to deploy between 4 to 8 nodes with antennas depending of the layout and size of the test site. The nodes may be battery or mains (220V AC) powered. One of the nodes will serve as a base station that will collect and analyze the real time data from the nodes and serve the localization information to a device with a web browser, such as a tablet or a laptop computer.

2. REFERENCES

[1] R. Schlub, J. Lu, and T. Ohira. Seven-element ground skirt monopole espar antenna design from a genetic algorithm and the finite element method. *IEEE Trans. Antennas Propag.*, 51:3033, 2003.

[2] J. Lu, D. Ireland, and R. Schlub. Dielectric embedded espar (de-espar) antenna array for wireless communications. *IEEE Trans. Antennas Propag.*, 53:2437, 2005.

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