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Intelligent Automation Incorporated

Coherent distributed radar for high-resolution through-wall imaging

SBIR Phase I Progress Report 9

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Summary
In this period of performance, we finalized the concept for the final demonstration. We have also demonstrated bench top frequency synchronization through our RF frontend.

1.0 INTRODUCTION
In this report we discuss progress in hardware design, synchronization algorithm, and definition of the final demonstration.

1.1 Synchronization algorithm
For frequency synchronization, we have completed a bench test of frequency synchronization through the RF front end and a wired attenuating channel.

1.2 Hardware design
We have constructed two complete synchronization transceivers (without antennas). We have determined the noise floor of the receiver. We have selected antennas.

1.3 Preparation for final demonstration
We have further developed the final demonstration scenario. We show the demonstration scenario in Figure 1 below. We will demonstrate a bi-static through-wall radar system. Bi-static radar, while more complex and harder to deploy than traditional monostatic radar, offers covert operation of the receiver, and increased resilience to electronic countermeasures as receiver location are potentially unknown as well as possible enhanced radar cross section of the target due to geometrical effects. For our final demonstration we propose a stationary transmitter, a mobile receiver, and a GPS base station. To be able to form SAR images from the received radar scattering, positions of both transmit and receive nodes must be known and both nodes must be synchronized , to within a small fraction of the transmitted bandwidth.

The stationary node consists of a synchronization transceiver, and a radar transmitter. It will be placed at a location with excellent GPS reception within 100m of the building. The radar transmitter will transmit radar pulses with timing derived from the synchronization transceiver. The radar frequency band will be sufficiently low to penetrate the building wall, with bandwidth in the one- to several hundred MHz. For the demonstration, we will use either a signal generator with modulation derived from the synchronization receiver, or a waveform directly synthesized by the same hardware used for the synchronization transceiver.

The mobile node consists of a synchronization transceiver, a radar receiver, a differential, dual band high-precision GPS receiver, and a PC. The mobile node will move along a trajectory near the building that will allow accurate GPS-aided positioning, and detection of radar reflections from the inside of the building. A directional antenna will be used and aimed by the user at the building. Its azimuthal orientation will be tracked a recorded with a magnetic compass. The accuracy of the synchronization will correspond to a small fraction of the radar signal bandwidth. The data corresponding to the received radar scans, timestamps from the synchronization transceiver, orientation of the radar antenna and the GPS location will be transferred to the PC, and processed in to a SAR image in semi-real time.

The GPS base station is located on the roof of the IAI office. It will provide corrections to the mobile GPS receiver.

We will use sufficiently stable clocks for the radar nodes so that the synchronization link can operate at very low duty cycle (<1 signal exchange /minute). Hence, the mobile radar node is largely passive.

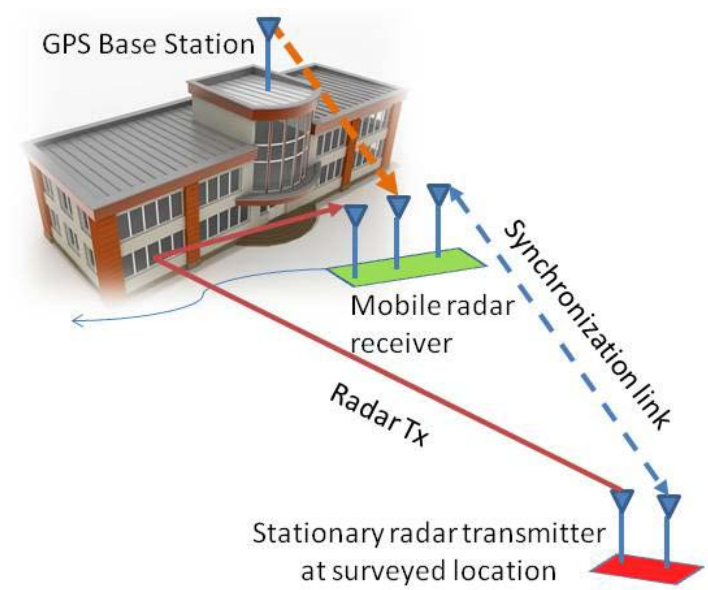

Figure 1. Final Demonstration Scenario.

3.0 CONCLUSIONS AND WORK PLANNED FOR NEXT REPORTING PERIOD

The next reporting period will focus on implementation of the time offset estimation algorithm in the digital hardware, further characterization and testing of the RF hardware, specifically the ability to accurately measure hardware delays. We will complete the definition of the final demonstration and present a schedule of activities remaining in preparation for the demonstration.

3.0 REFERENCES

None.

4.0 LIST OF SYMBOLS, ABBREVIATIONS, AND ACRONYMS