

Intelligent Automation Incorporated

Coherent distributed radar for high-resolution through-wall imaging

Progress Report 23

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1 Work performed this reporting period

1.1 Technical work performed in this reporting period

In this reporting period, we are continuing to collect indoors data and processing the scans for improving the indoors range accuracy. Since the transceivers are very tightly synchronized, the transmission phase and time, and the phase use for down conversion are well-controlled and repeatable as we perform the experiments.

We are continuing to take more data and develop algorithms for improved range accuracy based on both channel estimation and digital beamforming.

To facilitate the collection of data, we have configured the hardware and software to stream the complex correlator output at a rate of 10Hz to the PC. This will allow us to evaluate several algorithms for RF ranging offline.

A key parameter for the beam forming algorithms that will be used to improve ranging accuracy (and for imaging) is the aperture: the spatial range over which the multipath environment is sufficiently stationary to be processed coherently. If this aperture is large, a narrow beam can be formed, and multipath can be suppressed effectively. One way to estimate this parameter is to compute the spatial correlation length of the range error. In Figure 1, below, we show the results of an outdoor ranging experiment.

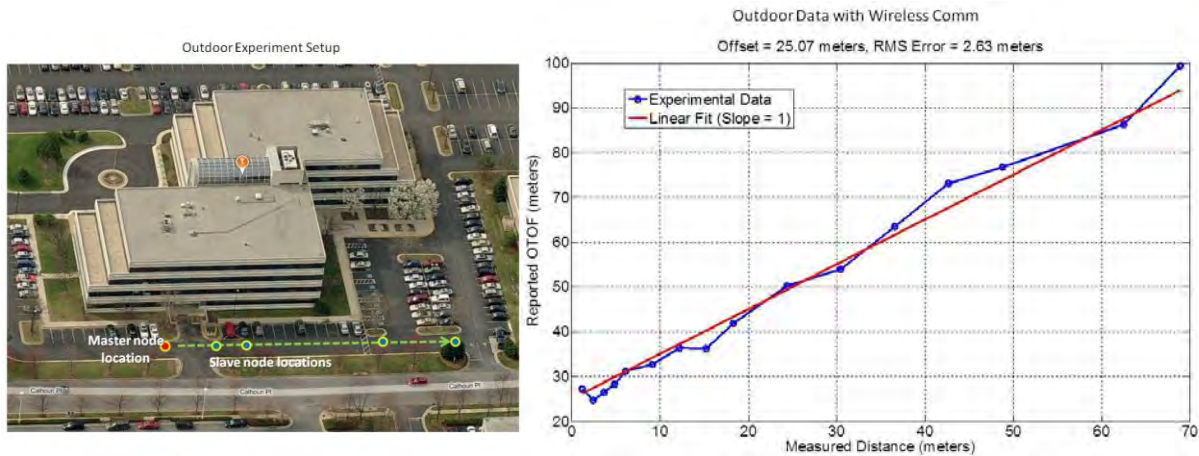


Figure 1. Left: outdoor ranging experiment. Right: reported distance vs. actual distance.

In Figure 2, we show the range error vs. range, and the spatial autocorrelation of the error. The range error de-correlates in about 10m.

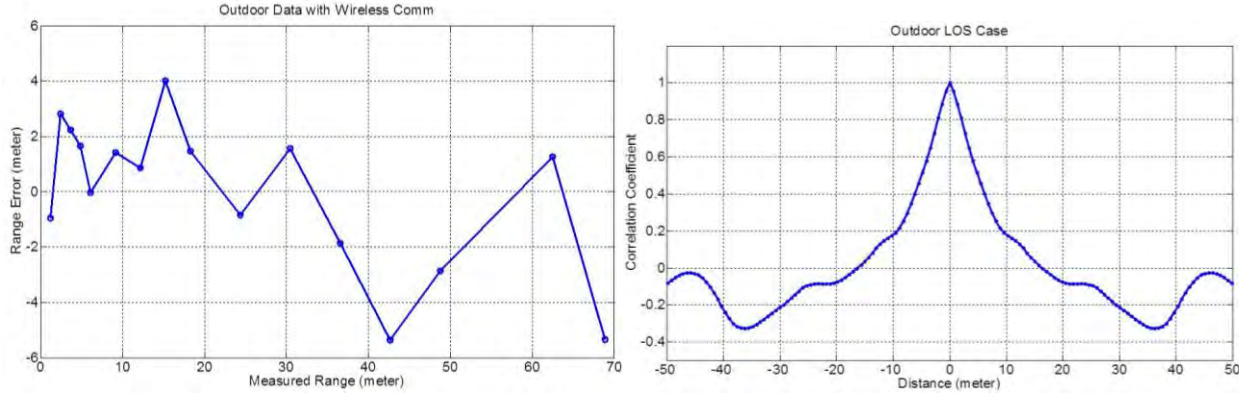


Figure 2. Left: Range error vs. range. Right: Spatial autocorrelation of range measurement.

This result is specific to the particular outdoor environment; carrier, bandwidth, and ranging algorithm used here, but suggest that an aperture of several wavelengths is possible. With beamforming measurements spaced at roughly half wavelength, the potential for beam forming is present.

For an indoors environment, due to the higher density of scatters, the error de-correlates faster, and hence the aperture will be smaller, reducing the potential for beam forming to improve the range accuracy. We show the autocorrelation plots for an indoor office environment below.

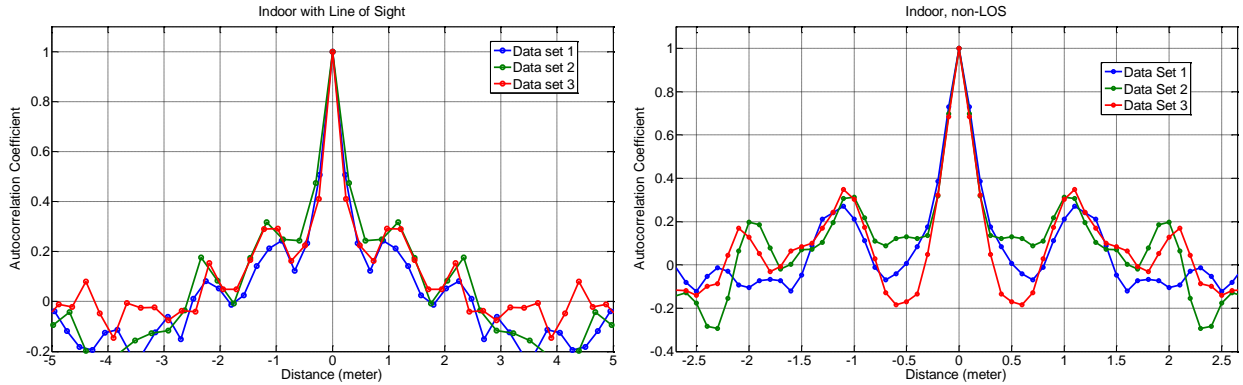


Figure 3. Autocorrelation of range measurement. Left: indoor environment with LOS (corridor). Right: indoor environment without LOS.

For the indoor environment, the aperture will be reduced to 1-2m, essentially making the beamforming approach, at the used frequencies and bandwidth, not suitable for the indoor environment.

In the next performance period, we will continue to take measurements, and develop ranging algorithms, as well as imaging algorithms for bi-static radar.