A Software Defined Radio PN Channel Sounder for Unmanned Aerial Vehicles

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This document describes the design and construction of a Pseudo-random Noise (PN) based radio channel sounding system that was constructed for measuring the complex radio channel from an Unmanned Aircraft System (UAS). Implementation of such a system on a UAS presented unique Size Weight and Power (SWaP) constraints which ultimately drove the design philosophy and final hardware implementation.

All radio systems must perform within the context of a multipath channel. This includes RADAR systems as well as communication systems. Our system is intended to complement RADAR research for Moving Target Indication (MTI) by providing multipath information as perceived by the target; in this case a UAS. Reciprocity indicates that the multipath as measured at the UAS is proportional to the multipath that would be received at a monostatic RADAR receiver. Note that the reflected components include both a direct ray, to and from the UAS target, as well as reflections from the surroundings. It was important that our system be able to resolve multipath within feet of the receiver and have the ability to measure Doppler shifts within reflected components.

The design of the system, both hardware and software, is presented. The receiver is a sliding correlator architecture with IQ sampling using a Software Define Radio (SDR). The presentation includes a description of the interfaces between the UAS and the flight package as well as the components of the flight package itself. The transmitter for this system is ground based and is also presented. A description of analysis software is included. The output data included not only the complex samples but sufficient metadata so that individual samples can be correlated with UAS location and bearing. Calibration of the system is presented along with example output plots.

The system described was used for a data collection, capturing over 15 GB of multipath data from the urban cluttered environment from a downward looking transmitter at 3 GHz. The flight package has also been used to capture 28 GHz wideband channel data with the use of mmW up/down converters. While, to date, our data has not been collected simultaneously with radar returns, the data should be very applicable for radar analysis. Our sliding correlator equipment is capable of resolving multipath to 0.75 m with a Doppler resolution of 8.5 Hz.