

Exhibit to support Application for Special Temporary Authority (STA)

FRN Number: 0025370479

STA Confirmation Number: EL822103

STA File Number: 0315-EX-ST-2016

Date of Submission: March 8, 2016

Requested by: Ohio University

Chris G. Bartone, Ph.D., P.E.

Professor, School of EECS

349 Stocker Center

Athens, OH 45701

740-593-9573 (O), 740-591-1660 (M)

bartone@ohio.edu

STA Explanation:

This STA request is to transmit a radar type signal on a mobile unmanned aerial system (UAS) platform to test a detect and avoid capability for a mobile UAS platform. Many UASs in operation today do not have any detect and avoid capability and run the risk of hitting stationary and mobile objects. This research will focus on adding a low-cost, light weight, short-range radar to a UAS (i.e., less than 55 lbs) to help minimize UAS-to-fixed obstacle and UAS-to-mobile collisions.

The purpose of these operations will be to test a low-cost, light weight, short-range radar that is installed on a test UAS (i.e., 3DR Robotics X8 UAS). A small target UAS will be instrumented with an aluminum spherical ball, that will provide a uniform radar cross section (RCS) to the radar. The target UAS will remain in a hover and the radar equipped UAS will slowly approach the target UAS and hover at fixed ranges (i.e., 200, 100, 50, 20 meters). Data will be collected on-board the radar equipped UAS and the data will be processed. The primary objective of these first tests will be to characterize the detection range.

Operation Start Date: April 25, 2016

Operation End Date: September 25, 2016

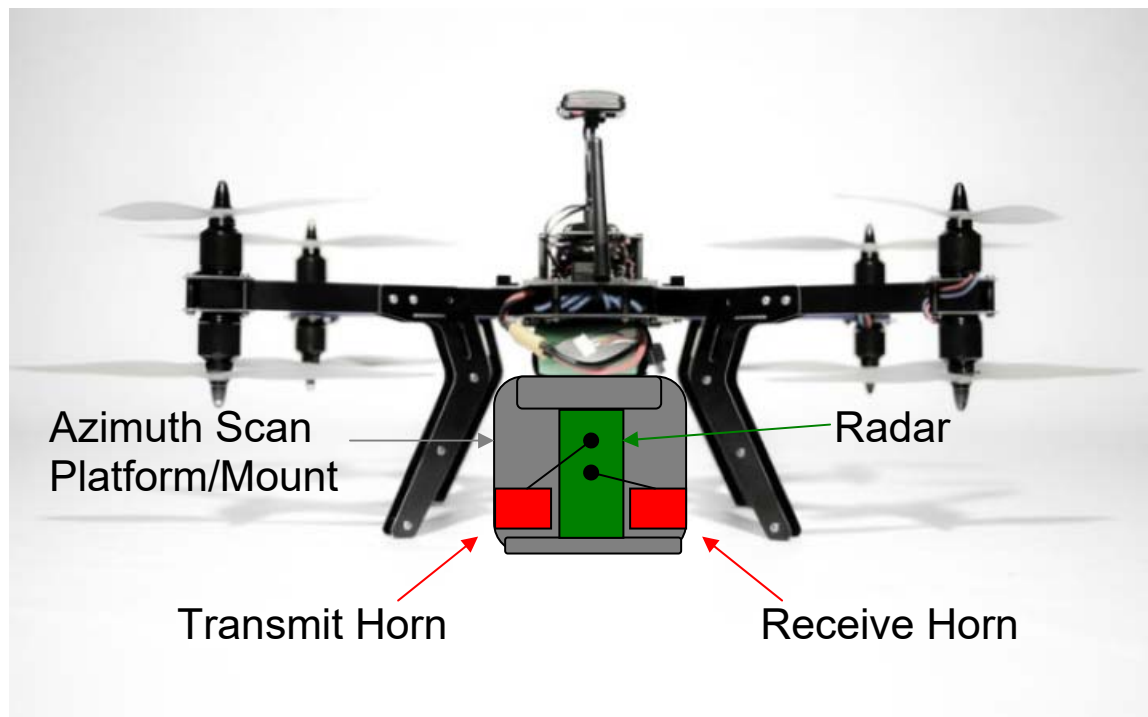
Equipment Operation:

The small low-power, short range radar is planned to transmit in the 9,300-9,500 MHz band. The anticipated operating range of the radar is expected to be less than 300 meters. The center frequency can be selectable from: 9320, 9360, 9400, 9440, 9480 MHz, with a selectable modulation waveform of FMCW or FSK. Additionally, the FM sweep bandwidth can be selectable from: 20, 50, 100, 200 MHz. A single directional standard gain horn will be used for transmission with maximum boresight gain of 15 dBi and beamwidths of 30 deg in the vertical and horizontal directions. The radar is a modified version of the Ancortek SDR-980B Kit, see attached data sheet, which we have designated as OU-SCR-940. The modified version to be operated will use directional horn antennas for transmit (and receive), rather than the 6-element patch antenna array shown on the data sheet, and can be configured to operate with the parameters listed in this paragraph, and summarized in the table below.

Selectable Operational Parameters for the Ohio University OU-SCR-940 Radar			
Parameter	Unites	Value	Comment
Center Frequency	MHz	9320, 9360, 9400, 9440, 9480	Software selectable
Modulation Waveform		FMCW-triangle, FSK	Software selectable
FM Sweep Bandwidth	MHz	20, 50, 100, 200	Software selectable
FSK Frequency Step	MHz	6	Software selectable
Sweep Time	ms	1, 2	Software selectable
Number of Samples per Sweep		512, 1024	Software selectable
Power Output	dBm	18	Fixed initially; plan to expand to 33 dBm.
Transmit Antenna Gain	dBi	15	Separate Horn Antennas (co-located)
Vertical Antenna Beamwidth (3dB)	deg	30	Fixed
Horizontal Antenna Beamwidth (3dB)	deg	30	Fixed
Transmit Polarization		Linear, Vertical or Horizontal	Plan to test both

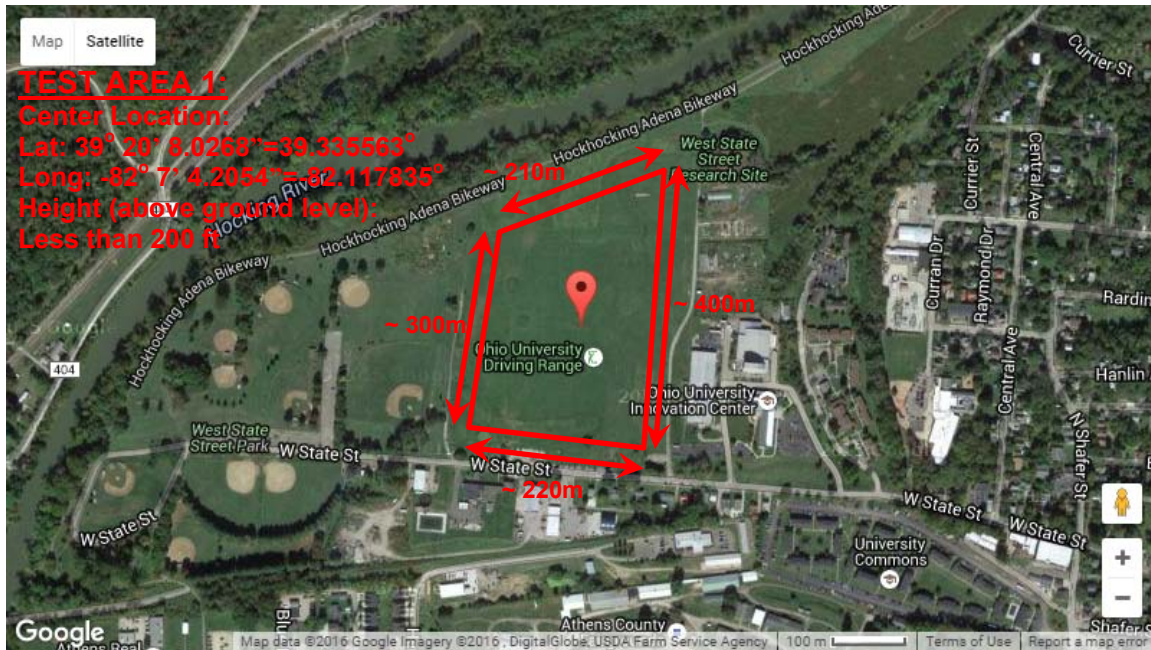
The radar equipped UAS is illustrated below. The radar will operate with a transmission horn antenna and a separate reception horn antenna.

3DR Robotics X8 UAS with OU-SCR-940 Radar



Geographical Coordinates and Illustrations of Test/Mobile Antenna Location are shown below. The mobile antenna locations, will be on the property owned by Ohio University. The first test/antenna location is centered around the Ohio University Golf Driving Range. The area is very flat. All UAS tests will be done within range of sight to the mobile UAS platform.

Ohio University, Golf Driving Range, Athens, OH 45710



Ref: <http://itouchmap.com/latlong.html>, visited March 3, 2016

The second test/antenna location is centered around a remote hiking trail located at the Ohio University Ridges area. The area is fairly very flat. All UAS tests will be done within range of sight to the mobile UAS platform.

Ohio University, Open Area on Ridges, Athens, OH



Ref: <http://itouchmap.com/latlong.html>, visited March 8,

MODULATION SIGNAL DESCRIPTION

Once the center frequency is selected from 9320, 9360, 9400, 9440, 9480 MHz, the modulation type will be selected. The modulation can be selected as Frequency Modulation – Continuous Wave (FMCW) with a sawtooth waveform or a Frequency Shift Key (FSK), i.e., binary.

NECESSARY BANDWIDTH DESCRIPTION

For an FMCW selection, the modulation waveform will be sawtooth where the FM sweep bandwidth can then be selected from either 20, 50, 100, or 200 MHz. When the center of 9400 MHz is selected, then any of the available FM sweep bandwidths could be selected. When anything other than the center frequency of 9400 MHz is selected, the bandwidth will be reduced. When either the 9360 or 9440 MHz center frequency is selected, then 20, 50, or 100 MHz bandwidth would be selected. When either 9320 or 9480 MHz is selected for the center frequency, only 20 MHz will be selected for the FM sweep bandwidth. For an FSK modulation selection, the transmitter will have a bandwidth frequency spacing of 6 MHz between “mark” and “space”, which could be used on any of the available selectable center frequencies (i.e., 9320, 9360, 9400, 9440, 9480 MHz). We plan to utilize various test modulations with our primary mode of operation using the FMCW-sawtooth modulation waveform with the center frequency set to 9400 MHz and FM sweep bandwidth of 200 MHz.

FAA Liaison: One January 20, 2016, Dr. Chirs G. Bartone (Ohio University) met with Mr. Donal Nellis to discuss this project and plans. Mr. Nellis did not see any issues in proceeding with these test from an experimental basis and encouraged Dr. Bartone to apply for the experimental license.

FAA Liaison POC: Donald Nellis, FAA Spectrum Engineering Group, FAA National Headquarters, 800 Independence Ave. SW, Orville Wright Bldg (FOB10A), Washington, DC 20591. 202-269-9779, donald.nellis@faa.gov.

The following references have been reviewed and considered for this application.

References:

1. U.S. Department of Commerce, National Telecommunications and Information Administration, Manual of Regulations and Procedures for Federal Radio Frequency Management, May 2014 Revision of the May 2013 Edition, pp. 4-49, pdf page 169/806.
2. International Telecommunications Union Radiocommunications Sector of ITU (ITU-R), Characteristics and spectrum considerations for sense and avoid Systems use on unmanned aircraft systems, M Series, Mobile, radiodetermination, amateur and related satellites services, Report ITU-R M2204, (11/2010)
3. International Telecommunications Union Radiocommunications Sector of ITU (ITU-R), Characteristics and protection criteria for terrestrial radars operating in the radiodetermination service in the frequency band 8 500- 10 680 MHz, M Series, Mobile, radiodetermination, amateur and related satellites services, Report ITU-R M1796-2, (02/2014)
4. International Telecommunication Union Radio Regulations, Articles, Edition 2008, Sections 5.474, 5.475, 5.475A, 5.475B, 5.476.
5. Department of Transportation, Federal Aviation Administration, Aircraft Certification Service, Washington, D.C., Technical Standard Order, Airborne Weather Radar Equipment, TSO-C63d, 02/28/12