Active Project (2016 - 2018)

# Collision-avoidance radar for small UAS, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

## ABSTRACT

In the near future unmanned aircraft systems (UAS) will be utilized for many societal and commercial applications. However, the hurdle of operation safety in the form of avoiding airborne collisions must first be overcome. UAVradars LLC is proposing a small, lightweight, and low-power radar system designed specifically to give small UAS (< 55 lbs) airborne collision-avoidance sensory capability. Radar is ideally suited for this purpose due to its all-weather capability to provide accurate position and velocity data. The proposed radar is based on previous R&D funded by NASA and performed at the University of Kansas from 2012 to 2014. This effort resulted the successfully flight testing of a large scale proof-of-concept radar that was then miniaturized as an academic demonstrating of the potential reduction in size, weight and power (SWaP). The SBIR Phase I focuses on overcoming critical factors specific to commercialization needs that were left unresolved. These were 1) replace the bulky user laptop controller with a small Raspberry Pi 2 to allow the miniature radar system to be installed on a sUAS; 2) move the radar operations to the ISM band to avoid FCC licensing complications; and 3) implement radar transmit encoding to allow multiple radar systems to operate in the same area without cross jamming. The successful complete of Phase I indicated the radar commercialization feasibility which leads into Phase II. The objectives in Phase II is to create a flight tested prototype. This involves 1) maximize radar hardware performance; 2) create a target detection and tracking algorithm; and 3) perform radar flight testing to validate its capability. By completing these tasks, the Phase II miniature radar system will be proven as a disruptive technology for overcome key sense-and-avoid barriers in NASA?s efforts of integrating UAS in the National Airspace System (NAS).

## ANTICIPATED BENEFITS

**To NASA funded missions:**


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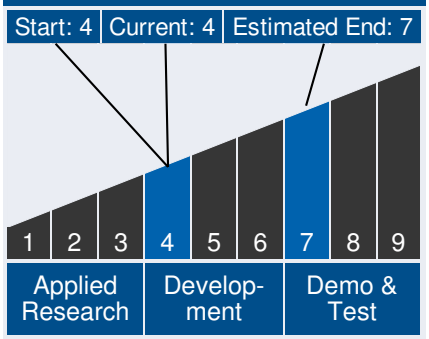
### Technology Maturity




### Management Team

**Program Executives:**

- Joseph Grant
- Laguduva Kubendran

**Program Manager:**

- Carlos Torrez

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Potential NASA Commercial Applications: NASA currently has multiple UAS applications/technology development programs which could benefit from the proposed situation awareness radar system. The Phase II miniature radar system will allow NASA pilots to operate multiple UAS with minimal oversight, enhance multi-vehicle cooperation (especially in an unknown environment), and achieve higher levels of situation awareness for intelligent decision making in real-time. For example, NASA?s Autonomous Robust Avionics (AuRA) would directly benefit from the radar?s ability to reduce operator workload. Either as a stand-alone sensor or integrated with other devices, the situation awareness provided by the radar is a disruptive solution that will greatly affect the rules and regulations for UAS in the NAS which NASA, the FAA, and other agencies are collaborating on. NASA AFRC has successful R&D on large scale UAS in the NAS using vehicles such as the Ikhana but will so move towards sUAS such as the DROID3 or Area I. This proposed radar system with its miniature SWaP form factor has been identified as suitable for installation onboard these sUAS. Furthermore, detection range and coverage provided by the radar lends itself to be a backup sensor on the large scale UAS without upsetting the current payload limitation. Finally, since radars are capable of operating in outer space, the proposed radar could theoretically be applied to space mission as well.

**To the commercial space industry:**

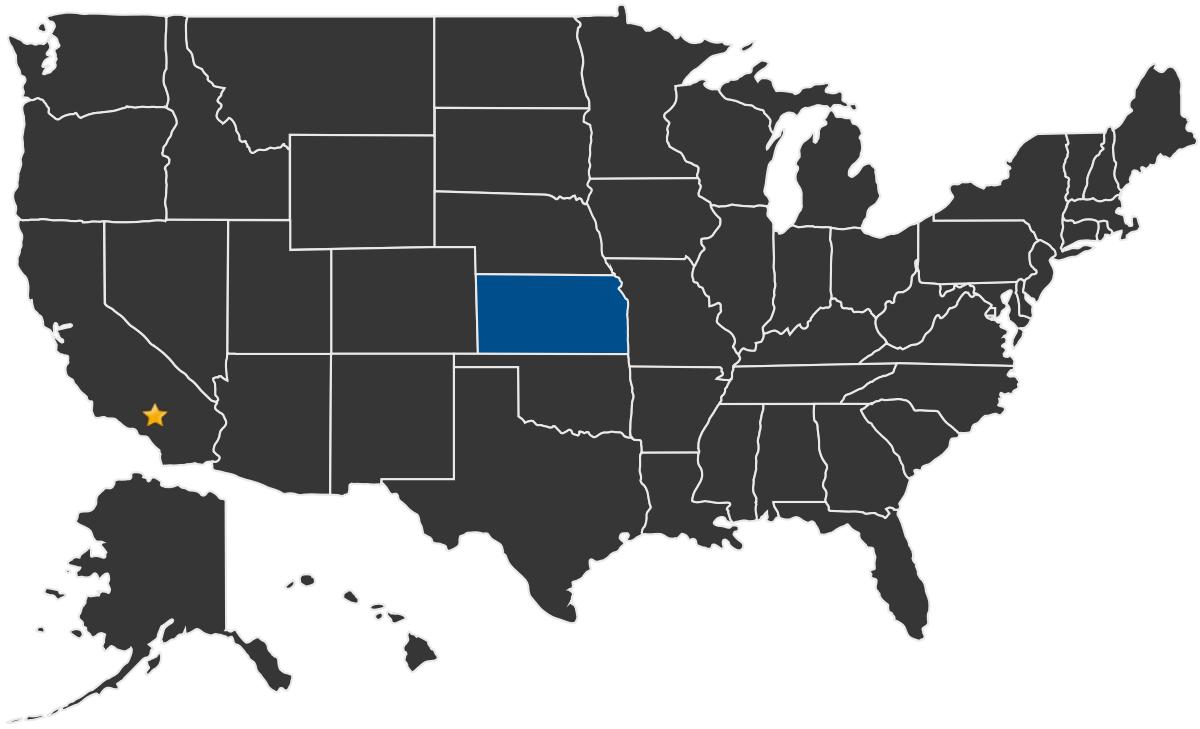
Potential Non-NASA Commercial Applications: The worldwide commercial UAS market is already a multibillion dollar industry and growing at 15 to 20 percent each year. The U.S. however, is lagging due to FAA restriction on UAS operations primarily due to collision-avoidance concerns. Research has shown that once unleashed, UAS will be use in agriculture, film/photography, academia, package delivery, law enforcement, and many more creating a multibillion dollar UAS industry in the U.S. almost overnight. However, to achieve this possibility, UAS operation must first be made safe. The proposed radar system will be a critical sensor in achieving this safety threshold and therefore,

**Management Team *(cont.)***

**Principal Investigator:**
- Lei Shi

will be applicable to all commercial sUAS that has roughly a 4-lbs payload. This is expected to include precision agriculture, the movie industry, pipeline monitoring, search and rescue, border patrol, package delivery, and many more. Beyond Phase II, UAVradars will work towards developing sensor and autopilot integration, creating a complete airborne collision-avoidance package that is plug-and-play to further reach additional markets. As an example, Amazon in Dec 2015, presented its latest UAS for package deliver which changed form a hexa-copter to fixed-wing aircraft. This is exactly the type of sUAS that could carry and benefit from the collision-avoidance radar system since flight beyond line-of-sight must be performed to have any commercial value.

## U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

**Lead Center:**
Armstrong Flight Research Center

**Other Organizations Performing Work:**

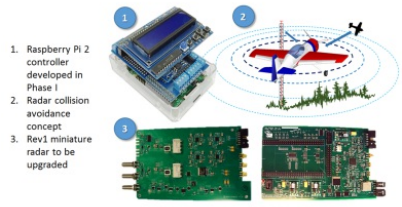
- UAVradars, LLC (Lawrence, KS)

## PROJECT LIBRARY

### Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23194)

## IMAGE GALLERY




*Collision-avoidance radar for small UAS, Phase II*

## DETAILS FOR TECHNOLOGY 1

### Technology Title

Collision-avoidance radar for small UAS, Phase II

### Potential Applications

NASA currently has multiple UAS applications/technology development programs which could benefit from the proposed situation awareness radar system. The Phase II miniature radar system will allow NASA pilots to operate multiple UAS with minimal oversight, enhance multi-vehicle cooperation (especially in an unknown environment), and achieve higher levels of situation awareness for intelligent decision making in real-time. For example, NASA?s Autonomous Robust Avionics (AuRA) would directly benefit from the radar?s ability to reduce operator workload. Either as a stand-alone sensor or integrated with other devices, the situation awareness provided by the radar is a disruptive solution that will greatly affect the rules and regulations for UAS in the NAS which NASA, the FAA, and other agencies are collaborating on. NASA AFRC has successful R&D on large scale UAS in the NAS using vehicles such as the Ikhana but will so move towards sUAS such as the DROID3 or Area I. This proposed radar system with its miniature SWaP form factor has been identified as suitable for installation onboard these sUAS. Furthermore, detection range and coverage provided by the radar lends itself to be a backup sensor on the large scale UAS without upsetting the current payload limitation. Finally, since radars are capable of operating in outer

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