Ohio Department of Transportation Research Project Fact Sheet

District Highway Maintenance Research On-Call (ROC) - Task 07: Radar Emplacement Prediction Tool Exploration and Recommendations

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The Problem

Emerging autonomous aircraft require unique infrastructure to provide vital information to ensure they remain well-clear of other flying objects. While there are many systems designed to provide such functionality, termed detect and avoid (DAA), ground-based radars have emerged as one of the most promising technical solutions to this challenging problem. Ground-based radars can detect and communicate the location of cooperative and noncooperative aircraft or objects present in the National Airspace System (NAS) to support the safe operations of crewed and uncrewed aircraft operating in the NAS simultaneously. Ground-based radars do not require aircraft to carry heavy equipment onboard. One major drawback to ground-based radar is that their performance is heavily influenced by where the sensors are located. Nearby objects such as trees/roads/buildings generate false tracks or shield the radars returns leading to large, uncovered regions. This line-of-sight limitation is a major hurdle for emplacing such systems over a wide geographical area and makes each emplacement assessment unique. Emplacing radars strategically is necessary to maximize airspace coverage while also identifying airspace regions that are not covered.

Purpose

Currently, The Ohio State University is leading a large program designed to emplace ground-based radars to provide DAA support to Uncrewed Aerial Systems (UAS) operating in urban environments. Predictive radar tools provide an efficient method to estimate a radar's performance in a geographical region. Additionally, these software predictions provide an opportunity to optimize strategic radar emplacement and maximize line-of-sight view, as well as identify blind spots and limitations of a radar's particular location before being emplaced in real life. This Research-On-Call (ROC) Task explored the use of a simplified version of OneSky's radar software prediction tool to develop an introductory understanding and identify criteria to look for in future software prediction models utilized. This ROC also provided recommendations when vetting potential radar candidates.

Findings

Physics based prediction capabilities were deemed essential to successfully utilize radar software prediction models when strategically analyzing emplacement options and vendor candidates. Having a software model that predicts the radar's detection range based on power, frequency, and pulse etc. inputs will be helpful to identify optimal radar parameters and respective emplacements. The software platform also needs to be able to process building and terrain obstruction data that covers at minimum a 15 nautical mile radius from a simulated radar. This will help support vetting radar candidates by testing them in software

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prediction models to verify coverage capabilities before purchase and live emplacement. When vetting radar candidates, considering the tracking range of small UAS, large UAS, and general aviation aircraft will be critical when navigating emplacement and understanding coverage performance.

Radar Software Prediction Model Recommendations

For future work, below is a list of recommended features for radar prediction model software to support.

- Radar profiles can be built with 0 to 360-degree coverage.
- A radar's coverage analysis prediction can process a 15 nautical mile minimum radius from an emplaced radar of terrain and building obstructions.
- Software is physics based to predict a radar's detection range and coverage simultaneously based on power, frequency, and pulse etc. inputs.
- Provide a volumetric coverage analysis option where the user is able to understand how much volume of air the radar is able to see, and what volume of air the radar is not able to detect due to building and terrain obstructions in a given region. This coverage analysis would also include an option to specify a detection obstacle, such as a small UAS for example, as an input to understand the maximum coverage and what the radar is able to detect, view, and not see given its emplacement.

These features would help provide critical insights of a radar's predicted performance in a defined region.

Radar Candidate Criteria Consideration Recommendations

When vetting potential radar candidates, below is a list of questions to consider asking vendors.

- What are the output data format options?
- What is the tracking range of sUAS, large UAS, and general aviation aircraft?
- What is the power output of the radar?
- What is the operational frequency?
- Are there any additional licensing requirements for emplacement and do you offer services to facilitate the approvals?
- Are the radars part 87 or part 90 certified?
- What additional infrastructure is required for installation?
- What is the general size/weight/power of the radar head and supporting equipment?
- What emplacement services are offered to ensure performance once installed?

These questions will be critical to know before purchasing a radar. Using a radar's manufacturer specifications as a reference, a radar profile can be constructed using a predictive software platform to simulate the radar's performance. Multiple emplacement locations can be tested with a variance in input parameters to predict capabilities and whether the radar provides enough coverage given local infrastructure and terrain. This will be beneficial to test radar candidates and predict their performance before purchase and support rapid radar emplacement.

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