Autonomous Construction Vehicle for the Rapid Airfield Repair Mission

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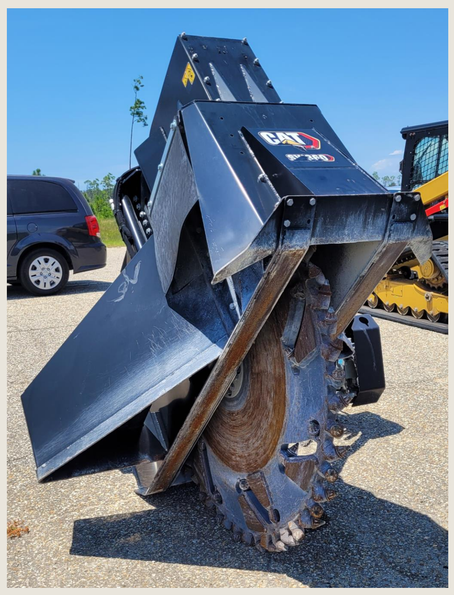
ABSTRACT

The USAF operates around the world, and many of its airfields are vulnerable to aerial attack. After an airstrike, the runway may be unserviceable due to significant damage. The Air Force Civil Engineering Center supports the Rapid Airbase Defense and Repair (RADR) mission to deal with this possibility. Additionally, unexploded ordinance (UXO) may litter the area and pose a very dangerous and difficult problem for Explosive Ordinance Disposal (EOD) experts. With an autonomous cutting capability, prepping for repair (cutting) could begin with untreated UXOs still in the area because no human operators would be at risk. Thus, UXO mitigation and damage repair could occur in parallel. This offers a potential time saving of several hours to days. A novel robot design is in development utilizing Robot Operating System to perform autonomous navigation and computer vision and other sensing to detect, characterize and localize damaged areas, then plan trajectories for precise cutting operations. Our objective was to develop a robotic system that allows the cutting stage of the repair process of RADR to operate fully or semi-autonomously, including debris clearance, precision cutting, and multiple cuts per mission.



Rapid Airfield Damage Repair Process

- Rapid Airfield Damage Assessment System (RADAS) swiftly identifies surface UXOs, pinpoints entry points of subsurface UXOs, and detects other forms of runway damage.
- RADAS seamlessly transmits gathered data to systems tasked with UXO cleanup and precision cutting around damaged areas.
- Robots adeptly navigate to identified runway damage sites, execute precise cutting maneuvers, clear debris, and autonomously return to the base station

AFCEC Concrete Cutting Capabilities

- **Fully Autonomous**: The robot can navigate and operate on its own
- **Multi-Functional:** The robot can cut, sweep, and navigate.
- **GPS Denied Capability:** The robot can navigate from GPS coordinates
- **Contested Environment Capable:** It can operate while being shot at by enemies
- **Meeting the Time Constraint**: It can complete the entire operation within an hour
- **Cutting through Reinforced Concrete:** The blade can cut through any concrete
- **Traverse Multiple Terrains:** The robot can navigate on uneven surfaces
- **Ease of Use:** The robot only needs to be turned on and monitored
- **Cut Precision:** The robot can cut a square with corner angles close to 90 degrees and straight lines
- **Man-Operable**: The robot has a function to be run by a human if something were to go wrong
- **Resistant to UXOs:** The robot will not break if it runs over a UXO that explodes

Ongoing Work

- Use Superdroid MLT-42 chassis and navigation capability for basic autonomous behaviors
- Use computer vision and other sensors to detect, characterize runway damage
- Apply best practices to determine cutting paths prior to repair
- Develop trajectory planning and sensing to executing cutting operations with precision
- Experimentation is ongoing to determine the best sensor or combination of sensors to use

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