Augmented Reality in Human-Robot Cooperative Search

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I. Description

Robots operating alongside humans in field environments have the potential to greatly increase the situational awareness of their human teammates. A significant challenge, however, is the efficient conveyance of what the robot perceives to the human in order to achieve improved situational awareness. We believe augmented reality (AR), which allows a human to simultaneously perceive the real world and digital information situated virtually in the real world, has the potential to address this issue. We propose to demonstrate that augmented reality can be used to enable human-robot cooperative search, where the robot can both share search results and assist the human teammate in navigating to a search target.

II. Equipment

The equipment provided will be a Clearpath Jackal, Microsoft Hololens (Fig. 1), laptop, PicoStation, and a set of Apriltags. A closed network will manage communications between the robot, Hololens, and a central server.

III. Requirements and Safety

The indoor area is preferred for this demo. While the effectiveness of the Hololens mapping is not limited by being outdoors, it can be difficult for the user to see holograms in bright light. Barriers of some kind are necessary as well to limit movement and visibility for both the user and the robot. Power will be required for the PicoStation, laptop, and robot battery charging. A TV, monitor, or table to place our own monitor device would be preferred. The volunteer will maintain a safe distance from the robot at all times, regardless of operating speed or visible path. A demonstration team member will monitor all experiments and enable an emergency stop if necessary.

IV. Demo Procedure

Each demo will last approximately five minutes, with one volunteer acting as the human teammate wearing the HoloLens. The demo will proceed as follows. The volunteer will start the application and provide an intial pose estimate for the robot via the AR interface.Using this initial estimate for position and orientation as a starting point, the robot will perform online point cloud alignment of the robot point cloud with the pointcloud generated from HoloLens mesh.

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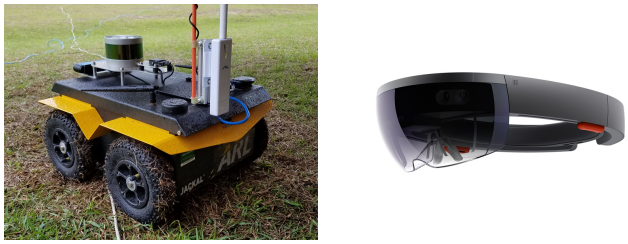
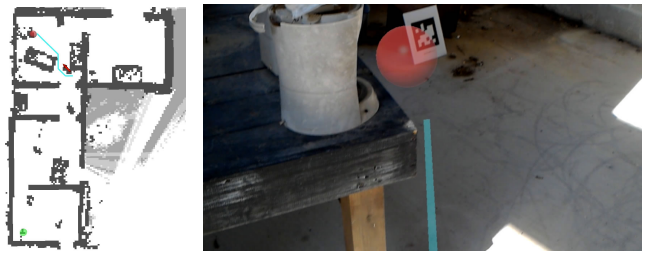


(a) (b)

Fig. 1: Mobile robot (a) AR head-mounted device (b) for the demonstration.



(a) (b)

Fig. 2: Rviz (a) and AR head-mounted device (b) views showing a highlighted target and planned path through a robot-explored environment.

The demonstration scenario is for the robot to search the area to identify and localize targets and provide localization and navigation assistance to the human teammate. This is representative of a situation where a robot may have more discriminitive power or resource availability to find and locate targets, e.g., disaster victims needing medical attention. To emulate this, the robot will navigate the area, either by remote control or through autonomous search, and locate AprilTag targets scattered throughout the environment. Once a target has been located, the robot will use its onboard navigation and a human motion model to generate a path for the human, through the environment, to the target (Fig. 2). The user will be notified by the Hololens and the target path will be presented via the AR device to the human teammate. When the human reaches each target, the target is marked as complete and the path to the next detected target will be presented. The demo is complete when all targets are located.. Although this project is continuously under development and may be improved before the conference date, the main structure of the demo will remain the same.