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Efficiency Evaluation of USAR Control Methods

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Project Specification

1 Introduction

Teleoperated Urban Search and Rescue (USAR) robots is a quickly developing technology and, with the robots' increasing refinement, will most likely play a larger role in future rescue missions in environments too hazardous or inaccessible to human beings. However, controlling these unmanned vehicles offers many challenges. There are numerous kinds of different and advanced sensors one can employ to convey environmental information, but combining them and presenting the information in an intuitive way, without too heavy cognitive load for the operator, is a problem many are continuously working on. Challenges lie in conveying information that range from poor visibility and steep inclines or depressions to protruding debris. All of which demand a high level of situational awareness being delivered from a wide array of sensors to the operator. This while still having the operator being able to focus on his task or mission.

In this essay I will attempt to isolate and compare variations in control variables. The different approaches will be modeled and implemented, to the best of my ability, using the Unity 3D engine. Performance will be measured using a custom made obstacle course, with test subjects attempting to navigate and complete tasks while being monitored and timed.

2 Problem statement

Unmanned USAR vehicles can be called upon to operate in extremely complex and varying environments. They can be extremely difficult to navigate and hostile to delicate machinery. The robot must both avoid collisions and be able to efficiently survey the area for targets, such as human survivors. It is therefore critical for their operators to achieve a high degree of situational awareness to be able to make optimal judgment calls, especially since lives may depend upon it. This situational awareness is, hopefully, attained though an array of complex sensors and the way

in which this data is compiled and conveyed to the operator. There are however innumerable ways to present this data to the user and this is the subject of an active field of research. Determining which control schemes are the most efficient can really only be done though user evaluation and testing, which is what I aim to undertake.

3 Approach

When attempting to create a control interface for an unmanned vehicle, there are numerous challenges to overcome. Most of these require expensive and complicated technologies as well as considerable expertise to implement. Since I am limited in both resources and expertise, I intend to focus on a select few interface design decisions and evaluate varying implementations in relation to each other. These will be very limited and simple in comparison to the state-of-the-art.

I will select a few design decisions and implement variations on them in the Unity 3D engine. A virtual environment with obstacles, targets and a user controlled vehicle will be created. Test subjects will then be trying out the different interface implementations and be benchmarked in metrics such as task completion time, number of collisions and targets found. I will also interview the subjects after the tests and inquire about which methods they preferred and the reasons for it.

4 References

I have already read two papers, one of which is a litterature review, on the subject matter. They have given me great insight into the state-of-the-art technologies that are currently being employed.

- B. Larochelle and G.-J. Kruijff, Multi-view operator control unit to improve situation awareness in USAR missions, RO-MAN, 2012 IEEE.
- J. Y. C. Chen, E. C. Haas, and Barnes, "Human Performance Issues and User Interface Design for Teleoperated Robots," Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on, vol. 37, no. 6.

5 Time plan

The essay is due in just over 2 months. My preliminary plan will be something along these lines:

- One week of reading literature about the field.

  Start rough outlines on background.

  Start writing on problem statement.

- Four weeks of implementation in Unity.

  Create 3D test course.

  Create drivable vehicle.

  Create GUI and the different variations.

  Add things to the 'approach' section when applicable.

- One week of user evaluations and interviews.

  Arrange time and place for testing.

  Perform actual user testing.

  Write approach and result in report.

- Two weeks of report writing.

  Write conclusions and discussion.

  Finalize the other sections