Implementing Localization and mapping with advanced AI for autonomous navigation

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Abstract:

Over the course of this semester, our lab has been constructing a racecar (based on the MuSHR hardware) and implementing various forms of AI programs to allow the racecar to be fully autonomous. We will transfer this software from the small scale of the racecar, to a full-sized rover within the coming months.

Background:

- Current obstacle detection programs fail to detect many high-speed obstacles, our goal is to eliminate the risk of collision with these objects to allow for improvements in autonomous driving
- Create an AI program to allow rovers/cars/drones better detect static and moving objects to create a safe environment for these vehicles to operate without colliding with anything or anyone.

Methods:

•Constructed racecar based on MuSHR racecar
•We used SLAM (Simultaneous Localization and Mapping) on a simulation of the racecar that allowed our racecar to know where it is without user intervention.
•We will be implementing this same SLAM software on the physical racecar

Figures

Fig 1: Racecar (software version) detecting its localized area and plots its own navigational course autonomously

Fig 2: Stripping rover of all previous components to install new materials to maximize performance

Experimental Results:

- In the simulation version of the racecar, it was able to detect any static obstacle we placed in front of it and avoid it without user-intervention.
- During the preliminary test of implementing of the software on the physical racecar, it was able to visualize the local area and detect static and moving objects

Fig 3: Installation of servo motor-arm, allowing to produce twice the torque as the original arm

Fig 4: Rover is programmed with list of commands we will use to implement SLAM software and other AI programs.

Conclusions and Future Work:

- Successfully constructed racecar and simulation software works efficiently with any obstacles placed in its path.
- The simulation software and physical racecar both proved successful in localization and mapping, which will prove beneficial as we further add to the programming to allow the rover to be able to better detect static and quick-moving objects.

Future Work:

- We will be working on the racecars ability to detect obstacles and on its autonomous navigation to allow the racecar to become fully self-navigating and self-aware of its surroundings.

Fig 5: Rover is being tested using wireless controls (no-AI implementation at this state)

Acknowledgements:

1. We based our racecar off on the MuSHR.io racecar instructions, then followed their software implantation, where we began to implement our own software to allow for better obstacle detection.
2. We'd also like to thank the College of Computer Science because without their support we would have not been able to get to the point we are now without them.

References:
MuSHR. A Low-Cost, Open-Source Robotic Racecar for Education and Research. www.arxiv.org/abs/1908.08031. Accessed July 20, 2022