Autonomous Racecar

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Background

- The National Highway Traffic Safety Administration says "94 percent of serious crashes are due to dangerous choices or errors people make behind the wheel."
- Driverless cars can remove the erratic behaviors of careless drivers and potentially reduce the number of accidents due to human error.

Goal

- Build a custom RC car that can be driven with no human intervention.
- Research various algorithms, such as pathfinding, obstacle avoidance, and Simultaneous Localization and Mapping (SLAM) algorithms, to find the optimal combination of algorithms for autonomous driving.
- Demonstrate autonomous driving and interaction of 2 RC vehicles running on different driving algorithms.

Graphical User Interface

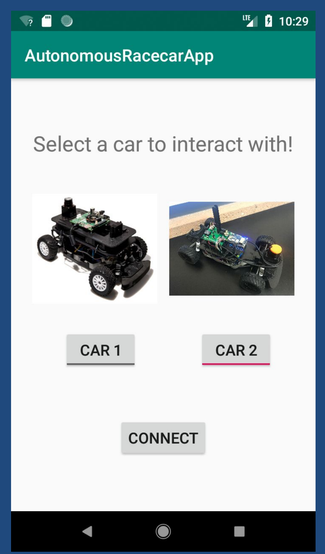

Fig. 1 - Main menu of the Android app

Fig. 2 - Control interface for each car

Current Progress

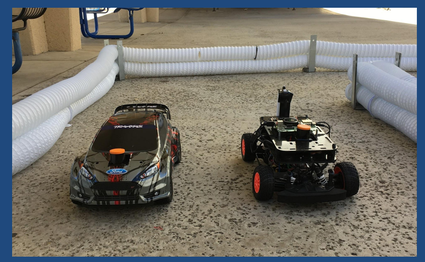

Fig. 3 - Image showing both the new and old cars

Reactive Obstacle Avoidance Algorithms

- *Follow the Gap*
- *Vector Field Histogram*
- *Vector Polar Histogram*

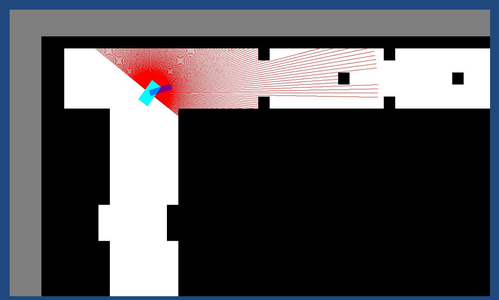

Fig. 4. Simulation with a virtual world to test our algorithms

Fig. 5 - Two vehicles going in the same direction while avoiding obstacles.

Algorithm Comparisons

Performance	Follow the Gap Method	Vector Field Histogram	Vector Polar Histogram
Crowded Environments	✓		
Intensive Parameter Tuning	✓	✓	✓
Computationally Expensive		✓	
No convergence at U-shaped obstacle	✓	✓	✓
Smoother turns			✓

Future Works

Machine Learning with Dynamic Variables

- Use machine learning to tune the parameters in the algorithms to optimize their performance instead of manually tuning the parameters.

Dynamic Obstacle Detection

- In order to run multiple cars or take into account people, we would like the current algorithms to be extended to work better at detecting moving obstacles from the sensors.

Simulation Realism

- Improve on the existing simulation such as wheel friction, complex shaped obstacles, moving obstacles

References

1. Sezer, Volkan, et al. “A novel obstacle avoidance algorithm: ‘Follow the Gap Method’.” *Robotics and Autonomous System*, Vol. 60, no. 9, 2012, pp. 1123-1134.
2. Ulrich, Iwan and Borenstein, Johan. “VFH+: Reliable Obstacle Avoidance for Fast Mobile Robots” *IEEE International Conference on Robotics and Automation. Leuven, Belgium, May 16–21, 1998, pp. 1572 - 1577*
3. Gong, Jianwei. “VPH+: An Enhanced Vector Polar Histogram Method for Mobile Robot Obstacle Avoidance”. Proceedings of the 2007 IEEE International Conference on Mechatronics and Automation