Autonomous Car Intersection Simulation Project

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Abstract

This project aims to investigate some of the aspects involving traffic management with autonomous vehicles. In particular, we want to know how it can be possible to regulate self driving cars through an intersection, and if it is possible to achieve this without a centralised controller and the use of communication. We will run a simulation of an intersection with self driving cars and discuss our findings, comparing different methodologies and related work.

1 Introduction

A presentation of previous research (related work), different paragdigms of control (basic theory), and our angle.

2 Related work

Most of the research that has been conducted on intersection management systems for autonomous vehicles tends to prefer centralised systems that can handle traffic requests. Particularly relevant is the research of two major groups in this area: the researchers at the University of Texas at Austin, and an international group of researchers composed by members of the Massachusetts Institute of Technology (MIT), the Swiss Institute of Technology (ETHZ), and the Italian National Research Council (CNR).

At the University of Texas, Kurt Dresner and Peter Stone developed AIM, Autonomous Intersection Management, a reservation-based system built around a detailed communication protocol able to coordinate movement of self driving cars through intersections [1]. Through a simulation they are able to demonstrate the potential of this system to outperform current intersection control mechanism: traffic lights and stop signs. In the simulation, the intersection center is divided into a n x n grid of reservation tiles. Through a "first come, first served" policy, approaching vehicles make a request to the system to reserve the space-time they need to cross the intersection. Their trajectory is then computed by the system and if the requesting vehicle at any time occupies a reservation tile that is already in use, the request is rejected. The vehicle will then continue requesting until it can pass.

A similar approach is also followed by the international group of MIT, ETHZ and CNR researchers. They developed a centralised slot-based intersection [2]. In their simulations, cars adjust their velocities in approaching the intersection in order to arrive and cross at a given slot of time that is made available for them. This system also involves communication between vehicles and a centrlised controller.

3 Theory

Reactive vs. deliberate vs. hybrid.

maybe theory makes more sense before related work

The theory we have touched upon is from multiple fields of engineering. One field is within traffic engineering, namely intersection management. The other is within the field of robotics, namely robot control.

We use the term agents for robots or other actors moving within an environment. We use the term environment as being synonimous to the world in which the agent is confined.

3.1 Reactive Control

This paragdim is also coined Sense-Act. This is due to the fact that it can be explained as simply as sensing the environment and reacting instantly to the registered values. Consider a simple robot with only one distance sensor in the front. While there is nothing infront of it for a certain distance it moves forward, else it does not.

3.2 Deliberate Control

This paragdim is also known as Sense-Plan-Act. Compared to the reactive control it introduces a layer of planning. This however requires alot more information about the environment. Any change to the environment would also invalidate the current plan as this is not factored in. This is computationally heavy since it senses, plans a step, executes the step and starts over.

3.3 Hybrid Control

4 System description

- Presentation of our model.
- Intersection w/wo traffic lights. Cars going straight vs. cars turning.
- Car model and sensor modelling (sick vs simplified directional).
- Graph for navigation.
- Reactive controller.
- Special rules (right hand).
- Sensor range limitation based on braking distance considerations.
- SimScale to RealWorldScale

5 Experiments

we have some fixed parameters such as light control on or off. Mimics intersection lights.
Whether simulated vehicles are able to turn or not.
We have different max speeds - 60 or 40 km per hour approach. This translates to lower speeds during turns (roughly half).

tests are different combinations of above parameters. And results are measured in collisions, cars spawned, cars reaching destination, and time before deadlock.
Deadlock is the situation where cars have been stuck for a period of time in the 'intersection zone' without entering or leaving.

6 Discussion

Discuss experimental results. Shortcomings of model. Improvements for further tests.

7 Conclusion

References

[1] K. Dresner and P. Stone. A multiagent approach to autonomous intersection management. 1905.

[2] R. Tachet, P. Santi, S. Sobolevsky, L. I. Reyes-Castro, E. Frazzoli, D. Helbing, and C. Ratti. Revisiting street intersections using slot-based systems. 1905.