Multi-Vehicle Systems

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***Abstract*—Multi-robot formations are an important advance in recent robotic developments, as they allow a group of robots to merge their capacities and perform surveys in a more convenient way. With the aim of keeping the costs and acoustic communications to a minimum, cooperative navigation of multiple vehicles is usually performed at the control level**

I. Introduction

Cooperative surveying using multiple autonomous vehicles has become an ubiquitous topic in the robotics community. Among the advantages that these methods provide, the most relevant is the ability to parallelize the survey of a given area by using multiple robots, thereby opening the door to large area mapping in less time than when using a single robot.

II. Literature review

A. Safety

Travel by motor vehicles provides unprecedented degree of mobility, leading to continuous growth of traffic. As the number of motor vehicles and roadways miles and hence vehicles - miles of travel increase throughout the world, the population are more exposed to traffic accidents.Highway safety is a world wide problem with over 500 million cars and trucks in use, and more than 500,000 people die each year in motor vehicles crashes, and about 15 million are injured. Economic cost components of crashes include productivity losses, property damage, medical costs, rehabilitation costs, travel delay, legal and court costs, emergency service costs, insurance administration costs, premature funeral costs and costs to employers.

B. solutions to safety problem

An implicit objective of the transportation system is to minimize the risk of collision, yet maintaining a desired level of mobility. Traditionally, this has been done through improvements to the geometry or physical layout of the roadway. For example, smoothing horizontal and vertical curves and increasing stopping sight distance can make roads safer to drive on. Transportation has also been made safer through the implementation of various safety features on the roadway such as guardrails, traffic barriers and rumble strips. There have been safety features implemented in automobiles such as seatbelt, air bags and structure that have also improved the overall safety of highway travel. Traditional focus has been on protecting vehicle occupants. Recently the focus is moving toward preventing accidents all together: If we can prevent the crash from ever occurring, motor fatalities, injuries, property damage, and travel delays will not occur. Despite these efforts, fatalities, Injuries and accidents are too high. A new approach is needed to reduce the incidence and severity of highway crashes, particularly when the large share of accidents is caused by driver error. This offers a compelling reason for investigating intelligent vehicle and highway technologies as a crash reduction measure.

C. Crash Avoidance And Warning Systems

Crash (or collision) avoidance systems is one of the tools designed to help drivers better detect and quickly respond to impending collisions. Such countermeasures may include advanced technologies to alert drivers of impending collisions as well as enhancements to conventional systems, such as brakes, mirrors and lights. t. Driver error and poor performance, caused by factors ranging from momentary distractions to driving rules intentional violations, are the main contributory causes of most highway crashes. Therefore, the development of such systems requires multi-discipline expertise and involvement of human factors engineers and psychologists in conjunction with mechanical engineers, and electrical engineers to plan, manage and conduct research to better understand vehicle technologies, driver performance, and driver behavior.

III. multi-vehicle systems challenges

A. Cooperative Control

Worldwide, there has been increasing interest in the use of autonomous marine vehicles (AMVs) to execute missions of increasing complexity without direct supervision of human operators. A key enabling element for the execution of such missions is the availability of advance systems for motion control. The problems of motion control can be roughly classified into three groups: i) point stabilization, where the goal is to stabilize a vehicle at a given target point with a desired orientation; ii) trajectory tracking, where the vehicle is required to track a time parameterized reference, and iii) path following, where the objective is for the vehicle to converge to and follow a desired geometric path, without an explicit timing law assigned to it. A particular important scenario that motivates the cooperation of multiple autonomous vehicles and poses great challenges to systems engineers, both from a theoretical and practical standpoint, is automatic ocean exploration/monitoring for scientific and commercial purposes. In this scenario, one can immediately identify two main disadvantages of using a single, heavily equipped vehicle: lack of robustness to system failures and inefficiency due to the fact that the vehicle may need to wander significantly to collect data over a large spatial domain. A cooperative group of vehicles connected via a mobile communications network has the potential to overcome these limitations.

B. Path-Planning

collision avoidance is a common problem in many areas, including navigation and robotics. In dynamic environments, vehicles may become involved in potential collisions with each other, particularly when the vehicle density is high and the direction of travel is unrestricted. Cooperatively planning vehicle movement can effectively reduce and fairly distribute the detour inconvenience before subsequently returning vehicles to their intended paths.

C. Road conditions

Road conditions could be highly unpredictable and vary from places to places. In some cases, there are smooth and marked broad highways. In other cases, road conditions are highly deteriorated - no lane marking. Lanes are not defined, there are potholes, mountainous and tunnel roads where external signals for direction are not very clear and likewise.

D. Weather conditions

Weather conditions play another spoilsport. There could be a sunny and clear weather or rainy and stormy weather. Autonomous cars should work in all sorts of weather conditions. There is absolutely no scope for failure or downtime.

E. Traffic conditions

Autonomous cars would have to get onto the road where they would have to drive in all sorts of traffic conditions. They would have to drive with other autonomous cars on the road, and at the same time, there would also be a lot of humans. Wherever humans are involved, there are involved a lot of emotions. Traffic could be highly moderated and self-regulated. But often there are cases where people may be breaking traffic rules. An object may turn up in unexpected conditions. In the case of dense traffic, even the movement of few cms per minute does matter. One can't wait endlessly for traffic to automatically clear and have some precondition to start moving. If more of such cars on the road are waiting for traffic to get cleared, ultimately that may result in a traffic deadlock.

F. Accident Liability

The most important aspect of autonomous cars is accidents liability. Who is liable for accidents caused by a self-driving car? In the case of autonomous cars, the software will be the main component that will drive the car and will make all the important decisions. While the initial designs have a person physically placed behind the steering wheel, newer designs showcased by Google, do not have a dashboard and a steering wheel! In such designs, where the car does not have any controls like a steering wheel, a brake pedal, an accelerator pedal, how is the person in the car supposed to control the car in case of an untoward incident? Additionally, due to the nature of autonomous cars, the occupants will mostly be in a relaxed state and may not be paying close attention to the traffic conditions. In situations where their attention is needed, by the time they need to act, it may be too late to avert the situation.

G. Radar Interference

Autonomous cars use lasers and radar for navigation. The lasers are mounted on roof top while the sensors are mounted on the body of the vehicle. The principle of radar works by detecting reflections of radio waves from surrounding objects. When on the road, a car will continuously emit radio frequency waves, which get reflected from the surrounding cars and other objects near the road. The time taken for the reflection is measured to calculate the distance between the car and the object. Appropriate action is then taken based on the radar readings. The principle of radar works by detecting reflections of radio waves from surrounding objects. When on the road, a car will continuously emit radio frequency waves, which get reflected from the surrounding cars and other objects near the road. The time taken for the reflection is measured to calculate the distance between the car and the object. Appropriate action is then taken based on the radar readings. When this technology is used for hundreds of vehicles on the road, will a car be able to distinguish between its own (reflected) signal and the signal (reflected or transmitted) from another vehicle? Even if multiple radio frequencies are available for radar, this frequency range is unlikely to be insufficient for all the vehicles manufactured.

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