ROBOTIC HIGHWAY SAFETY MARKERS

The safety of highway construction and maintenance workers is an important issue and proper traffic control is critical to work zone safety. Devices such as signs, barricades, traffic cones, and plastic safety barrels are used to control traffic. Work zone housekeeping, tasks such as covering and uncovering signs and moving traffic control devices, is one of the most important elements in reducing accidents. While housekeeping is important, it comes at a very high cost. Worker time is required to set up hundreds of safety devices—often at the beginning and end of each workday. However, safety markers located far from the work crew or left in place around the clock leads to driver complacency. In addition, deployment and retrieval activities are extremely dangerous because of the proximity of passing vehicles. New technologies may be useful in reducing accidents.

This project has developed a mobile Robotic Safety Barrel (and a similar Robotic Safety Sign). Safety barrels guide traffic and serve as a visible barrier between traffic and work crews. These barrels consist of a brightly colored plastic drum (approximately 130cm high and 50cm in diameter) that is attached to a heavy base. The robotic safety barrel replaces the heavy base with a mobile robot that transports the safety barrel. The robots work in teams to provide traffic control.

Independent, autonomous barrel motion has several advantages. First, the barrels can self-deploy and self-retrieve, eliminating the dangerous task of manually placing barrels. Second, their positions can be quickly and remotely re-configured as the work zone changes thus reducing the work zone size. Finally, barrels can continuously follow work crews during slow moving maintenance operations such as asphalt overlay.

The proposed approach clearly has a higher equipment cost than traditional systems; however, there are possible cost reductions in labor and increased worker safety. In addition, the cost of traffic congestion in the United States is conservatively estimated to be approximately $100 billion annually and the proposed approach could lead to less congestion by reducing the time required to deploy markers and reducing the size of the work zone. The approach is not fitted for every work zone but there are many situations where it would be useful and practical (e.g. urban lane closures, incident management).

A system that consists of a lead vehicle (or robot) and several low-cost barrel robots was developed. A distributed planning and control approach was created that reduces the per-robot cost by centralizing the intelligence and sensing while keeping communication bandwidth low by distributing local control. Test results are presented including a statistical analysis of the local controller and field tests of the full system.

This project has proven the concept of robotic highway safety markers. Eight robotic safety barrels and one robotic sign were constructed. These robots are designed to be low-cost and reliable. A localization sensor system and control system were designed and tested to allow the robot to self-deploy and self-retrieve as well as continuously follow slow moving maintenance operations such as asphalt overlay or lane striping.

Two basic forms of motion were achieved. The first is where the robots are randomly placed on a road side. The user then designates desired positions for the barrels (e.g. taper to close right lane). Then, the robots create a plan and execute a motion to the desired final positions. The second motion was where the user designates a desired formation for the robots. The robots then autonomously maintain that formation behind a slow moving vehicle. Here, the robots match the speed of the vehicle up to 5 mph. This second motion exceeds the proposed objectives of the original phase one proposal and could be useful in slow moving maintenance operations such as asphalt overlay and lane striping.

Great technical progress was made and significant hardware was created during phase one of this project. This project has demonstrated the feasibility of the concept. The follow up proposal will lead to more complete field testing and push toward commercial implementation of the concept.

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