AUTOMATED VEHICLE PLATOON

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Keywords

prototype car, vehicle platooning, autonomous vehicle, sensors, control algorithm, V2V communication protocol.

Introduction

Road accidents remain a cause of death and injury despite considerable improvements over the past decade in transportation. Transport systems stakeholders recognize the role which intelligent transport systems can play in making roads safer. In recent years, increase in concern towards green technology is also a motivational factor for research and development in Intelligent Transport System of automobiles be fuel efficient.
One of the considered solutions to these problems is vehicle platooning; The class of Intelligent Transportation Systems with cooperative driving the platoon vehicles (one leader vehicle and many follower vehicles – rail-on-road), which are enforced to follow each other and to maintain a safe distance between them and organize their activities by exchanging information over a wireless communication infrastructure using V2X communication with limited human intervention from follower vehicles.
Testing of platooning on real vehicles is costly and hazardous. The use of such vehicles is also outside the reach of most researchers and students.

Hence in this project, a multiple (2 numbers) numbers of low-cost 1/10th scale testbed/platform cars having substantially similar behaviour of full-scale cars will be developed to demonstrate vehicle platoon and autonomous vehicle capabilities. The developed 1/10th scale platform car will have sensors, controllers, software stack, and other relevant artifacts that are like full-scale life size solutions.

Objective

The aim of the project is to demonstrates key features of vehicle platooning enabled by the 1/10th scale platform car and develop a platform which can be used to augment research and development in autonomous systems, vehicle platooning and making intelligent transport systems more accessible. It will be achieved by fulfilling following objectives

(a) To design and implement ECUs (Electronic Control Unit’s), control logic (software

modules stack) and hardware architecture for the 1/10th platform cars capable of operating in 3 modes of driving – Manual mode, Autonomous mode, and Platooning mode.

(b) To design and implement 3D printed mechanical chassis and other parts of the vehicle and assemble the 1/10th scale cars.

(c) To design and implement Perception, Planning, Control and Coordination logic for assessing road path, surrounding vehicles and other information using IR sensor set, and ultrasonic sensors.

(d) To implement V2V communication between vehicles by developing vehicle control unit and platoon control unit, ZigBee transceivers and remote-control unit for emergency takeover.

(e) Sensor fusion concepts are used to receive information from the IR sensor set, and Ultrasonic sensor to receive the vehicle position other parameters.

Methodology

The structure of a vehicle platoon is composed of N (2 in prototype) vehicles shown in Figure. 1

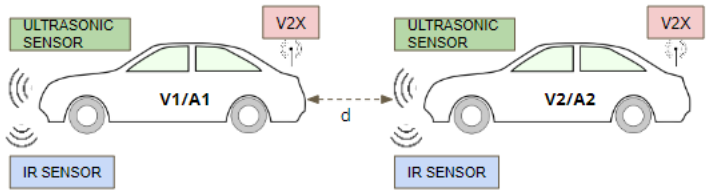

Figure. 1 Vehicle platoon structure (System overview)

Proposed prototype platform car can operate in 3 driving modes.

- Vehicle Platoon mode
- Autonomous mode
- Manual mode

Each mode of operation utilizes all the hardware circuits units for different purposes.

Example:

- During Manual mode – Ultrasonic sensors are used to warn the driver of an obstacle.
- During Autonomous mode – Ultrasonic sensors are used for Automatic Braking System.
- During Vehicle Platoon – Ultrasonic sensors are used for distance calculation between two vehicles. Hence only most distinguished and important part is explained here and detailed explanation for each mode will be given in final project report.

Vehicle Platoon mode:

Each Vehicle (Vi) with its control ECUs (Ai) is using the vehicle-to-vehicle/infrastructure (V2X) communications through a wireless network to negotiate and exchange information with the other platoon members (Leader – main driver which provides command to follower and. Follower – receives commands from leader and other driver assistance systems to follow the leader in proximity). The principal role of V2X communication is improving the vehicle performance and ensuring the complete platoon's stability. The vehicle's absolute position needs to be gathered by a sensor mounted on the car, and the distance **d** between vehicle **Vi** and vehicle **Vi-1** is determined using ultrasonic sensors. Vehicle platooning means that each car, a member in a platoon, must control its velocity and the relative distance to the other. These goals are reached by communicating with the other platoon members. The results of vehicle platooning are road safety improving, fuel consumption reducing, road capacity increasing, and emissions decreasing.

Autonomous mode:

Each Vehicle (Vi) with its control ECUs (Ai) is using IR (infrared sensors) and Ultrasonic sensors to gather the information using computer vision concepts and control unit (Ai) makes relevant decisions to drive patters and going to safe mode in case of warning. DC motors and Servo motor are used to enable the motion of the vehicle.

Manual mode:

Each Vehicle (Vi) with its control ECUs (Ai) will directly receive commands from driver, Remote control is used to communicate between driver and Vehicle control unit (Ai) using Bluetooth interface. Other units such as IR sensor, Ultrasonic Sensors will work as assistant or warning provider to driver.

All modes will be controlled by drivers based on the zones such as National Highways, State Highways and City roads.

During the prototype demonstration, similar road sample will be designed in lab and demonstration will be done.

Technical details and Methodology:

Technical details and methodology are explained with the help of a block diagram shown in Figure. 3.

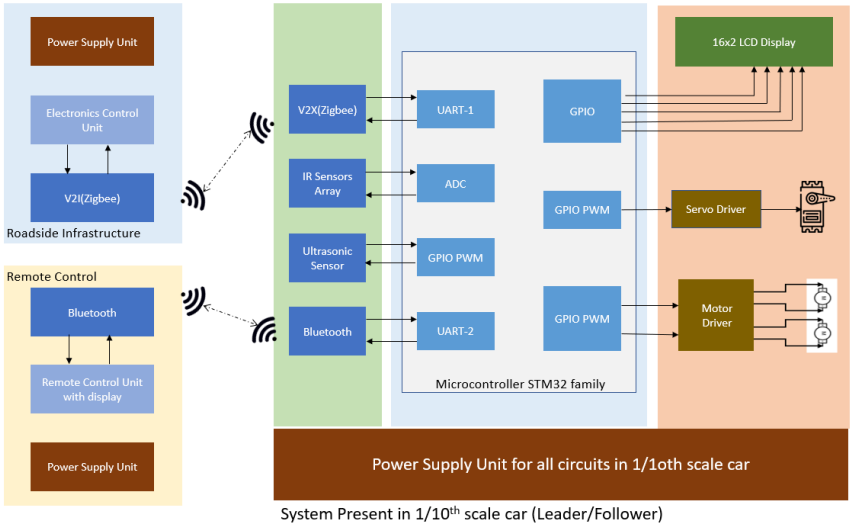

Figure. 3 Simplified Block Diagram of 1/10th scale car platform

Results and Conclusion

(a) Two Identical low cost 1/10th scale 3D printed cars as depicted in Figure. 4, which has the ability to work as the leader as well the follower in platooning mode, autonomous mode, and manual mode.

(b) The 3D CAD design files for chassis and other mechanical parts.

(c) Complete software stack consisting of control algorithms such as basic path control, longitudinal control, string stability and platoon converging for wireless V2V communication and V2I communication for vehicle platooning.

(d) Complete technical documents and of the project for future reference.

(e) "How to" documents of the project to reconstruct the project independently by other researchers, students, and interest groups.

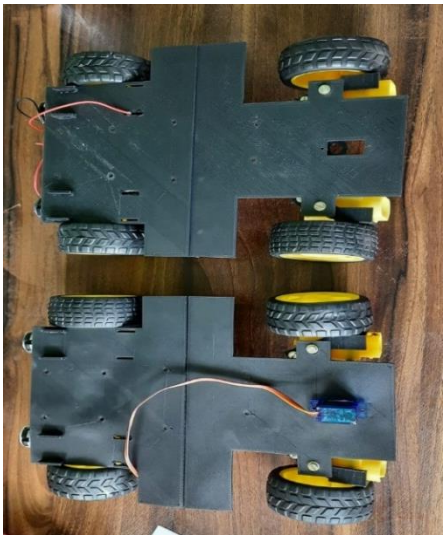

Figure. 4 Two Identical low cost 1/10th scale 3D printed cars

Future Work

Automated Vehicle Platooning contributes significantly to the green technology by reducing Vehicle hour loss, traffic death rate, CO2 emission, and air pollution cooperative driving technologies. Current project is directly in line with the Intelligent Transport Systems, it will enhance the availability of low-cost test bed platform cars to the research institutes for research and development and provide an opportunity to find new solutions in Intelligent Transport Systems domain. The intelligent transport system can detect any accident and receive alerts to ensure that ambulance reaches the spot within 10-15 minutes. This is the initial version of ITS, as technology develops, these ITS roads will be adapted for autonomous vehicle and vehicle platoons to enhance the road safety and to for fuel efficiency.