Automotive Embedded System for Vehicle Speed Analysis

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ABSTRACT

Real-time systems play a major role for safety-critical applications. Adaptive cruise control (ACC) is one such practical implementation. ACC is an intelligent system that automatically adjusts vehicle speed to maintain a driver selected distance from the vehicle ahead. This paper deals with the analysis of car speed on highways using ACC technique. This concept is implemented using mbed board ‘LPC 1768’. The speed of car is indicated and analyzed through stepper motor.

Keywords - Adaptive Cruise Control, Mbed Board, RTOS, Stepper Motor

1. INTRODUCTION

In the present era, electronic systems are extensively used in automobile industry. The heavier mechanical and hydraulic parts are gradually replaced by electronic hardware. Now-a-days, vehicles are deployed with embedded systems which is a combination of hardware and software especially set to control and monitor the vehicle. The system whose correctness depends on the logical result of computation, and also on the time at which the results are produced is referred to as a Real-time system. The main aim is to maximize the percentage of tasks that meet their deadlines and guaranteeing that all critical tasks always meet their deadlines. Some automotive applications are safety-critical whose tasks must be scheduled by some Real-time operating system.

The automotive system consists of a number of subsystems. These subsystems are used to monitor the various controls of the vehicle. Data which is obtained through sensor, is used to monitor the various parameters in the vehicle. Every system which includes computer processing unit and carryout actions based on these inputs are referred to as an embedded system. Some of these applications are engine control, antilock brake system, temperature control, adaptive cruise control, collision avoidance, brake or throttle control, electronic stability control etc.

This paper focuses on adaptive cruise control implementation in cars. The situation is analysed through RTOS programming concepts and implemented using mbed board ‘LPC 1768’ and speed difference is analyzed using stepper motor.

Section-2 gives the concept of adaptive cruise control followed by Section-3 which describes the controlling of car speed based on the situation and Section-4 presents the hardware implementation using stepper motor and finally section–5 presents the results and discussion. Section-6 concludes the paper with the future scope.

2. ADAPTIVE CRUISE CONTROL

Adaptive Cruise Control (ACC) is an automotive feature that allows a vehicle's cruise control system to adapt the vehicle's speed according to the existing traffic circumstances. A radar system or distance sensor is equipped at the front end of the vehicle. This helps in informing whether the vehicles with low speed are ahead in host vehicle’s path. When a slow moving vehicle is detected ahead of host vehicle, the host vehicle’s speed is accordingly reduced to adjust to the time-gap in order to avoid collision. If the system detects that the forward vehicle is no longer in the ACC vehicle's path, the ACC system will accelerate the host vehicle back to its initially set cruise control speed. This action allows the ACC vehicle to automatically slow down or speed up with the existing traffic without the intervention of the driver. The method by which the ACC vehicle's speed is controlled is through engine throttle control and limited brake operation.

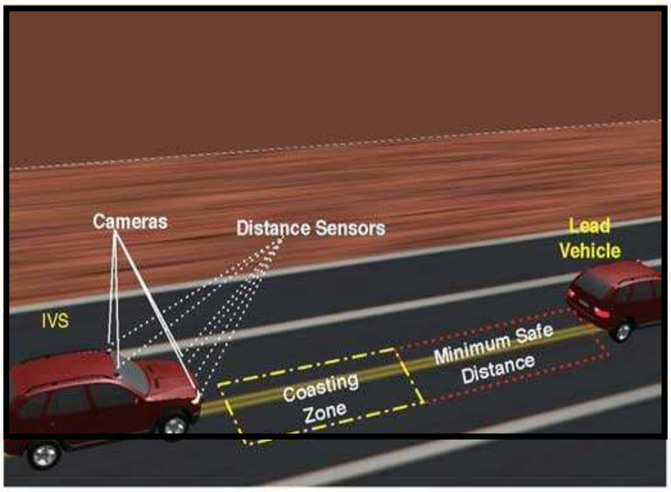


Figure 1: Car with various sensors and controllers

Adaptive Cruise Control is a key feature that is utilized when one needs to spend large amount of time on the highway or on long distance drives. The ACC is that the system is considered to be "Active instead of passive which means that the host vehicle speed is automatically adjusted to match the set speed accordingly based on the surrounding environment vehicles speed. This factor serves as an advantage.

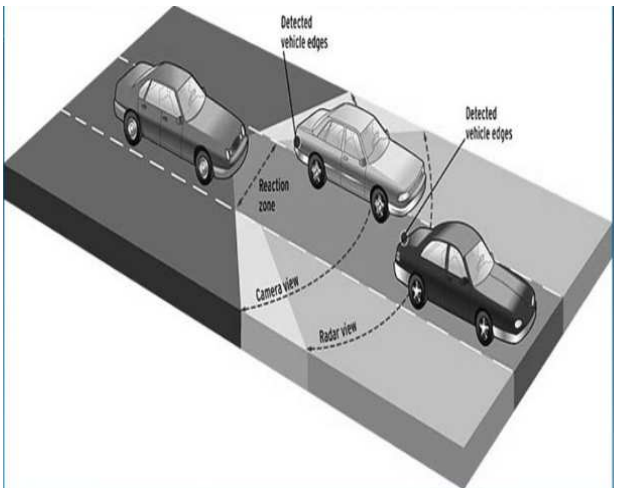


Figure 2: A situation on highway with cars on different lane.

3. CASE STUDY: ANALYSIS OF CAR SPEED

This paper deals with the implementation of ACC. Consider three cars car1, car2, car3 whose speeds are to be monitored. Car 2 is said to be the host car and only its speed can be controlled or monitored. The speeds of other cars i.e. car1 and car3 can only be observed and corresponding actions have to be taken.

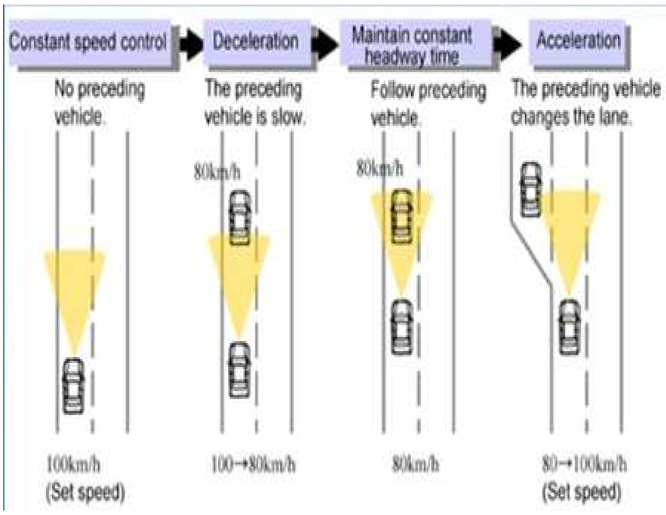


Fig 3: Different cases encountered while using ACC

Initially when no vehicle is ahead of the host vehicle, it moves at the set cruise set speed (say 100kmph). Consider a situation where in a car with a speed of 80kmph is moving ahead. Up to certain distance and time-gap the host vehicle can cruise at set speed. Later, it has to slow down automatically else it leads to collision. This action is performed automatically. Thus the driver can relax while on long drive. (Refer figure 3 for practical view) Consider another situation where three cars are moving on highway. Car1 and car2 are moving at 100kmph and car3 is moving at 150kmph. Now either car3 has to change the lane or car1 and car2 has to increase its speed.

These situations are created virtually by assuming the car speeds and is programmed. While programming each car is allotted an id and some speed. The output is indicated through LEDs on mbed board for various cases stated above. Car 2's task is considered as critical task as it has to see and adjust according to the environment in the case considered here for programming.

Figure 4: situation showing collision warning with brake support.

ALGORITHM

Step 1: Consider three cars on the highway and the host car associated with Adaptive Cruise Control.

Step 2: Assign vehicle id for each car.

Step 3: Calculate the distance between each cars and assign safety distance.

Step 4: Measure the speed of each cars.

Step 5: Track the cars speed along with safety distance and take necessary actions.

Step 6: Indicate the suitable flash message on the dash board (refer results section).

Step 7: If the car is about cross safety limits, alert the driver to switch from ACC mode to normal mode.

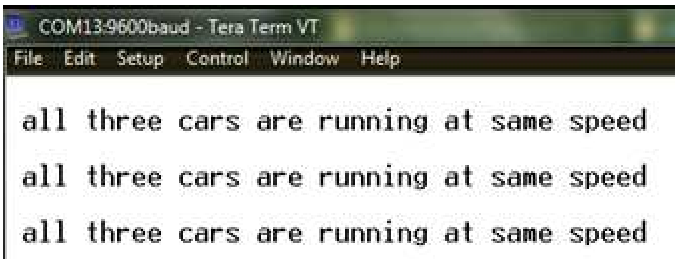
Step 8: If the car ahead is slow and host car's speed has to be slowed down this is indicated by clockwise rotation of stepper motor.

Step 9: If the car behind is fast and host car's speed has to be increased, this is indicated by anti-clockwise rotation of stepper motor.

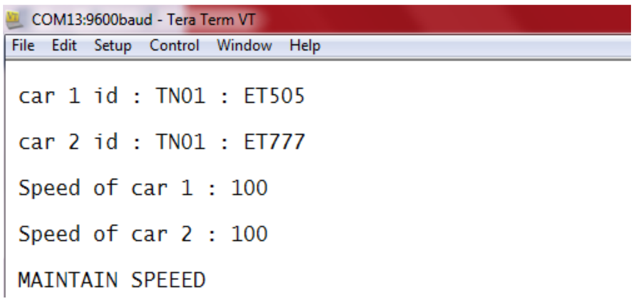
4. RESULTS

The following snapshot shows the various situations encountered while driving and its output obtained is indicated as a flash message on the screen. This function is verified using mbed board.

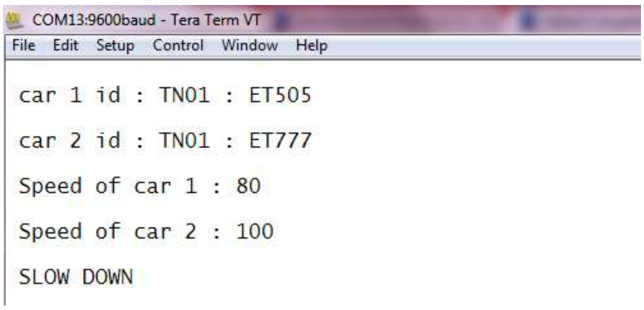
CASE 1: All Cars at Constant Speed and Distance



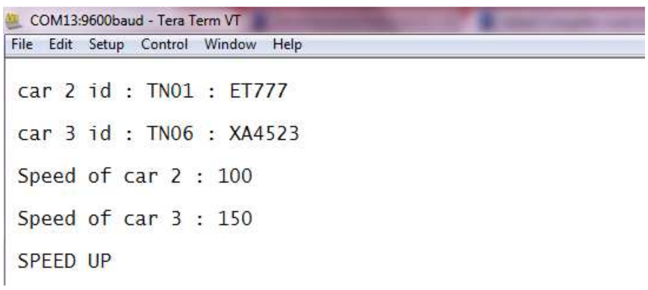
CASE 2: Constant Speed and Distance with Message Pop up on Dash Board



CASE 3: (Speed) 1 < (Speed) 2



CASE 4: (Speed) 3 > (Speed) 2



Here the car1 is given the id1, and car2 is given the id2, car3 is given the id3. Thus based on the car id and distance between them, corresponding actions are taken.

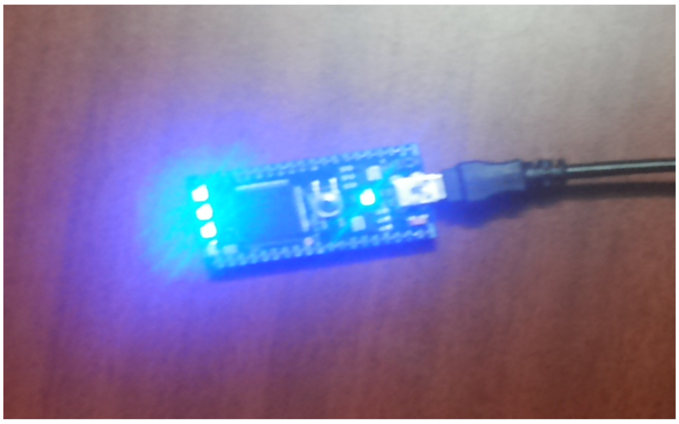


Figure 5: LEDs indicating that all cars are within safety range

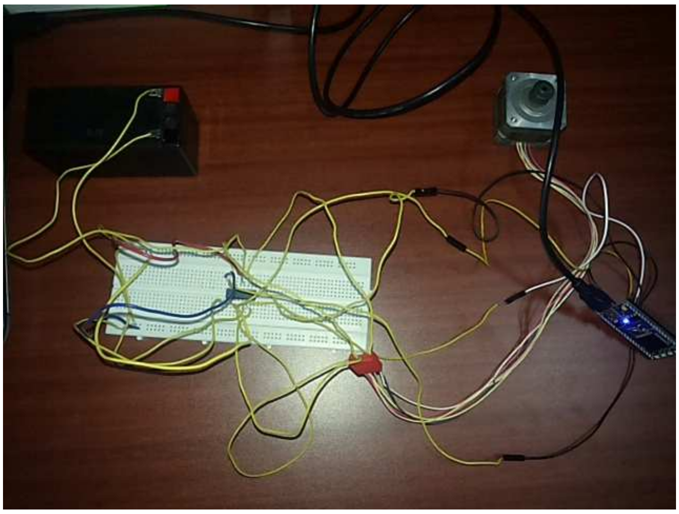


Figure 6: interfacing of stepper motor

5. CONCLUSION

To summarise, Adaptive cruise control (ACC) is an effective method employed and utilized by vehicles while on long drive. ACC helps the driver to relax himself while on long drive and the journey is smoothened. This scenario is virtually created and analysed using mbed board 'LPC 1768'which indicates the driver with the actions to be performed and stepper motor indicating the speed variations. The future scope of this research includes acquiring the information from sensors and then implementing the same using the above concept.

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