

Automatic Speed Control System by the Color Sensor for Automobiles -An Innovative Model Based Approach

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Abstract

Speed control is in the need of the hour due to the increased rate of accidents reported in our day-to-day life. During 2011, in India a whole of 4, 97,686 road accidents were reported which is a result of lack of speed control and violating the road rules. Road accidents can be prevented by adopting measures such as Traffic management, improving quality of road infrastructure and safer vehicles. The existing techniques still doesn't able to reduce the number of accidents. Hence there is a need to implement Intelligent Speed Adaptation (ISA) in which vehicles speed can be automatically controlled by various limit techniques which are based on zones, highway, traffic density etc. In this research work, it proposes automatic speed control system based on color strips for highway road and the roads where the speed control within limit is required. The methodology explains that a various color strips are marked on highway road or the roads where the speed control within limit is required and vehicle will have a color sensor attached which will recognize the color marked on the highway road and accordingly maintain the vehicles speed in that particular limit. In this developed system, the color detecting sensor of specific intensity is used to activate/deactivate the system of speed control within the color strips marked on the road. In actual practice, the system works that when vehicle enter in speed limiting roads like express-high way, high way and any other roads where the speed limit is required etc., the vehicle sensor detect the color to activate the system and send the signals to programmable ECU/MCU and the programmable ECU /MCU controls the position of throttle valve/fuel

pump/motor which result in controlling the speed of engine at given limit. When the system activated then our vehicle is controlled at given limited speed or below that limiting speed and can not exceed beyond that limit till the next color strip crossed. This reduces the road accidents and gets driving comfort for the driver, after implementation of this automatic speed control system.

Keywords: Speed control, road accidents, color detecting Sensor, Programmable MCU, Vehicle, implementation etc.

1. Introduction

Research on fully and partially automated roadway systems is being conducted in most developed countries. The major technologies are unlikely to be introduced before the end of the century and some are unlikely to be implemented within two decades. These systems offer excellent opportunities to control vehicle speeds and movements in order to avoid accidents but they rely, of course, on sophisticated features built into the roadway and vehicle. Progress with these systems should be monitored but they are unlikely to offer any significant short term solutions. But various types of accident are occurred on express highway road, highway road, off road just because of small uncertain activities. Rash driving, system failure, collision due to obstacles, exiting speed control limit etc. are just some causes of accidents. For prevention of this accident, government made some rules. Such as helmet, seat belt compulsion etc. Speed control at particular type of road is also necessary to avoid accidents. For this, there is no any system to control the speed of vehicle. That's why, there is need to invent such system which control the speed of vehicle automatically at given limit at particular limiting distance. If this concept methodology system is possible, the problems related to traffic as well as accidents due to collision will be controlled. Now it is possible to control or set the speed of vehicle at a given limit on the roads like highways, express high ways and any area where the speed limit is desired by the technique suggested in methodology described in this paper. In India mostly 65 km/hr. limit for high ways and below 80km/hr. limit for express highways. This developed system is applicable for any speed limit which can be set or controlled as per the roads. In this paper, the proposed methodology is suggested that one such kind of speed control system based on color strips for highway. The various design components of this system are the color strips which are painted on highway roads and a color sensor located below the bumper on chassis which will recognize the color on roads, the programmable MCU which process signals from various components and send the signal to control the throttle valve/fuel pump, speedometer and vehicle.

2. Concept Methodology

Many accidents are at least partially caused because of rash driving. This can happen due to many reasons: poor judgment on the part of the driver, poor driving by the

driver. Once the driver has lost control it is very difficult to drive the vehicle. So to avoid the road accidents and kept the speed control of vehicles is under government, and also to prevent losing of valuable property, it is necessary to have some safety system which will be the permanent solution for the above problems. Therefore, an innovative concept is suggested by which it can control the speed of vehicle automatically at given limit at particular limiting distance and practically by the developed concept system, the problems related to traffic as well as accidents due to collision will be controlled. In this paper, the proposed developed system is a kind of speed control system based on color strips for highway and where the speed control limit is desired. In this developed system, the various color strips are marked on highway and vehicles will have a color detecting sensor located below the bumper on chassis of vehicle which will recognize the color of color strips marked on roads and accordingly maintain the vehicles speed in that particular limit. In this way, this system reduces the road accidents and gets driving comfort for the driver because of limited speed. The different sources where the automatic speed control system recommended by the agencies are

- Mostly useful to avoid an accidents on turning area/sharp corners in government area (offices), defense / camp area or Residential area, school zones and villages that are located at the highways and beside the highways.
- Some times on zigzag roads speed limit takes place. In such case, also this system plays an important role to avoid accidents.
- On highway roads mostly this system is useful for safe driving and control the traffic problem. It's mostly 65km/hr in India, 80km/hr in the countries like U.S.A., Canada, and U.K.

3. Literature Survey

3.1 Investigations on concept Research

Several road safety literature databases were searched for articles on speed limiting for cars. Very few articles on this specific subject were found. The most advanced research is that being undertaken by the University of Lund in Sweden. The author has sought a status report on this project from Christer Hyden but no response had been received at the time of preparation of this report. Numerous articles were found on other issues related to speeds of vehicles. These are referred to in appropriate sections of this report. The author attended the recent ESV Conference in Melbourne and took the opportunity to seek information about the status of speed control research overseas:

Europe-Claes Tingvall from the Swedish National Road Administration confirmed that the University of Lund is still conducting research on this issue. The Swedes consider that substantial road safety benefits can be obtained by reducing urban traffic speeds. Jean Breen from the European Transport Safety Council is monitoring the work in Sweden. ETSC has identified the role of vehicle factors in speed mode ration as an important road safety issue.

USA-Ken Digges from NHTSA was not aware of any current research in the USA. He called that the issue of speed limiters in cars had been considered more than a decade ago and it got no further than preliminary investigations.

Japan-The paper by the Japanese Ministry of Transport indicates that "maximum speed and power output" are included in the list of items currently being considered in Japan. For many years vehicles in Japan have been required to be fitted with an alarm which activates if the vehicle exceeds 100km/h.

Australia-Several investigations by Monash University Accident Research Unit have identified speed limiters as a possible countermeasure to excessive speeds. The Australian Road Research Board conducted an early investigation of the effects of speed limiters on heavy vehicles. The related research concerns moves to reduce residential speed limits to 50km. In general Australia has much higher residential speed limits than other developed nations. As discussed later, the local speed limit is only one of many factors considered by motorists in judging an appropriate travel speed. Vehicle-based speed control devices might form part of the strategy if lower residential speed limits are introduced. During the conference, several overseas visitors commented that typical urban traffic speeds in Australia appeared to be too high. The literature review tended to confirm this observation.

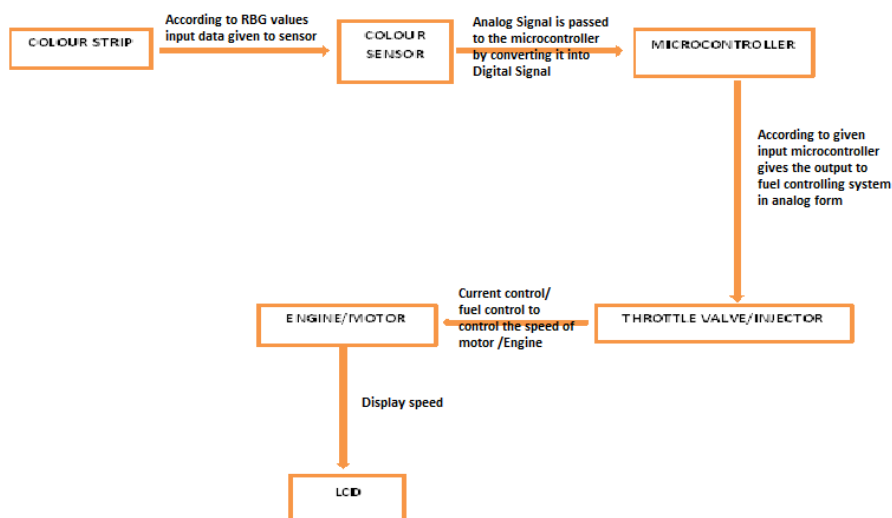
3.2 Sensors

Color sensor-Sensor provides a means for gathering information on manufacturing operations and processes being performed. In many instances sensors are used to transform a physical stimulus into an electrical signal that may be analyzed by the manufacturing system and used for making decisions about the operations being conducted. The purpose of sensors is to inspect work in progress, to monitor the work-in-progress interface with the manufacturing equipment, and to allow self monitoring of manufacturing by the manufacturing system's own computer. Color sensors register items by contrast, true color, or translucent index. True color sensors are based on one of the color models, most commonly the RGB model (red, green, blue). A large percentage of the visible spectrum can be created using these three primary colors. Many color sensors are able to detect more than one color for multiple color sorting applications. Depending on the sophistication of the sensor, it can be programmed to recognize only one color, or multiple color types or shades for sorting operations.

Hall sensor-It has been used in order to calculate speed of vehicle. It works on Hall Effect. It provides output pulse per revolution of bus wheel it will help us to measure the speed of vehicle. The simplest Hall sensor, has inside the Hall element and a differential amplifier. This amplifier must have some special characteristics. The Hall element may produce Hall voltages down to 20 microvolts. Therefore, the amplifier must have very low noise, high input impedance and high gain in order to detect and amplify this micro voltage. The output of the amplifier is usually driven through a The Hall switch and the sensor acts as a switch sensitive to magnetism. It works on Hall Effect. It provides output pulse per revolution of bus wheel it will help us to measure the speed of vehicle.

4. Operating Principle Methodology

It is the system which mainly uses the colour detecting sensor, ECU/MCU for controlling the flow of fuel to the engine using sensors, colour strips painted on the road. In this system, colour detecting sensor of specific intensity is used to activate/deactivate the system of speed control. Colour sensor is located below the bumper on chassis. Hall Effect sensors are located in the vehicle's wheels for the high accuracy measurement of speed of the car. Sensor fusion is applied to the information received by these subsystems, and used to adjust the longitudinal speed of the vehicle with a controller. In practice, when vehicle enter in speed limiting road like express-high way, high way etc., whose speed limit is approximately 80km/hr /60km/ hr/75km/hr etc. respectively, the colour detecting sensor detect the colour of colour strips on the road to activate the system and send the signals to MCU. MCU control the position of throttle valve which result in controlling the speed of engine at given limit. When the system activated then our vehicle is controlled at given limited speed or below that limiting speed and not exceed beyond that limit till cross the next colour strips on the road. In this way, this system reduces the road accidents and gets driving comfort for the driver because of limited speed. Now in this system, When driver wants to turn on highway to off-road at that time to taken off this speed limit it applies same colour strip on this off-road from some specific distance away from highway road because of this some distance, when vehicle enters in the off road, then only this limit is taken out and deactivate the system and our vehicle is work on our normal speed as drivers wish. When our vehicle complete its path on the same highway on normal speed and reaches up to the point where the speed limit zone comes at that point where the same colour strip painted on the roads and again the system activates. Our program installed in MCU is such that when colour detecting sensor detects this colour at one's, it applies speed control limit and again when the sensor detects the colour second times, then it removes speed control limit. Therefore the vehicle after crossing this colour strip second times on the road, it comes on normal speed because of out the limit zone.



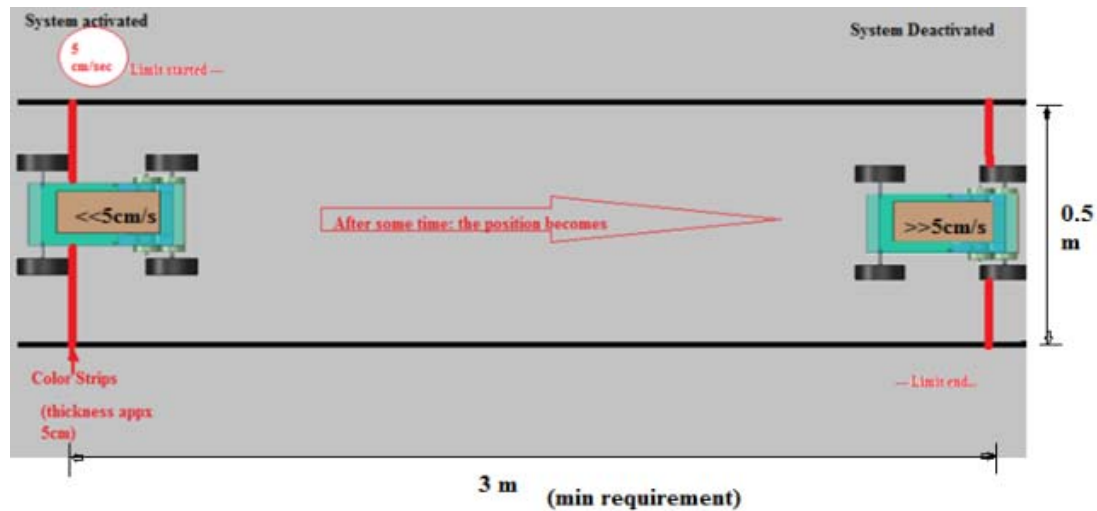


Fig. 1: Working principle and layout of automatic speed control system for automobile vehicle.

5. Design Methodolgy

5.1 Selecting drive wheel motors for mobile vehicles

The different parameters considered in design of drive wheel process for selecting drive wheel motors are

Gross weight of Vehicle (W) = 12 Kg, Radius of Wheel(R) = 5cm, Desired speed (V_{\max}) = 30cm/sec,

Desired acc. time (t_a) = 1 sec. the maximum inclined angle (α) = 2 degrees,

Worst working surface = Concrete (good),

Now, we have, the rolling resistance (R_r) = Weight x Surface friction (C_{rr}) = 0.12, Grade resistance (R_c) = weight x $\sin(\alpha)$ = 0.4188 Kg, Acceleration force = (weight x desired speed)/(grav.Accel.x desired time) = 0.3673 Kg, Therefore, the total tractive effort = $R_r + R_c + \text{Acc.}$ to achieve final velocity = 0.9061Kg.

5.2 Wheel Motor torque Design

In order to find the motor torque, we have the wheel torque = Total tractive effort x radius of wheel x "resistance" factor = 4.9834Kg-cm, (The term "resistance factor" accounts for the frictional Losses between the wheels and their axles and the drag on the motor bearings. Typical values range between 1.1 and 1.15 (or 10 to 15%). Here the designing of motor with consideration of friction coefficient between wheel and ground surface. Now the required torque from the drive wheel(s) to the ground is taken into account for design consideration in order to select the motor torque. The maximum tractive torque, a wheel can transmit is equal to the normal load times the friction coefficient between the wheel and the ground times the radius of the drive wheel. We have maximum tractive torque = weight x μ x R = 24 Kg-cm, μ = friction coefficient between the wheel and the ground (from data book the value for friction coefficient is around 0.4 for plastic on concrete. This total Tractive Effort is equal to

the net horizontal force applied by the drive wheels to the ground. Therefore the required torque applied per drive wheel is 6 Kg-cm. It is required to select the motor having torque more than the torque applied



Fig. 2: Design components of automatic speed control system.

5.3 Design of shaft axle-

In vehicle model, each wheel carries a separate shaft axle.

The different parameters considered for shaft axle design are

The Radius of wheel(R) = 5cm = 50mm, Yield strength = 35ksi = 241.3165 Mpa, Allowable shear stress = 56Mpa, Overhang distance = 32mm, Torque transmitted by motor = 6kg-cm, Weight of vehicle is (W) = 12Kg, Each shaft carried load = 3 Kg, Bending moment (M) = 940.8 N-mm, Torque transmitted (T) = 6 Kg-cm Equivalent twisting moment = $\sqrt{M^2 + T^2} = 1109.44$ N-mm, Equivalent twisting moment = $(\pi/16) \times (\tau) \times d^3 = 1109.44$, the shaft axle diameter obtained(d) = 4.6 mm

The diameter of shaft axle available and from safety point of view is taken as 6mm diameter

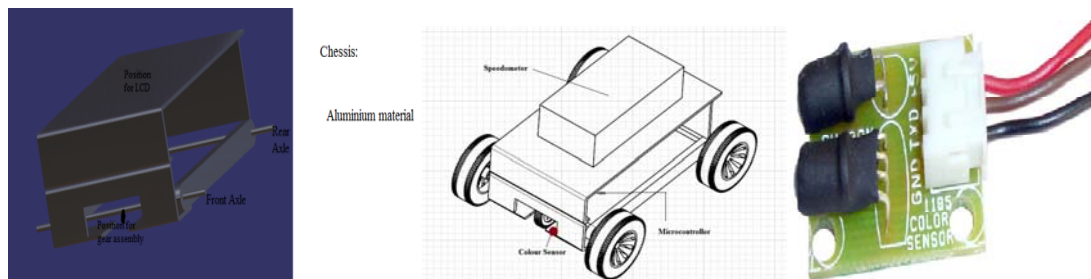


Fig. 3: Chassis design, Vehicle design and colour sensor of automatic speed control system.

5.4 Selection of Colour sensor

This color sensor identifies color and gives serial output of RGB value. It can identify 16.7 million color shades giving RGB value for the detected color. The detected color is identified as amount of three primary color values namely Red, Green & Blue with 8 bit accuracy for each primary color. Any color can be separated or combined into three primary colors Red, Green and Blue using the RGB values. RGB values are a type of UART interface for direct connection to any MCU or USB-TTL convertor.

6. Conclusions

This paper presents architecture for automatic adaptation of the longitudinal speed control of a vehicle to the circumstances of the road which can help to decrease one of the major causes of fatalities: the excessive or inadequate vehicle speed. Our approach is based on a combination of different sensor technologies: The proposed on-board architecture is portable and easily adaptable to any commercial car with minimal modifications. By this system, our approach is to control the speed of vehicle at limiting road area to avoid the accidents. The accidents and rash driving can be reduced up to 80 % and can save many lives and many valuable properties. In the empirical trials in our installations, the vehicle's speed was successfully changed as a result of the detection of the signals, increasing the driver's safety. The technology developed can assist human drivers in difficult road circumstances. By using this system, it can be reduced the rash driving within cities, within the regions of school zones, villages that are located at the highways and beside the highways.

7. Acknowledgements

Authors are grateful to the Principal, Govt. College of Engineering and Research, Awasari (Kh), Dist: Pune and teaching staff, Mechanical Engineering Department, for needful support and encouragement to carry out this work.

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