Design of Automobiles speed control system using RFID

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Abstract- *This paper presents a robust and reliable model for speed control in vehicles using the Radio-frequency identification technology. This system is used for accident prevention by taking control of the vehicle in accident prone zones near schools, office buildings, hospitals and construction sites etc.,. The speed of the vehicle will be automatically controlled on entering the zone and full control will only be transferred to the driver once the vehicle passes the zone. A display can be fitted on the dashboard which is used to convey the activities of the controller to the driver. To determine the functionality of this system, a basic model of a line following robot has been fitted with an RFID reader module and the system is tested for any errors shown during the working of the RFID.*

Keywords—*RFID, Speed control, sensor system, Automobiles*

I. Introduction

Road transport has been a major concern in the ever developing world. This can be proved by the statistics presented by the Association of Safe International Road Travel (ASIRT). According to them, road traffic crashes rank as the 9th leading cause of death and account for 2.2% deaths globally. These amount to USD $518 billion globally, costing individual countries from 1-2% of their annual GDP. They also predict that unless action is taken, road traffic injuries can become the fifth leading cause of death by 2030.

To increase road safety, Advanced Driver Assistance Systems (ADAS) have been developed. These are designed to avoid collisions and accidents by alerting the driver to potential problems or by taking control of the vehicles. One of the major ADAS is the Cruise Control system and its advanced version, the Adaptive Cruise Control (ACC) system designed to maintain a constant distance from the vehicle in front. A major limitation of this system is that it cannot distinguish between a straight and a curved path, where the speed has to be lowered to avoid collision. To combat this, curve warning systems (CWS) have been developed that use global positioning systems (GPS) and digital maps obtained from a Graphical Information System (GIS), to assess the threat levels for a driver approaching a curve too quickly.

Another such system is the traffic jam assist system which takes over the longitudinal and lateral guidance of the vehicle. This means that the vehicle can accelerate and brake automatically, as well as steer the vehicle within certain constraints. The driver can take over the system at any point of time. Traffic Jam Assist is based on the sensors and functionality of the adaptive cruise control with stop and go and lane keeping support, extended by adding electromagnetic steering. The traffic jam assist continuously analyses the speed of the surrounding vehicles and compares it with its own driving speed. If the system detects dense traffic or a traffic jam, the driver can activate the system. The vehicle will now automatically follow the vehicle in front and takes over the control of the vehicle. In this way, the system is able to react when an empty lane is formed.

However, these systems when used individually cannot provide the functionality necessary for automatically guiding the vehicle in situations like accidents, road diversions and roadwork. All these functions can be performed using the Radio-Frequency (RF) based technology which is the key concept presented in this paper. The main idea of this system is to tag sign boards and warning boards with an RFID tag. These tags can be detected by an RFID card reader which is attached on the vehicle and the information contained in these tags is decoded by the reader. This information is then presented to the driver who can manually perform the necessary function or the vehicle will perform that action itself. This ensures that the driver is aware about the impending collision before the vehicle takes action.

The main advantage of this system is that during poor visibility (insufficient light, difficult weather conditions or blocking of line of sight by other vehicles) RF signals are still transmitted reliably. Other sensors may not be able to function in such conditions. High frequency radio waves can also penetrate through other vehicles and objects which come between the RFID tag and the reader. This system also prevents the sole reliability on traffic lights and signboards to which the driver may not even heed at times. It can also be used as an excellent alternative to speed bumps which can be difficult for the driver to see at night. Another advantage of this system is to prevent the constant monitoring of crowded areas by traffic officials. These can be especially useful in town centres and market places where there are inevitable traffic jams and eventually road mishaps.

RFID technology has been gradually incorporated in commercial vehicles over the past few years. RFID based toll collection systems on highways are being employed in many countries such as the Telepass system in Italy or the Autopass system in Norway. Here the vehicle is assigned an RFID tag at the time of registration. The unique id for the tag will be feasible for only the vehicle to which it has been assigned. Another such system is the traffic control system where each lane on the road has an RFID reader to track the vehicle passing through it and each intersection has 8 RFID readers. Each intersection point has its own database to store the information regarding the vehicles that passed from it and the timestamp and traffic light. The RFID enabled device stores a unique vehicle identification number (VIN). This number can be used to identify the vehicle and its owner.

II. DESIGN METHODOLOGY

This section illustrates our project which aims to model a speed control system using the RFID technology on a basic line follower robot. The design and model of this robot have greatly helped us understand how this system can be implemented in a vehicle.

A. *Sensor System*

An RFID system consists of a set of tags which periodically transmit radio signals. These signals contain a unique identification code for the tag as well as some data stored in the tag's memory. This data is received using an RFID card reader which is to be fitted in the vehicle. Besides reading the tag ID, the card reader will also measure the received signal strength of the radio frequency signal. This indicates the range of the tag from the card reader.

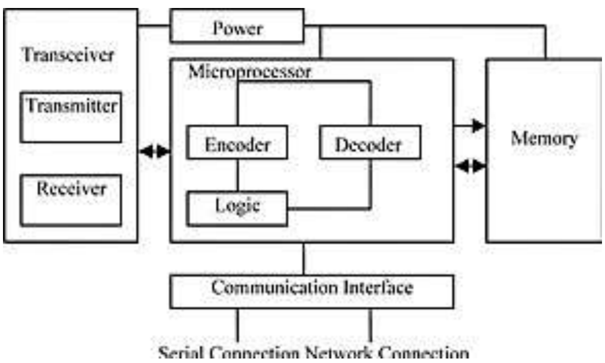

Fig 1. Block diagram of the RFID sensor system

The block diagram shown above (fig.1) demonstrates how the RFID tag (transmitter) and the card reader (receiver) communicate. The transmitter and receiver are together known as the transceiver. This receiver end of the transceiver is connected to the microcontroller (ATmega 8 microcontroller) of our robot. The encoded signal from the transmitter is first decoded in the microcontroller and the microcontroller then sends the decoded signals to be displayed on the LCD and to the motors to control the speed of the robot.

The signal range of the tags used in the project is less than 3 feet. But, this range can go from 15 -20 feet using an ultra-high frequency transponder. This range corresponds to passive RFID tags. For active tags the signal range can increase up to 100m. The only disadvantage in using active RFID tags is that these require a separate power supply unit to operate. Due to this, active tags can generate signals even when there is no card reader in range. While passive RFID tags are initialized only when a card reader is in range. The reader sends out electromagnetic waves which induce a current in the tag's antenna.

Tags may either be read-only which have only a factory assigned identification number or may be read/write where object specific data can be written into the tag by the user. These are write-once, read-multiple type tags. The blank cards may be written with an electronic product code by the user. We have used read-only tags which only contains the tag ID number.

The encoder shown in the figure is used when a read/write type of RFID tag is used. It is used to encode data in the tag.

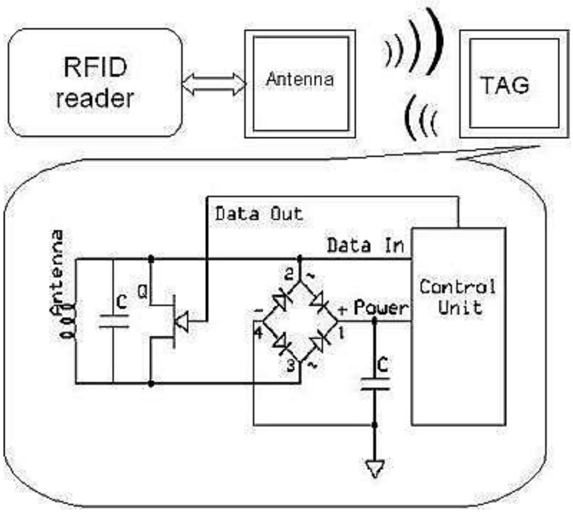

Fig.2 Circuit diagram for RF sensor

The figure (fig.2) shows the circuit diagram of a basic RFID tag. A basic tag consists of 2 parts: an integrated circuit for storing and processing information, modulating and de-modulating a radio frequency signal, collecting power from the reader and other specialized functions, and an antenna for receiving and transmitting signals. The tag information is stored in a non- volatile memory. The main advantage of RFID system with respect to other such technologies is its low production and maintenance cost which makes the system highly scalable. Their lifetime is also higher compared to other systems and can easily last up to five years. There have been many developments in this technology over the past two decades and only recently it has started to be implemented in road transportation, some examples of which have been stated above (last paragraph of the introduction).

B. *Components used:*

1. 2 RFID tags
2. An RFID card reader
3. ATmega 8 microcontroller unit connected to a line follower robot.
4. Liquid Crystal Display (LCD)

C. *Working:*

During testing of the system, the 2 RFID tags are fixed on separate poles and are placed about 3m apart. The robotic unit containing the card reader and the LCD is programmed to start moving a few meters before the first pole.

When the card reader comes in range of the first tag, it activates the tag and the radio-frequency signal containing the unique ID of that tag is transmitted to the reader. The signal is then sent to the microcontroller to be decoded. The decoded signal corresponds to the information regarding the decrement of the speed of the robot. The microcontroller then sends a signal to the motors which slow the speed of the robot. The microcontroller also sends a signal to the LCD to display the information "Slow down". This information can be displayed to the driver when we use it in an actual vehicle. It provides the driver with the option to decrease the speed of the vehicle manually.

When the card reader encounters the signal of the second tag, the speed of the robot is increased and the information "You may resume control" is displayed. This information can inform the driver that control of the vehicle has been transferred back to him. He may increase the speed at that point. The unique ID number which has been pre-assigned to each tag helps the robot to know what action to take. The user can program the robot using these ID numbers.

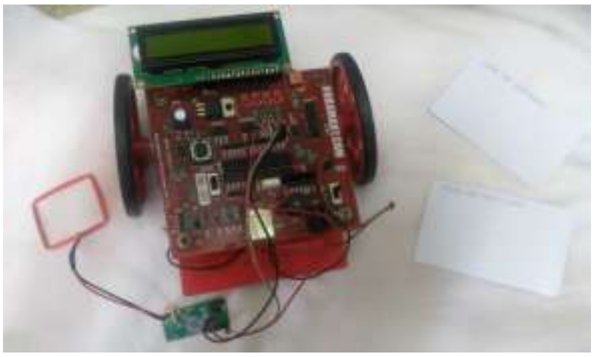

Fig.3. Robot Model

Our completed robotic model is shown in the above figure (fig.3) along with RFID tags (placed on the right side of the robot) and the RFID card reader with its antenna (placed on the left).

III. IMPLEMENTATION

This section deals with the implementation of the RFID system to control the speed of an actual commercial vehicle. It gives information regarding which actuators in the vehicle have to be automatically controlled to limit the speed of the vehicle.

A. *Concept of speed control in vehicles*

Normally, the speed of the vehicle is varied according to the pedal position of the accelerator. The difference in the previous and current pedal positions is fed to the Electronic Control Unit (ECU) of the vehicle which is the main microcontroller unit in the vehicle to keep track of the engine performance. The ECU then determines the position of the throttle based on the two pedal positions and the inputs received from other sensors. The adjustment in the throttle position leads to the change in the automobile speed. This type of speed variation system is used in normal automobiles which do not have RF based system. The hardware scheme of this system is shown below (fig. 4).

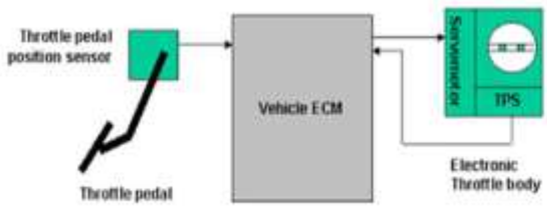

Fig 4. Hardware Scheme in Normal Automobiles

However, in the proposed vehicle speed control model, the accelerator pedal position is fed to a microcontroller unit (similar to a microcontroller used in the robot) and is then given to the Electronic Control Unit (ECU). The hardware scheme of this system is shown below (figure 3.2). There are 2 modes of operation of this system, normal mode and active mode.

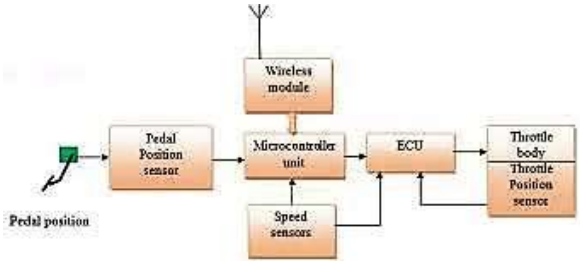

Fig 5. Hardware scheme of the proposed system

B. *Working:*

i. Normal Mode:

The vehicle is in normal mode of operation when the vehicle is out of the speed control zone (the zone between 2 RFID tags where the speed is automatically controlled). The microcontroller unit does not operate during this mode. The automobile receives the pedal position value from the position sensor connected to the pedal. This data is transferred to the ECU. In the ECU, the inputs from other sensors like the Throttle Position Sensor (TPS), Manifold Air Temperature Sensor (MAT), Mass Air Flow Sensor (MAF), Manifold Absolute Pressure Sensor (MAP) and the Oxygen sensor are also received. When the accelerator pedal is pressed, the new pedal position is compared with the throttle position from the TPS. The error signal generated by the ECU is then used to actuate the motor connected to the butterfly valve (throttle). Using this the speed of the vehicle can be increased or decreased depending on the error signal generated. The vehicle speed control operation in the normal mode is shown below (fig 6).

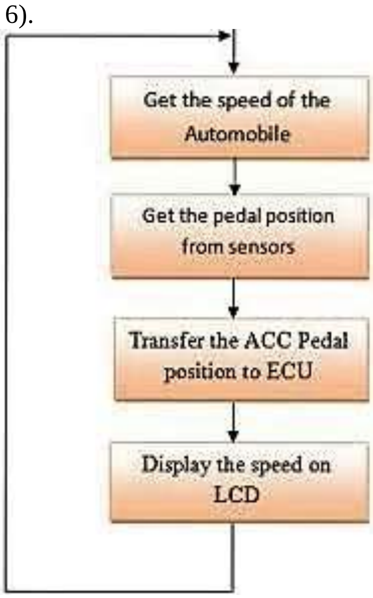

Fig 6. Flowchart scheme for operation in normal mode.

ii. Active *Mode:*

In the active mode of operation, the microcontroller unit continuously studies the speed of the vehicle. To control the speed of the vehicle according to the speed limits a fuzzy logic system has been developed. If the speed of the vehicle is above the maximum speed limit, then the microcontroller will send out a digital signal to the ECU such that the speed of the vehicle will be decreased. When the accelerator pedal is moved to increment the speed, the microcontroller calculates the speed that would be reached on this new pedal position. If the speed is greater than the maximum speed limit then it denies the excess speed and gives the appropriate signal to the ECU.

IV. RESULTS AND DISCUSSION

The tests on our robotic model have successfully shown that the robot slows its speed on encountering the first tag and increases its speed when it passes the second tag. We have also calculated the time period of an actual vehicle while it is in the range of the RFID transmission signal. For our study, we have considered an ATmega 8 microcontroller which operates at a frequency of 16 MHz and an RF based transceiver (AT86RF230) which operates at 2.4 GHz frequency. Its range is 30m and it can operate in the temperature range of -40 to 85 degree Celsius.

Initially, the transmitter (RFID tag) will be in the transmission state or the sleep state and the receiver is in receiving state. Let's say that our vehicle equipped with the card reader and microcontroller is travelling at a speed of 120 km/hr. When it comes in the range of the transmitter (RFID tag), the signal from the transmitter is detected by the receiver. This signal is decoded in the microcontroller and the decoded signal is then sent to the ECU where the actual speed control takes place (as explained in the previous section). Once the receiver receives the signal, it goes from the receiving state into sleep state and the vehicle enters active mode.

From the above considerations, we can calculate the time period during which the automobile will be in range of the tag. It can be computed using the formula,

Distance=Speed*Time

So, the time period for the above range and speed comes out to be 0.9 seconds i.e. 900 milliseconds. Using this formula, we can calculate speeds at different ranges of the RFID sensor and different vehicle speeds. The following graph (figure 4.1) shows the time period for 3 different vehicle speeds, 100 km/hr, 120 km/hr and 150 km/hr.

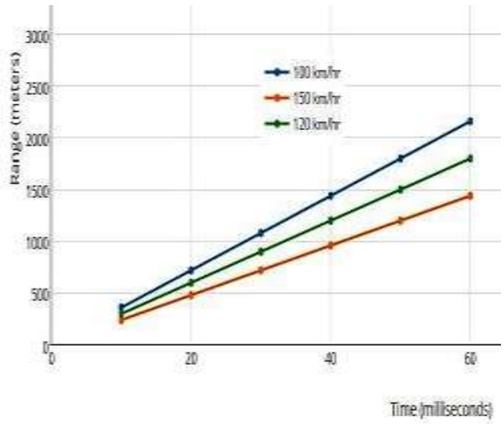

Fig 7. Time vs. Range graph for different vehicle speeds.

V. CONCLUSIONS AND SCOPE FOR FURTHER RESEARCH

In our study, we have presented a reliable model for speed control in vehicles. This system can be easily implemented on commercial vehicles and has a large number of applications. One of its uses is in the automobile sector where it can be used to increase road safety. We have explained about this application in detail in the paper.

We have developed a robotic model for testing this system and implemented it theoretically in a vehicle. Other vehicular applications of this system are toll collection systems on highways. These are being currently deployed in countries like Norway and Italy. This system can also be used in traffic light areas and can prevent constant monitoring of crowded areas.

So, there is a lot of scope for implementing this system in roadways not only in developed countries but also in the developing and underdeveloped world as it is very cost effective and requires less maintenance than other comparable systems. There is also scope for further research and development in the system making it more convenient for commuters at night. A clock system can be introduced which can help to bypass the automatic speed control system at night when there are lesser chances of accidents in certain areas like schools and construction sites.

REFERENCES

[1] Road Crash Statistics. Available online: www.asirt.org/initiatives/informing-

[2] road-users/road-safety-facts/road-crash-statistics

[3] www.products.boch-mobility-solutions.com/en/de/driving_comfort/driving_comfort_systems_for_passenger_cars_1

[4] www.microwavejournal.com/articles/5271-modern-rfid-reader

[5] www.electronics.stackexchange.com

[6] AT86RF230 data sheet. Available online: www.atmel.com/images/doc5131.pdf

[7] Joshue Perez Rastelli, Fernando Seco, Vicente Milanes, Antonio Jimenez, Dıaz Julio C., et al.. An RFID-Based Intelligent Vehicle Speed Controller Using Active Traffic Signals. Sensors, MDPI, 2010. <hal-00737405>.

[8] Nellipudi. Siva Rama Krishna Prasad, Arepalli Rajesh. RFID- based Hospital Real Time Patient Management System. International Journal of Computer Trends and Technology. Volume 3 Issue 3- 2012.

[9] Seda Yildirim, Kenan Aydin. A Qualitative Study on Perspectives of Retailers about RFID System in Turkey. International Journal of Computer Trends and Technology. Volume 19 Number 2-2015.

[10] U. Jyothi Kameswari, M Satwik, A Lokesh, G Venkateswara Reddy. A design model for automatic vehicle speed controller. International Journal of Computer Applications (0975-8887). Volume 35-No. 9, December 2011.

[11]. Manjunath Chincholi1, Dr. K. Chandrashekara2. Design & Analysis of Vehicle Speed Control Unit Using RF Technology. International Advanced Research Journal in Science, Engineering and Technology. Vol. 2, Issue 8, August 2015. ISSN(Online) 2393-8021