Design and Implementation of ARM Based Vehicle Automation for Legal Safety

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***Abstract*-- Automation will reduce the congestion on highways. Recently most development in automation for safe driving on vehicles. The proposed system developed based on traffic rules. It will make vehicle as fully automated driving with environmental aspects. The safety is provided by distance measuring from obstacle, obstacle avoidance by path changing. The use of RF module would be significantly increased if the vehicle speed could automatically adapt to traffic flow. The system predicts the obstacle and measuring distance of the obstacle, which is predict road signs to control the speed of vehicle. The collision avoidance system predicts accurately the likelihood of an imminent collision. If a collision is likely to occur, then the system responds in such a way as to reduce the threat and the response may involve the automatic control of the vehicle or simply an appropriate warning to the driver.**

Keywords: **Automation vehicle, Highway driving Collision Avoidance system.**

I. INTORDUCTION

VEHICLE automation is proposed as one of the solutions that will make transport safer, more comfortable, and more environmentally friendly [1]. Autonomous driving can currently be demonstrated, with highly equipped vehicles under human supervision.

Two main strategies for going towards autonomous vehicles can be distinguished. Vehicles on the DARPA Challenge [3] and CyberCars [4] now already offer a complete automation of the driving task on a private infrastructure through extensive high-tech equipment. For economical, legal and psychological reasons the alternative approach chosen by most car manufacturers is the step-bystep introduction of simple driving assistance systems which collaborate with the human driver for driving on public roads.

The latter approach is followed by European 7th Framework Programme (FP7) project HAVEit, which proposes an interaction scheme between driving system and the human driver along different automation modes [5][6][7] and the French National Research Agency (ANR) project ABV.

For economical, technical, legal, and psychological reasons, vehicle automation is not directly brought to market. It is incrementally introduced through advanced driver-assistance systems (ADASs) such as adaptive cruise control (ACC), intelligent speed adaptation (ISA), lane-keeping assist systems (LKAS), and lane-change decision aid systems [4]–[5].

A model that reduces accidents on the road and preserve the lives of human beings especially children and the old people. The system consists of Radio Frequency (RF) transmitter and receiver to set the limit speed. The speed of the automobile is continuously monitored and it is given to the embedded system [8].

The proposed system consist several automation system. These automation system does not supervising by driver. It will fully automate and any time takes over control to the human driver. This paper is organized as follows: The section 2 legal safety which discusses the basic traffic rules, section3 discusses the system architecture and presents the perception and control requirements., section 4 presents the system implementation on automotive, section 5 results and simulation and section 6 conclusion and future work.

II. LEGAL SAFETY

The legal safety concept describes basic traffic rules and driving rules. The proposed system designed to follow traffic rules for safe driving.

Rule 1: Drivers must drive their vehicles on the left side of the road.
Rule 2: Drivers shall use the stipulated hand signals or vehicle indicators to indicate slowing down, stopping, turning or overtaking.

Rule 3: Drivers must follow lane discipline. If turning to the left, the vehicle must be in the extreme left lane of the road and vice versa.

Rule 4: Overtaking of another vehicle moving in the same direction must only be done from the right side of that vehicle.

Rule 5: Speed must be adapted to road and weather conditions (e.g., visibility and road friction), speed limit signs, and the presence of other vehicles. The distance between vehicles must be such that a collision can be avoided if a vehicle performs an emergency brake. Drivers also must be able to avoid collisions with any foreseeable vehicle outside their perception zone.

Rule 6: The lighting of the vehicle should be adapted to visibility conditions.

Rule 7: Braking should only be performed for safety reasons and must be indicated with braking lights.

Rule 8: Only motor vehicles are allowed on highways. Vehicles shall not travel in reverse or in the opposite direction. Vehicles on the highway have priority over vehicles entering. If the vehicle needs to be stopped for a technical reason, this must be done on the emergency lane, if possible.

III.PROPOSED SYSTEM

System Architecture:

The architecture of automation system is shown in Fig.1. This will imitate driving system function with perception, decision and control components. The perception component gives an environment description (lanes, traffic signs, and objects) based on sensors. The decision component predicts object trajectories and calculates an optimal subject trajectory according to traffic rules.

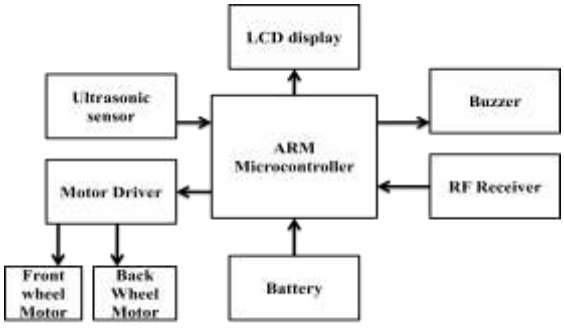

Fig 1. Architecture of Automation System

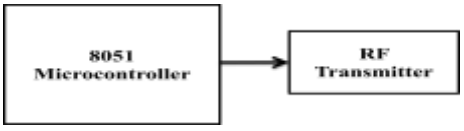

Fig 2.RF transmitter with Controller(Speed control module)

The perception component captures environmental aspects such as lane and object. All information transferred into control unit of the system. The control unit takes decision about action to vehicle. The sensor detects the obstacle and the decision component predicts object trajectories and calculates an optimal subject trajectory according to traffic rules.

Rule 5 requires the perception of traffic signs, i.e., speed limits, overtaking prohibitions, and lane closures. Both the content and distance of traffic signs are required. Traffic sign recognition by RF module [ ]. Rule 5 also demands adapting the vehicle speed to the road friction.

The main control component ARM controller which is high speed controller to control action of vehicle based on data the receiving from the road sign, control by 8051 controller.

The fig 2 Transmitter with controller, consist speed limit of particular road sign and related data which send to the receiver of the control unit. The vehicle speed controlled based on the received data of the road sign. RF transmitter and RF Receiver transmitting/Receiving data using Wireless communication.

The LCD and Buzzer connected to the control unit which indicate road sign such as hospital zone, crowed zone, No parking area.

IV. SYSTEM IMPLEMENTATION

A. Hardware Implementation

ARM LPC2148:

The architectural simplicity of ARM processors has traditionally led to very small implementations, and small implementations allow devices with very low power consumption. The ARM is a *Reduced Instruction Set Computer* (RISC).

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty.

Obstacle Detection And Avoidance:

A common use of ultrasound is for range finding. This use is also called sonar. Sonar works similarly to radar. An ultrasonic pulse is generated in a particular direction.

If there is an object in the way of this pulse, the pulse is reflected back to the sender as an echo and is detected. Measuring the difference in time between the pulses transmitted and the echo received.

Distance of object= (T× speed of sound) ÷2

Three different properties of the received echo pulse may be evaluated, for different sensing purposes. They are:

- Time of flight (for sensing distance)
- Doppler shift (for sensing velocity)
- Amplitude attenuation (for sensing distance, directionality, or attenuation coefficient)

In reflection mode (also known as "echo ranging"), an ultrasonic transmitter emits a short burst of sound in a particular direction. The pulse bounces off a target and returns to the receiver after a time interval **t**. The receiver records the length of this time interval, and calculates the distance travelled **r** based on the speed of sound **c**:

$$r = c * t$$

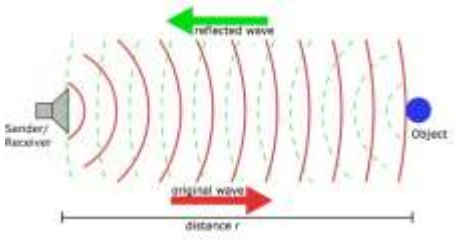

Fig 3. Reflection mode of sensor

RF module:

This radio frequency (RF) transmission system employs Amplitude Shift Keying (ASK) with transmitter/receiver (Tx/Rx) pair operating at 434 MHz. The transmitter module takes serial input and transmits these signals through RF. The transmitted signals are received by the receiver module placed away from the source of transmission.

The system allows one way communication between two nodes, namely, transmission and reception. The RF module has been used in conjunction with a set of four channel encoder/decoder ICs.

Here HT12E & HT12D have been used as encoder and decoder respectively. The encoder converts the parallel inputs (from the remote switches) into serial set of signals. These signals are serially transferred through RF to the reception point. The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs. These outputs can be observed on corresponding LEDs.

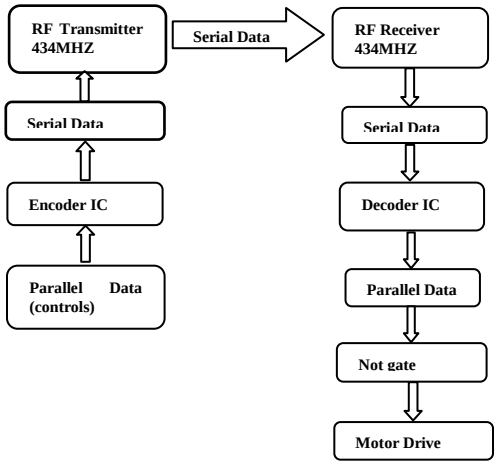

Fig 4. RF Module Communication and data transmission

The parallel signals generated at transmission end are first encoded (into serial format) by HT12E and then transferred through RF transmitter (434 MHz) at a baud rate of around 1-10 kbps. The same signals are acquired by RF receiver after which it is decoded by HT12D. For more details, refer RF remote control.

Since the encoder/decoder pair used here works on negative logic, the decoded signals are fed to an inverter (NOT gate) IC 74LS04. The proper (inverted) signals are then supplied to L293D. L293D contains two inbuilt H-bridge driver circuits to drive two DC motors simultaneously, both in forward and reverse direction.

Road sign perception

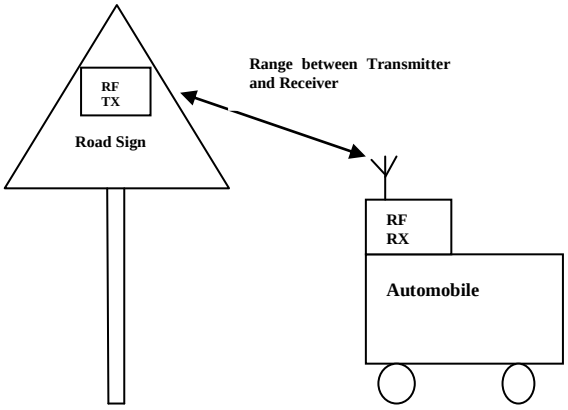

Fig 5. Road sign perception to Adaptive speed control

The RF transmitter can be placed on an existing road sign to transmit the information provided by signals placed on the road to adapt the vehicle's speed. Once the information is received from the RF TX, the vehicle's Electronic Display Controller automatically warns the driver, to reduce the speed according to the traffic sign indicated by the TX. It waits for few seconds for the driver's response to the information received; otherwise vehicle's EDC unit automatically reduces the speed.

Motor:

Electrical DC Motors are continuous actuators that convert electrical energy into mechanical energy. The DC motor achieves this by producing a continuous angular rotation that can be used to rotate pumps, fans, compressors, wheels, etc. As well as conventional rotary DC motors, linear motors are also available which are capable of producing a continuous liner movement.

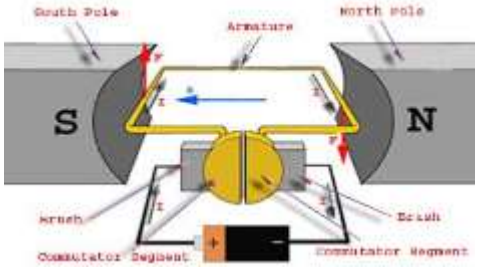

Fig 5. A Basic construction of DC motor

DC motors consist of one set of coils, called armature winding, inside another set of coils or a set of permanent magnets, called the stator. Applying a voltage to the coils produces a torque in the armature, resulting in motion. A DC motor in simple words is a device that converts direct current(electrical energy) into mechanical energy.

The operating principle of DC motor**,** its important that we have a clear understanding of Fleming's left hand rule to determine the direction of force acting on the armature conductors of dc motor. Fleming's left hand rule says that if we extend the index finger, middle finger and thumb of our left hand in such a way that the electric current carrying conductor is placed in a magnetic field (represented by the index finger) is perpendicular to the direction of electric current (represented by the middle finger), then the conductor experiences a force in the direction (represented by the thumb) mutually perpendicular to both the direction of field and the electric current in the conductor.

Motor driver

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

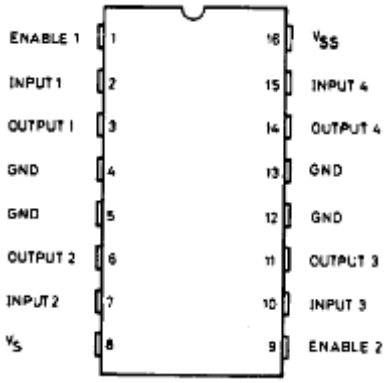

Fig 7. L239D Pin out

B. Software Implementation

Keil Software:

Keil Micro Vision is free software. It is an integrated development environment (IDE), which integrated a text editor to write programs, a compiler and it will convert your source code to hex files too.

The µVision2 IDE is a Windows-based software development platform that combines a robust editor, project manager, and makes facility. µVision2 supports all of the KEIL tools for the 8051 including the C compiler, macro assembler, linker/locator, and object-HEX converter.

Keil provides a broad range of development tool like ANSI C compiler, macro assembler, debugger and simulators, linkers, IDE, library manager, real-time operating systems and evaluation board for intel 8051,Intel MCS-251, ARM families.

Keil's µVision IDE and Debugger combines project management, make facilities, revision control, source

code editing, target program debugging, device simulation and Flash programming in a single fully-integrated environment.

Proteus Software:

Proteus is one of the most famous simulators. It can be uses to simulate almost every circuit on electrical fields. It is easy to use because of the GUI interface that is very similar to the real Prototype board. Moreover, it can be used to design Print Circuit Board (PCB).

Proteus Professional design combines the ISIS schematic capture and ARES PCB layout programs to provide a powerful, integrated and easy to use tools suite for education and professional PCB design.

V.RESULTS AND SIMULATION

The system developed with traffic rules, intelligent obstacle avoidance and vehicle speed control based on the road signs using RF signal. The Hardware Implementation of vehicle with automation system shown in fig 8. The model of vehicle is developed with sensor and RF module. The sensor enabled when vehicle starts moving which sense the path of vehicle continuously. If any obstacle in the path of vehicle will be detected by sensor and measuring distance of the obstacle is indicating by LCD display to user. The vehicle automatically changes from obstacle path to safe path.

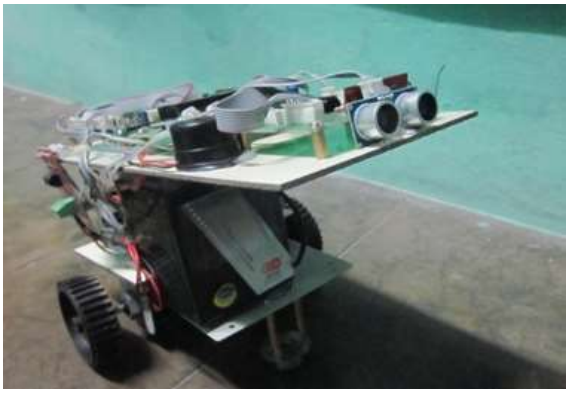

Fig 8. Implementation of hardware model of vehicle

The figure 9 shows the implementation of RF Transmitter module which consist control unit with encoder section. The transmission section sends encoded data information related to the Road Sign such as speed limit, Speed Breaker. The data transmitted through wireless communication using Radio Frequency.

Fig 9. Implementation of RF Module

The RF module is used to indication of road signs as warning through display and buzzer sound. The vehicle speed is controlled automatically by receiving data from RF module such as hospital zone, school zone and speed breaker.

The Simulation result of the automation system with obstacle Avoidance has shown in fig 10. The Sensor and motor is interfaced with ARM Controller, when the obstacle is detected motor will be stopped and distance of the vehicle is displayed in LCD.

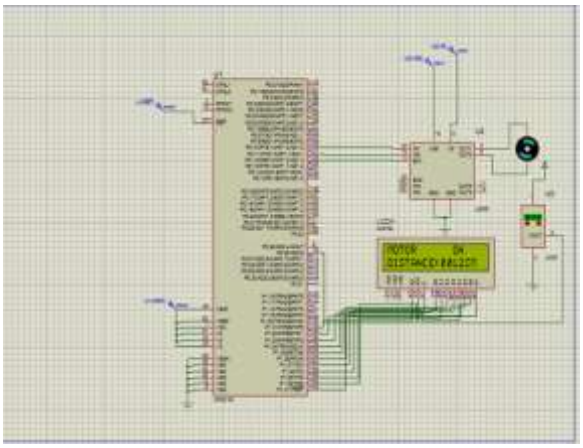

Fig 10.Simulation Result of Obstacle Avoidance

The simulation result of automation system with RF Communication showed in fig 11 .The RF module communicating to controller unit using wireless communication for controlling speed of vehicle. RF transmitter operated by radio frequency which send the data about road signs and speed limit related to signs. In this figure, RF Transmitter has shown in top- left and RF Receiver is interfaced with ARM controller. It includes also LCD Display and Motor.

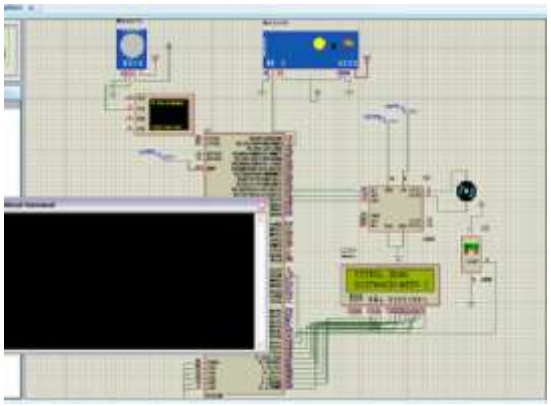

Fig 11. Simulation of road sign indication

When the road sign information is received using radio frequency, control unit adapt speed of vehicle based on information. The warning indication to user by LCD display and buzzer.

VI. CONCLUSION AND FUTURE WORK

This project is developed for avoiding accidents and safe driving. This paper discusses the automatic obstacle avoidance and perception of road sign for safe driving. Obstacle is detected by sensor module which informs to control unit to avoid obstacle based on measured distance of obstacle. The use of RF module would be significantly increased if the vehicle speed could automatically adapt to traffic flow and road signs. The simulation results show the automation during is achieved for some part.

The future work of this system can add with Lane Keeping system and Adaptive Headlight. The Lane Keeping system is used to maintain the lane path of vehicle with stability .The Adaptive Headlight concept describes light intensity will adapt with weather condition. The GPS system can use to get the information of navigation and mapping.

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