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Advanced Adaptive Cruise Control System

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Abstract: Advance Adaptive Cruise Control technology (AACC) has a critical role in the development of active safety systems for vehicles. There are other various technologies like Adaptive Cruise Control (ACC), Cruise Control (CC), Blind Spot Detection, etc. All these technologies too are the technology of autonomous driving. Therefore, during the development of these technologies using a system of system (SOS) control approach would help both decreasing the costs and unifying all these technologies under autonomous driving.[1] The main reason for the accident is Over-speeding. Driver's push the car to their limits to reach a destination. So, a system that can check for mile markers and control the speed according to the speed limit would also avoid an accident taking place. In recent years, road accidents have significantly increased due to driver's fatigue ness as well. Due to continuous and longtime drives, the driver gets exhausted and drowsy due to continuously sitting in the same position, which mainly leads to accidents. Therefore, there is a need for a system that can detect the driver's face and check for fatigue ness and alert the driver whenever he/she feels drowsy. Even after taking precautions and notifying the driver, yet if an accident takes place on a route where there is very little transportation/traffic, it is likely to happen that it will be late for the information to reach for the paramedic ambulance. Therefore, for the ambulance to reach soon at the location, we propose a system in both the individual's vehicle after receiving a certain amount of impact, it'll send the car's information to the nearest ambulance in that area using the GSM module.

I. INTRODUCTION

Advanced Adaptive Cruise Control technology (AACC) is regarded as a key component of future generations of intelligent cars. The impact driver's & passenger's safety and convenience as well as increasing road capacity by maintaining optimal separation between vehicles and reducing driver errors.

The ACC gives an idea of the sonar sensor technology used wherein the vehicle can be controlled from collision by forcing on brakes or using throttles. This sonar sensor senses the distance between the primary vehicle and secondary vehicle and maintains that distance to avoid any collision. If the distance between the two vehicles is closing in, the primary vehicle slows down its speed and matches the speed with the secondary vehicle, and maintains the set distance between the two.

The second feature we would like to introduce in our AACC feature is to stop the vehicle from over-speeding. Speeding has become one main reason for accidents happening in our country. For this, we propose a system wherein the receiver reads the distance specified along the roadside on the mile marker and sets its speed accordingly, and doesn't allow the car to go over the limit even after pushing on the throttle.

II Methodology

The ultimate goal of this work is to reduce the speed of the vehicle while violating the traffic signal rules and also prevent accidents by using an ultrasonic sensor. The Arduino Uno is used extensively across all blocks.[2] *Arduino* is an open-source microcontroller-based kit for building devices that can be extensively used in the digital world and interactive things to sense and control physical devices. Arduino is based on a microcontroller board design to implement various functions. It consists of digital and analog input/output (I/O) pins that can interface with various external boards and other circuits. The Arduino provides an integrated development environment (IDE) based on a programming language such as C and C++.

WHAT IS AN AUTONOMOUS VEHICLE?

There are several types of autonomy in the car.

Type 0. It does not have any computer control system.

Type 1.The vehicle has various elements to facilitate its driving, such as cruise control, parking assistance, or traffic assistance. Many ordinary cars are equipped with this type of facility, and it has to be emphasized that it does not make them work on their own. This is a basic first step towards the autonomous vehicle.

Type 2. The car can drive on its own for a while, but the system is unreliable to some extent that it requires continuous control from the driver. The driver has the responsibility to monitor everything that happens on the road and take actions accordingly

whenever needed.

Type 3. Here the driver is also obliged to constantly watch, but the control system is a bit more independent on its own. On the highways or freeways road sections, it can drive the vehicle by itself.

Type 4. The car drives by itself, without the driver's participation, but is unable to cope with all conditions (e.g., weather conditions). Sometimes it may be necessary to drive manually under some circumstances, therefore a driver is still required in the vehicle.

Type 5. It is only at this level that we can talk about full autonomy. Passengers can ride in the back seat of the car can be sent empty - without the risk that it cannot cope with the existing road and weather conditions.

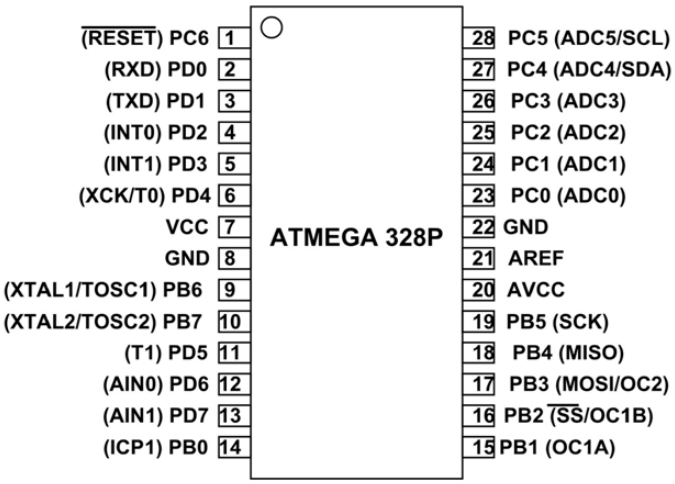

Figure 1: Pin Diagram ATMEGA 328P[2]

Arduino Uno could also be a microcontroller board supported by the ATmega328P. It has 14 digital pins, 6 analog input pins, and quartz having 16MHz frequency, a USB interfacing facility, an In-Circuit Serial Programming header, and a push-button. It supporting the microcontroller to simply connect it to a computer system with a USB cable or AC-to-DC adapter.[2] Arduino Uno has a large number of facilities to interface with a computer system, another microcontroller, or other Arduino boards.

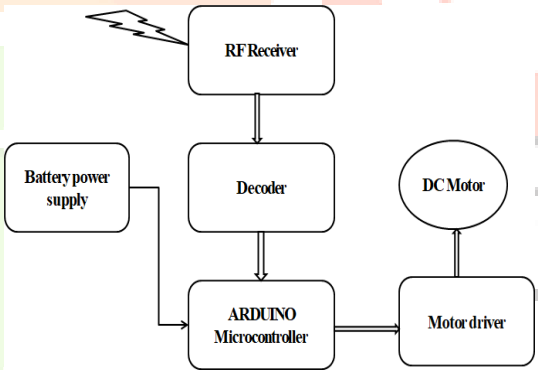

Figure 2: RF Receiver Module[2]

The signal sent by the RF Transmitter at the traffic section is received by the RF Receiver which may be fitted within the vehicle. The received information is decoded by the decoder utilized in our circuit. The transmitter and receiver utilized in this work of the RF (HT12E and HT12D). The color (Red or Green) the signal and time delay for that signal and everyone other information is sent to the Arduino Microcontroller. Based on the information obtained from the receiver module the microcontroller regulates the motor speed through a motor driver.

Motor Driver- It is a little current amplifier. The function of the motor driver is to take the low current control signal and then turn it into a high current signal that can drive a motor.[3] Motor drivers are circuits to run a motor. They are commonly used for motor interfacing purposes. The motor driver circuit is interfaced with the motor. L293D microcontroller is employed within the motor driver which is shown below.

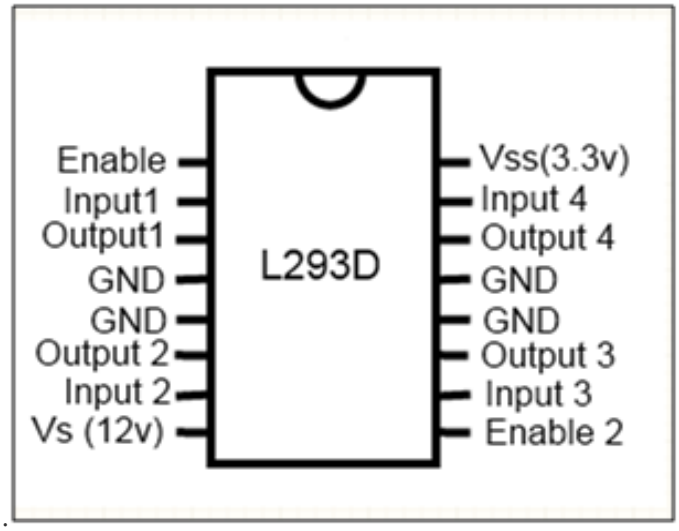

Figure 3: Motor Driver (L293D microcontroller)

RF Module- The RF transmitter and receiver are the smaller electronic devices won't to transmit and receive radio signals between them. They are desirable to communicate with another device wirelessly. This wireless communication is completed through frequency communication. An RF Transmitter module (HT12E) is capable of transmitting the radio wave and modulating that wave to carry data.[4] Transmitters are typically regulating the utmost allowable transmitted power output, harmonics, etc. Associate in Nursing RF Receiver module (HT12D) receives the modulated RF signal from the transmitter fitted within the traffic section and also demodulates the transmitted signal. There are two types of RF receiver modules. They are the superheterodyne receiver and super-regenerative receiver. The superheterodyne receiver has a performance advantage over super-regenerative, they offer increased accuracy and stability over a large voltage and temperature range.[5].

Ultrasonic sensor- The ultrasonic sensor is fixed in the vehicle that can measure the distance between the vehicles by using ultrasonic waves. The sensor heads emit an ultrasonic wave and receive the wave reflected from the target. Ultrasonic sensors measure the distance to the target by measuring the time between the emission and the reception. Ultrasound may be a very high-frequency sound wave, which is beyond the traditional audible range of humans. Since the audible frequency range is said to be between 20HZ to 20KHZ.It generally means acoustic waves above 20KHZ.[2] Based on this information, the vehicle can either stop or overtakes the opposite vehicle consistent with the present situation.

GSM Module- A **GSM module** may be a hardware device that uses GSM mobile telephone technology to supply a knowledge link to a foreign network. From the view of the mobile network, they're essentially just like a standard mobile, including the necessity for a SIM to spot themselves to the network. GSM modems typically provide TTL-level serial interfaces to their host. They are usually used as part of an embedded system.[6]

Piezoelectric Sensor (Pressure Sensor)- Piezoelectric sensors are a device that uses the piezoelectric effect to measure the electrical potential caused by applying mechanical force to a piezoelectric material. They are based on the principle of electromechanical energy conversion and primarily measures force, as well as other quantities such as pressure, acceleration, temperature, and strain by converting the acquired data to an electrical charge.[7]

III Results and Test Cases

Table 1: Result Table

Actuators and Actuators	How should they work	How are they working
ATMEGA 328P microcontroller	It has to be working according to the pins which are connected with the components in the Circuit.	It is working according to the expectations. As all the components are connected according to their PIN requirement.
L293D microcontroller (Motor controller)	This microcontroller should control the RPM of the Electric Motor connected to it and be able to shift between 5 speed levels (including the stopping of the rotations).	It is giving an affirmative output by controlling all the levels of RPM as mentioned in the program.
Sonar Sensor	The sonar sensor connected to the circuit should detect any object in front of its transmitter and receiver. It should return the RAW time span of the wave transmitted and received by the receiver.	The sonar sensor is calculating the time span of the wave which is reflecting back from the object and returning to the microcontroller. In order to calculate the distance in centimeter.
RF transmitter	This transmitter is separate from the actual system circuit, in this transmitter there are switches to transmit a high or low value from it.	The transmitter is transmitting the value from the two switches as {(Low, Low), (Low, High), (High, Low), (High, High)} Which are used to set speed of the motor at the receiver end.
RF receiver	This receiver should receive the transmitted values and provide it to the program as input.	The received values {(Low, Low), (Low, High), (High, Low), (High, High)} are then provided to the microcontroller which sets the speed levels of the motor according to those values.
Piezoelectric Sensor (Pressure sensor)	This sensor unit should discharge voltage up to 5V when applied with the mechanical force ranging from **0.7 Kilopascals to 70 Megapascals**.	When applied a small amount of pressure ranging from **0.7 Kilopascals to 70 Megapascals** to the plate on the sensor it discharges up to 5V and gives input to the microcontroller as high which activates the GSM and GPS module.
GPS Module	This GPS module retrieves its current location and generates the various data including Latitude and Longitude of the current location.	The module provides data like date, time, Latitude, Longitude, etc. But our system only requires the value generated of the Latitude and Longitude which is then provided to the GSM module.
GSM Module	This GSM module requires a 3G SIM card to provide various facilities like sending messages and providing a 3G signal when needed.	In our case the GSM Modules sends message to the Mobile No. defined in the program containing a message of occurrence of accident and with the Google Maps location Link.
Lcd Display	It is used as output device to check various status updates.	The LCD displays the status of the motor, system, shows the speed level at which the motor is spinning, provides the status of the GSM and GPS modules when in use, and the sending SMS status.
ROBOKIT Motor	It is used to show the RPM of the Shaft according to the pulses provided to it.	The RPM of the motor increases and decreases according to the pulse.
Joy Stick	It is used to give a forward and reverse direction to the rotations of the motor.	If pushed to the front and back it changes the direction of the rotation accordingly.

Test Cases

Test Case 1:

In the first test case we just started the system and give the input from the RF transmitter as (Low, Low), and input from the joy stick as forward.

Result:

From the given input the motor started rotating at the set speed of 1 (i.e. only 50 pulses were provided to the motor) in the forward direction.

Test Case 2:

After the execution of the first test case the RF transmitter Inputs were changed with interval of a 5 seconds from (Low, Low) to (High, Low), (Low, High), (High, High). Then after that a small object was placed at 8cm of the distance from the Sonar Sensor.

Results:

From the given input the speed of the motor increase from 1 to 2 (with 150 pulses), 3 (with 200 pulses), 4 (with 240 pulses). When an object was detected by calculating the distance from the object to the sensor with the help of calculated duration of the wave transmitted and received time span, the system detected that the object is between 5cm to 10cm distance, then the system decreased the speed of the motor to 1.

Test Case 3:

After the execution of the second test case, the object started to move towards the sonar sensor and then it reached at 4cm of distance from the sonar sensor.

Results:

When the object started moving towards the sonar sensor and reached to 4cm from the sensor the motor stopped rotating with 0 pulses provided to it.

Test Case 4:

The motor was rotating at the speed of 4 and a sudden pressure of 1 kilogram-force-per-square-centimeter (nearly **98.1 Kilopascals**) of mechanical force was applied at the pressure sensor.

Results:

When the pressure sensor was impacted with the pressure of **98.1 Kilopascals,** the sensor will generate a 5V of voltage when there is decrease in the distance between the two plates of the sensor and it is passed to the microcontroller. After receiving it the microcontroller shows on the LCD display that an accident is detected and it stops the rotation of motor and after that it takes the Latitude and Longitude form the GPS and reflects this values in the predefined message, and sends the message to the mobile no predefined in the program, Which says

"Accident Occurred!!!
Current Location >
https://www.google.com/maps/place/(Latitude),(Longitude)"

IV Future Scope

Transportation systems square measure an essential part of Human activities. The survey report shows that 40% of the total population spends a minimum of one hour on the road every day. Nowadays people mostly dependent on transportation systems in current days, transportation systems not only face several opportunities it also faces several challenges. The country's competitiveness, economic development, and productivity are heavily dependent on the transportation performance of the country. Intelligent Transportation Systems (ITS) have attracted increasing attention in recent years due to their great potential in meeting the above-mentioned transportation challenges. Advanced Vehicle Control System (AVCS) is a part of an ITS.[8] The central theme of AVCS is to improve the throughput and safety of highway traffic by using automatic control with its precision and fast reaction to replace human drivers.[9]

V Conclusion

In the modern developing world, the increase of transportation needs to reduce accidents, and thus a method to avoid vehicle collision has been achieved. Advanced Adaptive Cruise Control System that can commonly be seen in luxury cars nowadays. Fully autonomous cars are probably variable in the foreseen future. Some technologies are developed that may ultimately lead to vehicles wrapped in many different types of sensors. The nearby vehicles would be in constant communication with each other and act accordingly. It will probably take decades, but car accidents may eventually become almost as rare.[10] The automobile, which transformed the development work by offering mobility and will finally stop extracting such an enormous cost of human life. Thus, the speed of the vehicles in the speed limiting zones such as traffic signals and the accident prevention using ultrasonic sensors can be achieved through this work.

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