Vehicular Speed Regulation through Autonomous Braking System Embedded with Smart Insurance Facility using Iot

M. Shyam, R. SathyaVignesh, A. Sivakumar, J. Yogapriya

Abstract: The recent developments in the field of automotive engineering and the ease of automobile production has resulted in a drastic increase in the number of vehicles and subsequently heavy traffic congestion. This has naturally resulted in doubling of accidents due to negligence. The process of claiming insurances for the damages incurred is till date a very tedious and time-consuming process. Persons claiming pay-back from insurance policies even go up to the extent of faking documents or produce forged evidences to get monetarily benefitted. Till date there is no secure automotive system that provides safe driving through intelligent braking, combined with an IoT based insurance calculation smart device. The proposed idea provides a safety system to the driver through speed regulation that is primarily governed through an automatic braking unit. The system is centered with a microcontroller unit, which along with sensors interfaced, reads the vehicles around it and optimizes the speed of the vehicle. The autonomous braking system intervenes only when there is an emergency control of the vehicle required. An added feature to this autonomous unit is the smart insurance facility that ensures that insurances are claimed genuinely. The vehicle On-Board Diagnostics (OBD) is connected to cloud via IoT, which performs vehicle tracking continuously.. It collects data about the state of various parts, detection of any failure in the engine, signs like speed warnings and proximity levels and transmits the data automatically, which can be accessed using Android or iOS or a web browser. The data received, is then shared with the insurance providers and the clients, after which insurance procedures follow. Thus, the above hybrid system, ensures passenger safety and also aids in faster insurance claims for genuine cases of accidents, which can be done precariously based upon the magnitude of the accident.

Key Words: Autonomous BrakingSystem (ABS), Electric vehicle, UV Sensor, Internet of Things (IoT), Electronic Control Unit (ECU),On-Board Diagnosis Module (OBD), Sensors, Smart Insurance, Piezo Electric Transducer

* Correspondence Author
Mr. M.Shyam*,, Assistant Professor, R.M.K.Engineering College, Gumidipoondi, Tamil Nadu, India.smm.ece@rmkec.ac.in
Mr. R.SathyaVignesh, Assistant Professor, R.M.K.Engineering College, Gumidipoondi, Tamil Nadu, India. rsv.ece@rmkec.ac.in
Mr. A.Sivakumar, Assistant Professor, Gr-II R.M.K.Engineering College, Gumidipoondi, Tamil Nadu, India. asr.ece@rmkec.ac.in
Ms. J. Yogapriya,, M.E., Programmer Analyst, Cognizant Technology Solutions, Siruseri, Chennai , Tamil Nadu, India yogapriya.j@cognizant.com

I. INTRODUCTION

The increase in mortality rate due to road accidents has become a major concern with the multiplication of automobile production, sales and consumer usage. This is of greater magnitude in developing countries due to the population growing at an exponential rate. The causes for accidents may be due to various factors.

The primary reason of all being the ignorance of traffic rules or lack of skill of drivers.In most cases it was observed that the reaction or response time was too short for drivers to respond, leading to disastrous accidents. Next, the claim for insurance after most accident cases is very tedious and time-consuming, making it very difficult for people to acquire back their compensation. The insurance providers too face a very tough task of pay back as calculating insurance is done considering several factors all at the same time. The job is inherently time-consuming as insurance providers initially have to verify the candor of the claim so that the sum is not sanctioned for deceitfully fragmented evidences. This has resulted in a need for remodeling the existing accident prevent and insurance claim systems and implement a navigation system for a safer and more secure transport.

II. EXISTING SYSTEM

Most automobiles in our country are not implemented with any automatic speed control mechanism nor are the vehicles designed with any intelligent maneuvering mechanism to optimize and steer the vehicle, ensuring safety to the passengers. The braking systems available are also not too bright, resulting in disastrous accidents that claim the lives of many people. In most cases the primary reason behind accidents is the failure in the braking mechanism of the vehicle.

The subsequent procedures that follow the accidents are generally too tedious and time-consuming. It is generally a very difficult task to analyze the reason for the accident and much more difficult to calculate the compensation that must allocated for it. The calculation and compensation for insured vehicles is extremely tough as several factors have to be considered at the same time. This further increases the time delay for the consumers in acquiring the insured amount from the corresponding insurance agency.
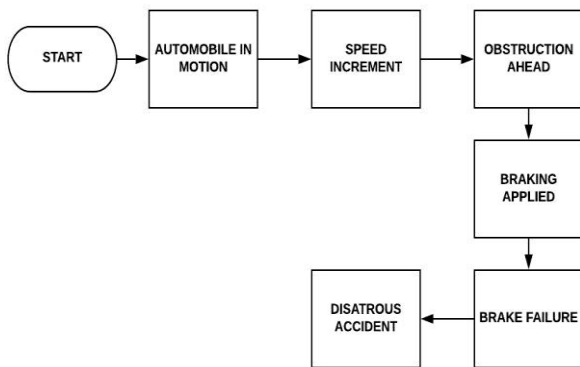
Fig-1. A conventional braking system

III. PROPOSED SYSTEM

The projected idea tries to solve the above mentioned problems by providing the drivers with safety and optimality. The system effectively controls the speed of the vehicle depending upon the closeness, position and velocity of the vehicles that are adjacent, with the help of an Electronic Control Unit (ECU) interfaced effectively with sensors.[1,2] In emergency conditions, an autonomous braking system gains control over the vehicle and adjusts the speed of the vehicle or utmost halts the vehicle with proper indication to successive drivers. Inspite of all precautions, if ever the vehicle meets with an accident, the data containing intricate details such as the speed, position, location, velocity viz. the status of the vehicle at the time of accident, is immediately shared to the insurance provider, through IoT, to give a better perception of the situation and henceforth the claim of insurance.
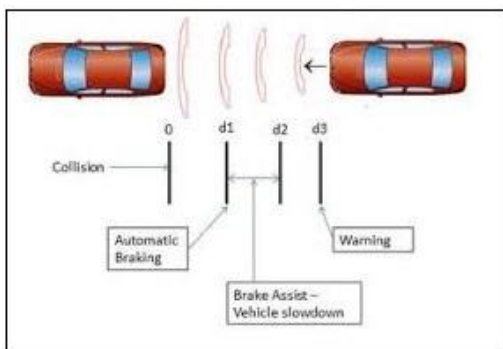

Fig-2.Autonomous Braking System

IV. SYSTEM OPERATION

The proposed idea is mainly designed to eliminate any mishaps while driving and ensure passenger safety through a unique mode of operation, i.e .automatic speed control of the vehicle[2,3] through autonomous braking system. The smart insurance facility provided is an added feature that ensures easy insurance claim. Both the features are elaborated in detail in the forthcoming sections to highlight on the uniqueness of the proposed idea.

V. SPEED CONTROL MECHANISM

The speed control mechanism of the automated system is mainly governed by an Arduino microcontroller interfaced with appropriate sensors. Henceforth it is evident that this system is aimed and designed to give maximum

optimality for electric vehicles. The functionality of the system is attained through the exclusive use of ultrasonic sensors that are positioned precariously on the periphery of the vehicle[4].

A. ULTRASONIC SENSOR

The main purpose of the ultrasonic sensors employed is to sense and detect the distance and position of the adjacent vehicles through ultrasonic waves. Ultrasonic sensors or transducers are generally of 3 types: transmitters, receivers and transceivers. The ultrasonic sensor employed here contain a separate transmitter and receiver. The two nodes available are commercially termed as "trigger" and "echo" respectively. The trigger pin emits out a signal in ultrasonic frequency. The waves emitted out impinge on a nearby obstacle or vehicle and is returned back at an angle to the sensor. The reflected ultrasonic wave is received by the echo pin (hence the name), and is then converted into its equivalent electrical signal with the help of a piezo electric transducer or capacitive transducer that is present inside the transducer.[6].The distance of the adjacent vehicle is calculated as follows:

The principle of ultrasonic sensor is that, it calculates the time taken for the ultrasonic wave to hit an object and come back. One half of this time is the time taken by the ultrasonic sensor to reach the object (here, the adjacent vehicle). As the speed of sound in free space is already known, the distance of the object (i.e., the vehicle) can be calculated using the formula,

Distance= (Speed of sound) *Time/2 (in meters) [5]

Example:
Speed of sound in air = 343 m/sec
Response time of UV Sensor = 1 msec (apprx)
Distance of adjacent vehicle = (343*1) / 2= 171.5 metres

Fig-3.Ultrasonic Sensor

The table given below lists out the functionality of each pin available in the UV sensor. This information is essential for interfacing the sensor with the main controller.

Table1. UV Sensor Pin Description

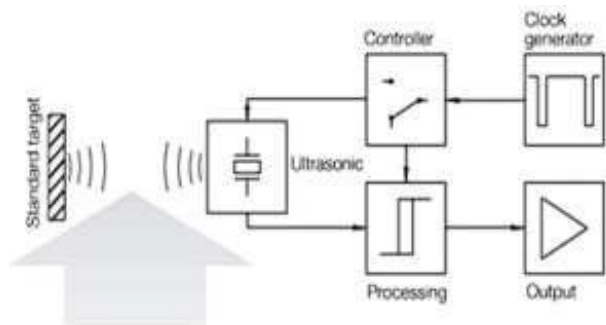| Pin Name	Pin Description
Vcc	Supply Voltage (+5V)
Trig	Input-Trigger Pulse
Echo	Output-Echo Pulse
GND	Ground (0V)

Fig-4. Schematic of Ultrasonic Sensor

An Ultrasonic sensor (UV) can be directly interfaced to a Arduino processor, like any plug-n-play device. Hence, it is directly compatible with the controller from where it can receive instructions in the form of signals or voltages directly [6]. The schematic of a UV sensor interfaced to a Arduino processor is illustrated below

Fig-5.Arduino Interfaced with UV Sensor

An Infrared sensor can also be used as an alternative for determining the distance. The output from the IR sensor in turn is fed to a microcontroller. Arduino is generally employed for obtaining the above said functionality.

VI. FUNCTIONALITY

The Arduino microcontroller is pre-programmed with a specific threshold value, attaining which activates the autonomous braking system. This activation is usually done by triggering a speed control signal which is sent to a motor driver, which in turn is interfaced to the motor of the electric vehicle. If the received value (distance), from the UV sensor is less than the preset threshold value, the microcontroller commands an LCD Display that is inter-connected to it. The display provides a visual alert signal to driver for subsequent action. If there is no change in the status of the vehicle, i.e. if there is no response from the driver after a very short, specific time delay, usually in microseconds, the autonomous system takes control over the vehicle. The Arduino commands the motor driver to slow down the motors by varying the voltage levels fed to the motors. Thus the speed of the vehicle isintelligently controlled. It may be noted that three sensors are diligently installed on the front and lateral sides of the vehicle. The inputs from these sensors are obtained simultaneously and fed to the microcontroller, which analyses the data from all the three sensors and processes them instantaneously. Hence, the speed control mechanism is implemented successfully.

VII. AUTONOMOUS BRAKING SYSTEM

The next section details the working of the automatic braking system, which not only controls speed of the automobile, but also brings the vehicle to a complete halt if the situation demands. When vehicles running on the road are too close, to avoid any collision, the autonomous braking system is activated.

This system includes the setting a critical threshold value similar to the UV threshold value, in the Arduino for interpreting the closeness of adjacent vehicles. Whenever this critical threshold is exceeded, the Microcontroller gives directions for the motor driver to stop the motors by giving active low signal (i.e., 0V) to all the pins of the motors [3]. This drastically cuts-off the voltage to the motors, gradually reducing the velocity of the vehicle. This, stops the vehicle, thereby preventing itself from major damage.

However, it may be noted that the autonomous braking system takes over the control of the vehicle only under critical conditions such as very less response time for any driver to react.
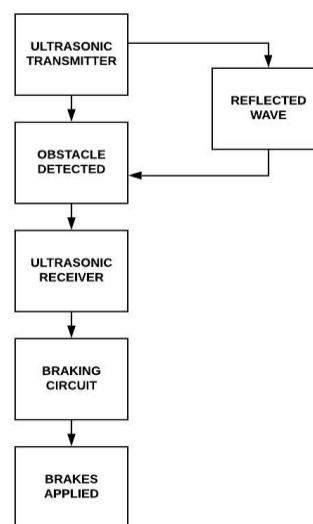

Fig-6. Step-Wise Working of Autonomous Braking System

VIII. ON-BOARD DIAGNOSTICS (OBD)

The On-Board Diagnostics module receives data as inputs from various systems in-built within the automobile. The Motor Controller Module in the automobile provides information related to the indicators, motor controller, accelerator pedal and battery[7]. The motor controller is armed with a powerful Microprocessor and thus can control the electric motors by limiting or redirecting the current to the motors.

The Regenerative Braking system permits the taking out of energy from the braked components, which can be reused later. Accordingly, the braking information can be extracted from the vehicle. The Drive system is associated with the transfer of mechanical energy to the traction wheels and hence, the data related to this can be received from the drive system. The Battery Monitor is a sensor that can monitor the charging, discharging and recharging of the vehicle battery and consequently can be used to gather evidence about the battery condition of the vehicle. All these data are fed to the Electronic Control Unit (ECU) of the vehicle.

These data are made available at the OBD-II port in-built in the vehicle. Then, with the help of a Wireless OBD-II WI-FI Scanner/adapter, this data is stored in the cloud and can also be sent to an android/iOS device or a desktop [8].
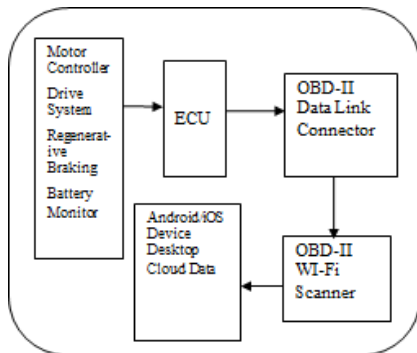

Fig-7.On Board Diagnostics on an electric vehicle

IX. SMART INSURANCE FACILITY THROUGH IOT

This facility is included as a stand-out feature in the proposed system, and serves to a great extent in calculating the insurance premium, in certain critical scenarios. This Smart Insurance facility is generally activated when other non-intelligent vehicles, bump into our parked, stationary vehicle, or when the braking system responds slowly. The Smart Insurance facility is generally controlled and monitored through IoT.

The facility is generally activated when one of the following scenarios occur. Firstly, ,inspite of the precariously designed autonomous braking system, due to harsh road and weather conditions like wet slippery roads our braking will not be complete. Due to the excessive slipperiness of the road due to water or ice, the tires screech without halting completely. Due to this extra, unwanted momentum, the vehicle slides without stopping. This may lead to hitting of any adjacent vehicle.

Secondly, any ordinary passing-by automobile that is completely under human control may bump into the proposed vehicle that is parked and is stationary This is primarily due to the delay in the response from the driver that may be cited due to various reasons such as drowsiness, excessive consumption of alcohol and so on. In this case, the vehicle sensors do not respond as the entire system is in sleep state, to conserve power. Thus, insurance claim and pay-back becomes inevitable here. This is where our unique smart insurance facility plays a vital role in analyzing all parameters thereby aiding in providing the exact compensation to the vehicle owner.

The main notion of this system here is to eliminate all the errors arising due to the faulty manual inspections. Henceforth this system is designed as follows. The vehicle is fitted with an IoT based On- Board Diagnosis Module (OBD), provided by the Insurance provider. The OBD module has a Cellular Radio that connects to any Internet Service Provider (ISP) network, a Bluetooth Radio, a simple computer and a GPS Receiver. The module is plugged into the OBD-II port which will be installed under the dashboard permanently. [8] Once installed, it transmits data automatically, and the information is stored in the Cloud. This information can later be accessed from Android and iOS apps or a Web browser [9].

The information referred here includes data about the driver behavior while driving (including speed and braking) and the status of various parts of the vehicle (which is usually monitored with the help of various sensors), failure detection, warning signs proximity levels etc. These data are shared with the insurance providers and can be accessed anytime.[10]. This aids insurance claim agencies to calculate the compensation accurately within a very short span of time.

X. WORKING SUMMARY

This section details the overall consolidated working of the intelligent system. The working of the proposed system is explained picturesquely with the help of flow diagram. The flow diagram is designed with a view to show all the unique features such as speed regulationthrough autonomous braking as well as smart insurance facility controlled through IoT.
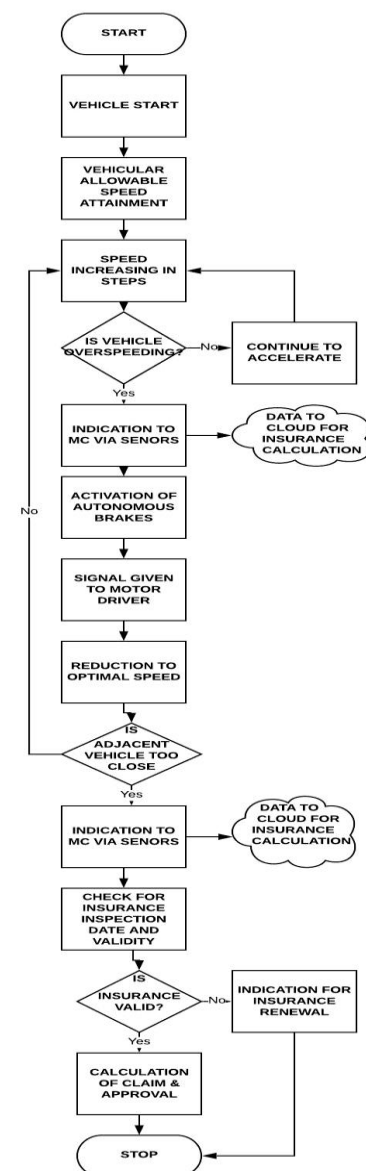

Fig-8.Overall Flow Diagram

XI. RESULT

The autonomous braking system works very effectively when installed in any automobile. It diligently maneuvers the vehicle from hitting onto any adjacent vehicle by intelligently adjusting the vehicle speed, automatically and thus providing safety to passengers in as well as outside the vehicle. The automatic change in speed is very clearly illustrated in the graph represented below, enabling us to understand the uniqueness of the proposed idea.
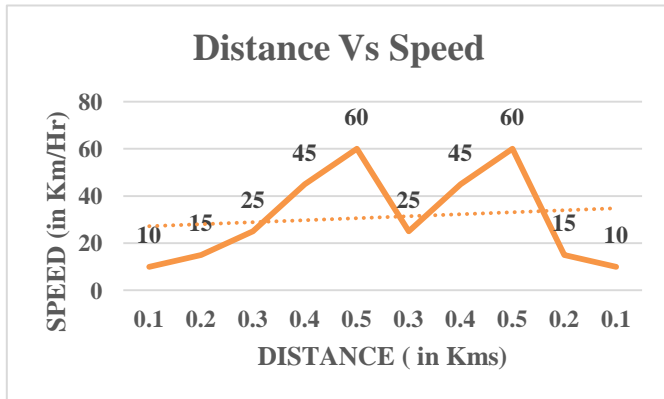
The proposed system is mainly aimed in reducing the accidents level to zero, providing safety to passengers as well as on-goers and other animals. Since braking is done instantaneously based upon adjacent vehicles, a reliable system for driver safety is achieved. As an added advantage, the system is designed to obtain the actual interpretation of the causes of an accident and the henceforth the status of the driver and the engine at the time of accident. The extensive use of IoT facilitates the insurance provider with true and reliable information, which eliminates the need for manual examination.

Any new damage created to the vehicle with the motive of increasing the insurance money can be identified easily and instantaneously. Additionally, the check for insurance validity can be done and the renewal date too can be intimated to the driver, once it is near. Therefore, the intelligent combination of Speed Control and Autonomous braking system creates a sense of reliability and security.

XII. FUTURE ENHANCEMENT

The proposed idea can be expanded to suit the need of the hour in future. A major facility that can be incorporated in the system is sensing of the road conditions pre-hand and activating the braking system effectively. This induces optimal braking and maximum throughput from the system. Large dents and pot-holes can be sensed and the result contributed to the braking system for producing varying braking torques according to the demand. Threshold values of speed can be calculated in real time based upon the road conditions and hence restrict drivers from over speeding. In addition, different driving modes for hilly and plain region can also be incorporated in future.

Data is continually uploaded and stored securely in the cloud through IoT, which always gives us the advantage of data manipulation at any point of time. The stored data for any specific period of time can be accessed at any point of time, analyzed and processed. From the stored tabulation of any specific vehicle, the driving pattern and behavior of the

specific driver can be analyzed. This in turn helps a great deal when designing of any automobile. With the specific set of data the automobile can always be tailored to suit the specific demands of a driver. In addition, the obtained pattern can also be extended to aid the design of the structural pattern of any road. Hence, both automobiles as well as roads can be designed based on the averaging of the data obtained to provide an optimal and safest driving experience to all.

XIII. CONCLUSION

An intelligent autonomous driving system is thus completely designed and detailed for an elaborate and clear understanding. Though several autonomous systems are prevalent in today's vehicles, the proposed system is unique as it is available with a hybrid combination of autonomous braking system backed by smart insurance facility. Autonomous braking facility provides a very secure and relaxed driving comfort which can be experienced by anyone utilizing the proposed idea. The system is precariously backed up by the smart insurance facility activated through IoT which ensures a further feeling of security by ensuring precise and timely calculation of insurance. Thus, the system promises compensation to the drivers as well as eliminates the complexities involved in computation of insurance. In addition, it is to be noted that the system stands out from other autonomous systems as it provides a 2-level protection to the consumers as well as insurance agencies. Hence, a novel automotive safety system embedded with intelligence and interfaced through IoT is designed. The systems design is proposed in such a way that it can always be upgraded through IoT, providing one of the safest mode of navigation to mankind.

REFERENCES

1. Mohammed Arivanto, GunawanD.Haryadi,M.Munadi,Rifky Ismail, ZulfaHendra, "*Development of Low-Cost Autonomous Emergency Braking System (AEBS) for an Electric Car*", 5th International Conference on Electric Vehicular Technology(ICEVT), IEEE Conference, 2018.
2. HyuminChae, Chang Mook Kang, ByeoungDo Kim, Jaekyum Kim, Chung Choo Chung, Jun Won Choi, "*Autonomous Braking System viaDeep Reinforcement Learning* ", 20th International Conference on Intelligent Transportation Systems (ITSC), IEEE Conference, 2017.
3. Abdulrahman.H.A.Widaa, WaddahAbdelbagieTalha, "*Design of Fuzzy-based Autonomous Car Control*", International Conference on Communication, Control, Computing and Electronics Engineering(ICCCCEE) , IEEE Conference, 2017.
4. Begum KorunurEngiz, Rakan Bashir, "*Implementation of a Speed Control system Using Arduino*", 6th International Conference on Electrical and Electronics Engineering (ICEEE), IEEE Conference, 2019.
5. AtanasDimitrov,DimitarMinchey, "*Ultrasonic Sensor Explorer*", 19th International Symposium on Electrical Apparatus, and Technologies (SIELA), 2016.
6. Yun Jin,Shengguan Li, Juan Li, HongbingSun,Yuanwang Wu, "*Design of an Intelligent Active Obstacle Avoidance Car Based on Rotating Ultrasonic Sensors*", 8th Annual International Conference on CYBER Technology in Automation, Control, and Intelligent Systems, IEEE Conference, 2018.
7. Mathias Syendsen, MadsWinther-Jensen, Anders Bro Pedersen, Peter Bach Andersen, Thomas Meier Sorensen,"*Electric Vehicle Data Acquisition System*", IEEE International Electric Vehicle Conference (IEVC), IEEE Conference, 2014.

8. C.Alaoui, Z.M.Salameh,"*On-Board Diagonostic and Rejenuvation System for Electric Vehicles*", 58th Vehicular Technology Conference VTC-2003-Fall (IEEE Cat No. 03CH37484)Vol.5 ,IEEE Conference, 2003.

9. JastiSatyakrishna, RajKumarSagar, "*Analysis of Smart City Transportation Using IoT*",2ndInternationalConference on Inventive Systems and Control (ICISC), IEEE Conference, 2018.

10. PuntavutLertpunyavuttikul,PinyaratChuenprasertsuk, SorayutGlomglome, "*Usage-Based Insurance Using ioT Platform*", 21st International Computer Science and Engineering Conference (ICSEC), IEEE Conference, 2017.

AUTHORS PROFILE

Mr. M.Shyam,, M.E, Assistant Professor, R.M.K.Engineering College, Gumidipoondi, Tamil Nadu, India.smm.ece@rmkec.ac.in

Mr. R. Sathya Vignesh, M.E, Assistant Professor, R.M.K.Engineering College, Gumidipoondi, Tamil Nadu, India. rsv.ece@rmkec.ac.in

Mr. A. Sivakumar, M.E, (Ph.D.) Assistant Professor, Gr-II R.M.K.Engineering College, Gumidipoondi, Tamil Nadu, India. asr.ece@rmkec.ac.in

Ms. J. Yogapriya,, M.E.,Programmer Analyst, Cognizant Technology Solutions, Siruseri, Chennai , Tamil Nadu, India yogapriya.j@cognizant.com