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IOT Based Automatic Vehicle Accident Detection and Rescue System

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Abstract - The problem of road accidents causing loss of life is a significant issue, especially in developing nations where there is often a lack of efficient emergency response systems. These accidents result in higher fatalities due to delays in reporting to emergency services and reaching medical facilities. To address this, a new automatic vehicle accident detection and rescue system is proposed. This system utilizes accelerometers to detect vehicle crashes and sends the GPS location of the accident to relevant authorities and contacts through GSM module. This technology aims to improve response times compared to traditional methods, potentially saving more lives through swift intervention.

***Key Words*: RF Transmitter, Accidents, GPS, GSM.**

1.INTRODUCTION

Road transportation is gaining widespread popularity globally, but there's a concerning rise in road accidents, particularly in urban areas, posing uncertainties that significantly impact the socio-economic development of communities. The ramifications include substantial costs such as loss of livelihoods, impoverishing families, and causing damage to infrastructure. This paper prioritizes measures to prevent human casualties in accidents, emphasizing the urgent need for timely response to victims, often hindered by delayed reporting or inadequate information provision to emergency services.

Indian Governments, are actively pursuing strategies to mitigate road accidents through awareness campaigns and effective road safety education. However, accidents frequently occur unexpectedly, presenting challenges in providing timely medical assistance to victims. Hence, there's a pressing necessity to implement an IoT-based automated system to detect accidents, promptly alert emergency services, and notify family members for effective rescue operations, thus saving lives.

The paper also addresses obstacles like traffic congestion that delay emergency vehicle response times, and proposes improvements such as enhanced smart traffic lights designed to prioritize lanes with heavier traffic and facilitate the passage of emergency vehicles using Radio Frequency (RF) communication. Despite emergency vehicles being permitted to breach traffic rules in life-threatening situations, they still face challenges in reaching destinations promptly due to congestion, thereby increasing the risk of loss of life and property. Consequently, the paper advocates for a more efficient system to address these challenges

The improved smart traffic light boasts several notable features aimed at alleviating congestion in lanes with high traffic density. Specifically, in this design, traffic lights are engineered to facilitate the passage of emergency vehicles using Radio Frequency (RF) communication. These emergency vehicles are tasked with providing immediate assistance in accidents or disasters. In critical situations like these, emergency vehicles are authorized to disregard all traffic regulations to swiftly reach their destination. However, they often encounter significant delays due to traffic congestion, especially during peak hours in urban areas. These delays can result in increased risk of loss of life and property damage in emergencies such as accidents or fires. Additionally, emergency vehicles themselves may be involved in accidents as they are permitted to exceed speed limits and bypass red traffic lights when in emergency mode. Therefore, there is a need for a more efficient system, as proposed in this paper.

The subsequent sections of the paper include a literature review, the design of an automatic vehicle accident detection and rescue system, results and discussion, and conclusion.

2. LITERATURE SURVEY

I. Accident Detection Systems

In many developing countries, there's a lack of automated accident detection systems, relying mostly on eyewitness reports which can be ineffective, especially during adverse conditions or in remote areas. Proposed systems include using accelerometers and heart rate sensors to notify hospitals and relatives, but face challenges like phone malfunctions. Another approach using GPS to monitor vehicle speed is deemed unrealistic as it assumes accidents are solely due to speeding.

II. Smart Traffic Controller Systems

In developing countries, traditional methods of signalling emergency vehicles face challenges during peak traffic times. Solutions include a smart traffic system that communicates with traffic lights to give priority to emergency vehicles and a system using laser and photodiodes to manage traffic density. Another approach involves RFID tags and barricades to grant priority to lanes with emergency vehicles, reducing accidents caused by reckless driving. Upon detection, the RFID reader initializes the opening of the barricade in the corresponding lane, while simultaneously altering the traffic light system to grant priority to the lane containing the emergency vehicle by displaying a green signal. Conversely, the signal for other lanes turns red, and the barricades in those lanes close. This method effectively reduces the occurrence of accidents caused by reckless drivers.

3.METHODOLOGY

The automatic vehicle accident detection and rescue system depicted in this study, as illustrated in Figure 1, is a compact IoT-based solution that functions at a cost-effective rate with the primary goal of preserving human lives.

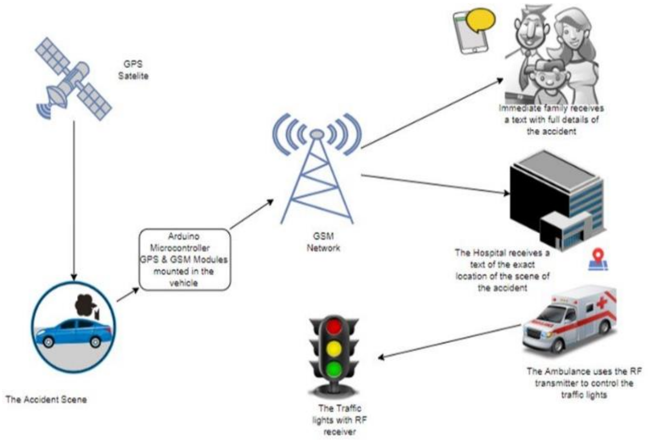


Fig1: Overview of the automatic vehicle accident and rescue

The automatic vehicle accident detection system is an IoT-based project consisting of four primary subsystems: the accident detection subsystem, Emergency Medical Service (EMS) subsystem, ambulance/EMS vehicle subsystem, and traffic light subsystem.

I. Accident Detection Subsystem

The accident detection unit, as depicted in Figure 2, comprises several components mounted within the vehicle, including the accelerometer sensor, buzzer, 16 x 2 LCD, GPS, and GSM modules. Notably, an MPU-6050 3 Axis Gyro accelerometer sensor was employed for this purpose in the study.

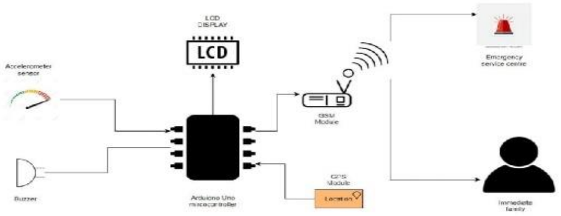


Fig2: Architectural design for the accident detection and notification segment

The accelerometer is responsible for detecting crashes by gauging the vibrations generated during an accident. If these vibrations surpass a predetermined threshold, the accelerometer triggers a signal to the Arduino microcontroller, initiating the notification process. Additionally, the sensor can detect if the vehicle has deviated from its position along the 3D real axis. The orientation of the accelerometer is illustrated in Figure 3.

The accelerometer is activated to transmit a signal to the Arduino microcontroller only when the angle exceeds 80 degrees in the X-axis and 70 degrees in the Y-axis, measured from its original zero-degree position.

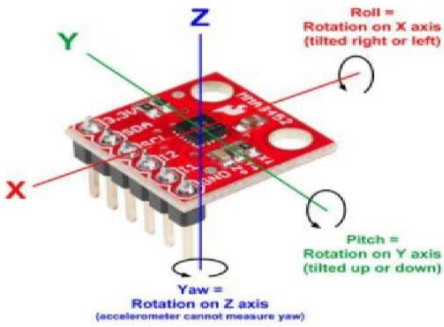


Fig3: Architectural design for the traffic controller

This signal, set to HIGH, initializes the accident detection and reporting system. Upon receiving a signal from any of the mentioned sensors, the Arduino Uno microcontroller activates the buzzer to confirm the accident detection. Subsequently, the Arduino controller instructs the GPS module to gather latitude and longitude data from the accident scene. Additionally, the design incorporates an Nrf24l01 module for both transmitter and receiver functions, a SIM800L GSM module equipped with an inbuilt helical antenna, and a port for a PCB antenna.

A comprehensive text message containing precise details of the accident location is promptly dispatched via the cost-effective GSM network to both the Emergency Medical Service Center (EMSC) and the registered immediate family member's phone number stored in the system. Additionally, a reset button has been integrated to address instances of minor and false detections.

II. The Emergency Medical Service System

The Emergency Medical Service (EMS) Centre swiftly identifies the nearest hospital to the accident location using its database and promptly notifies it to dispatch an ambulance for casualty rescue. This involves determining the quickest route to reach the accident scene or deploying the EMS's own ambulance or rescue vehicles if they are closer to the reported accident site. Integration of the EMS into any country's emergency service system can be achieved by aligning the communication systems involved.

III. The Ambulance/EMS Vehicle Sub System

Figure 3 depicts the traffic light control mechanism utilizing a wireless RF communication system. Upon identification of the nearest hospital by the EMS center, it promptly notifies the hospital to dispatch an ambulance to the accident location via the quickest route available. The emergency vehicle is equipped with a circuit comprising push buttons, an RF transmitter, and an Arduino development board. When the emergency vehicle approaches a traffic light while in emergency mode, the system intervenes to prioritize the lane occupied by the emergency vehicle. This functionality is limited to situations where the emergency vehicle is within a 100-meter radius of the traffic junction. Upon meeting this criterion, the driver activates a designated switch button corresponding to the vehicle's lane, triggering the RF transmitter to emit a signal at a frequency of 433 MHz, traveling at the speed of light (3 x 10^8 m/s) in serial communication format. Given the high-frequency nature of

RF communication, the operational distance is restricted to 100 meters. While a longer wavelength RF transmitter could extend this range, budget constraints dictated.

As frequency increases, the wavelength decreases, leading to a restricted operational range for RF communication systems, typically between 10 to 100 meters. This system is equipped with four push buttons, each corresponding to one of the four lanes at a traffic junction. When an emergency vehicle approaches a traffic light, the signal controlling the lane occupied by the emergency vehicle automatically switches to green to facilitate its passage, while the signals for the other three lanes are set to red, halting traffic flow in Fig4.

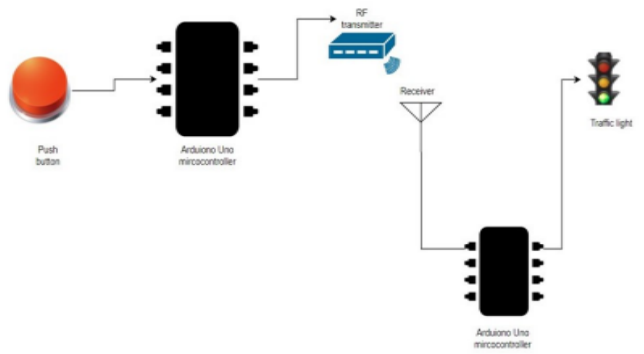


Fig4: Architectural design for the traffic light subsystem

IV. The Traffic Light Sub System

The traffic lights regulate the movement of motor vehicles in a systematic and safe manner, typically managing one lane at a time. However, to facilitate swift passage for emergency vehicles, a RF receiver circuit has been integrated with the traffic lights. This RF receiver circuit intercepts signals transmitted by the RF transmitter in the emergency vehicle and deciphers them, enabling manipulation of the traffic signal sequence. Consequently, when an emergency vehicle approaches, the traffic signal governing the lane it is traveling from automatically switches to green, ensuring the vehicle reaches its destination promptly to aid the accident victim. The received signal is decoded by the RF receiver, prompting adjustments in the traffic light sequence. Priority is granted to the lane occupied by the emergency vehicle, indicated by a GREEN signal, while RED signals are activated for the other three lanes, effectively halting traffic flow to allow the emergency vehicle to pass unhindered

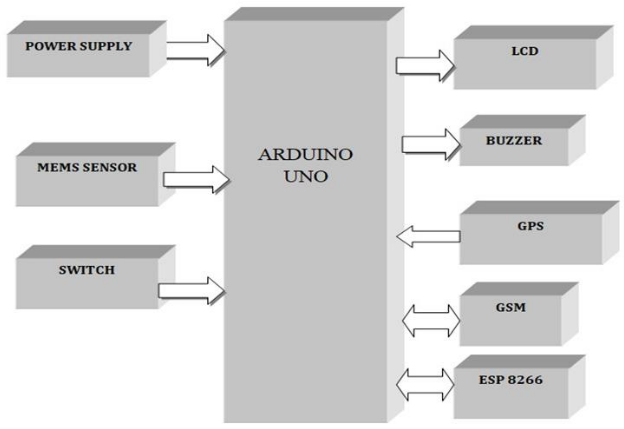
The enhanced smart traffic light system is designed for complex intersections and multiple lanes, aiming to enable timely arrival of emergency vehicles at their destinations. The integration of RF technology into the traffic lights proves particularly effective and relevant for facilitating the passage of VIPs, including presidential motorcades and other high-profile individuals.

x-coordinate	y-coordinate	Crash
323	374	N
220	310	Y
416	256	Y

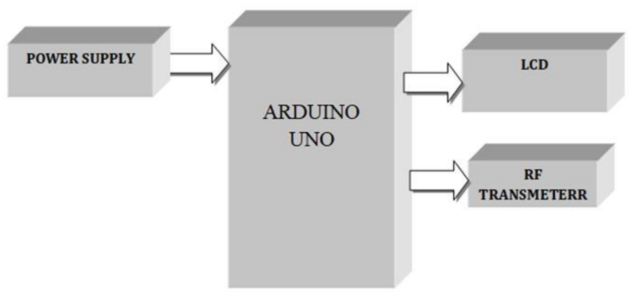
Table-I: Tilt Sensor Analysis

4.BLOCK DIAGRAM

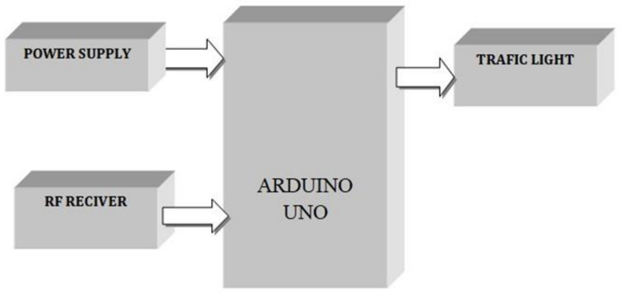
I. Vehicle Unit



II. Ambulance Unit



III. Traffic Unit



5. RESULTS AND DISCUSSIONS

Different scenarios were simulated to assess the performance of the subsystems under real-world conditions. Evaluations were conducted to determine if the observed outcomes align with our anticipated results and the project's requirements.

I. Tilt Measurement Test

A study was conducted to assess the accuracy of tilt angle measurements obtained from the accelerometer sensor and to establish threshold values for accident detection. An accident was deemed to have occurred if the tilt angles surpassed the predefined thresholds of 80 degrees in the x-axis and 70 degrees in the y-axis. Table I illustrates the number of trials

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conducted to evaluate the performance of the tilt sensor. The accelerometer sensor demonstrated satisfactory results by accurately displaying the measured angles with minimal error deviation. Any discrepancies observed may have arisen from systematic errors during the manufacturing process.

II. GSM Configuration Test

The evaluation of GSM performance in sending text messages across three different networks—BSNL, JIO, and Airtel—was conducted. The received text messages from a GSM module on the three selected networks are illustrated in Figure 4, while the corresponding response times are presented in Table II. The initial configuration step was successful, indicated by the blinking LED of the GSM module at three-second intervals. The response times observed during the GSM tests varied but generally fell within the anticipated range. This variance can be attributed to differences in the operational performance of various network providers across different geographical locations.

The GSM utilized in this experiment exhibited excellent performance, consistently sending text messages within a matter of seconds. This outcome aligns with the project's objective of promptly notifying both the emergency department and the registered immediate family member.

Network name	Response time(sec)
BSNL	5
JIO	4
Airtel	3

Table-II.: GSM Test on Different Network Providers

III. GPS Configuration Test

The GPS module's capability to pinpoint the precise location of an accident was assessed at three distinct locations. Table III presents the data gathered from the GPS module across these various sites.

The findings outlined in Table III revealed minimal error attributed to variations in the manufacturing processes between the mobile GPS and the U b lox Neo GPS. The built-in antenna expedited efficient communication between the module and satellites, facilitating the extraction of accurate longitude and latitude coordinates for each tested location. The primary aim of using this GPS module to pinpoint the accident site was achieved successfully, as the GPS promptly transmits the precise accident location to the Arduino microcontroller upon detection.

GPS Location	GPS Coordinates(degree)	
	Latitude	Longitude
Anantapur	14.6819	77.6006
Kurnool	15.8281	78.0373
kuderu	14.7307	77.4306

Table-III: GPS Data At Different Locations

IV. RF Communication Test

An RF transmitter was utilized to activate LED lights connected to an RF receiver circuit. The experimental results, detailed in Table IV, were deemed satisfactory. Each press of a push-button promptly triggered the corresponding LED light to illuminate. On the transmitter side, an Arduino monitors the status of the push-button switches. When a switch is pressed, the microcontroller detects a HIGH logic signal at its analog inputs, encoding the data for transmission. The Arduino then transmits the encoded data to the analogous light on the receiver circuit, where the corresponding switch is pressed. The RF receiver decodes the transmitted data, generating a HIGH signal on its pins to illuminate and turn off the LEDs accordingly. However, as the distance between the RF transmitter and receiver increased, there was a noticeable delay in action. Beyond 100 meters, functionality was compromised according to the device datasheet.

V. General Performance of The Overall System

An accident is deemed detected when the threshold values of 80 degrees and 70 degrees are exceeded in the x and y axes respectively, along with surpassing the threshold value of 4000 mV/G sensitivity of vibration. Upon receiving a HIGH signal indicating an accident, the Arduino activates the buzzer and updates the LCD to indicate that an accident has occurred, as depicted in Fig. 5. The Arduino then requests the precise longitude and latitude values from the GPS module. The GPS module establishes communication with satellites to obtain the exact location values of the scene, which are subsequently transmitted to the microcontroller for display

Fig-5: Google Maps used to identify the nearest hospital for immediate rescue

The GSM module compiles information received from the GPS module to alert both the emergency center and the registered immediate family member. Upon successful transmission of the message to the designated recipients, the system displays a confirmation message. The emergency center and the registered family member receive a notification text message in a specific format, as illustrated in Fig. 6. For example, if an accident occurs at 10 cranswick road in sandton, the emergency center utilizes the provided longitude and latitude values to pinpoint the accident scene on google maps, facilitating identification of the nearest hospital for immediate medical assistance, as shown in Fig.7.If the emergency center is distant from the accident scene, it notifies the nearest hospital to provide urgent medical aid to the accident victims.

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Attempts on different locations	Accident Detected?	Accurate Navigation Status	Text message sent status
1	Yes	Yes	Yes
2	Yes	Yes	Yes
3	Yes	Yes	Yes
4	Yes	Yes	Yes
5	No	No	No
6	Yes	Yes	Yes
7	No	No	No

Table-IV: General Performance Of The Accident Detector Subsystem

Fig-6: SMS received by GSM and GPS

Fig-7: RF Transmitter Signals

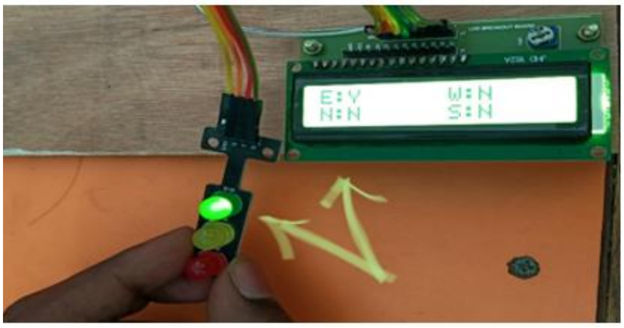

Fig-8: RF Receiver Representation

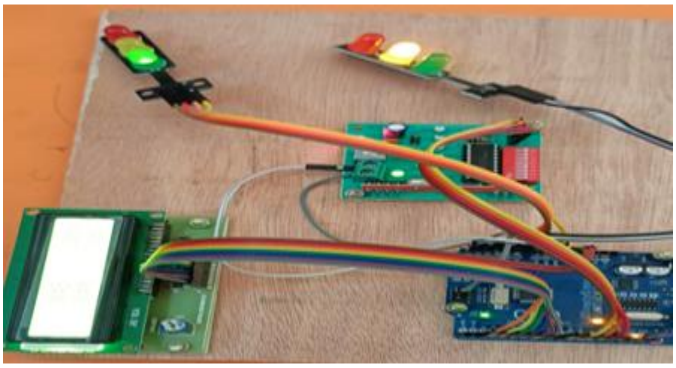

Fig-9: Traffic Signals Representation

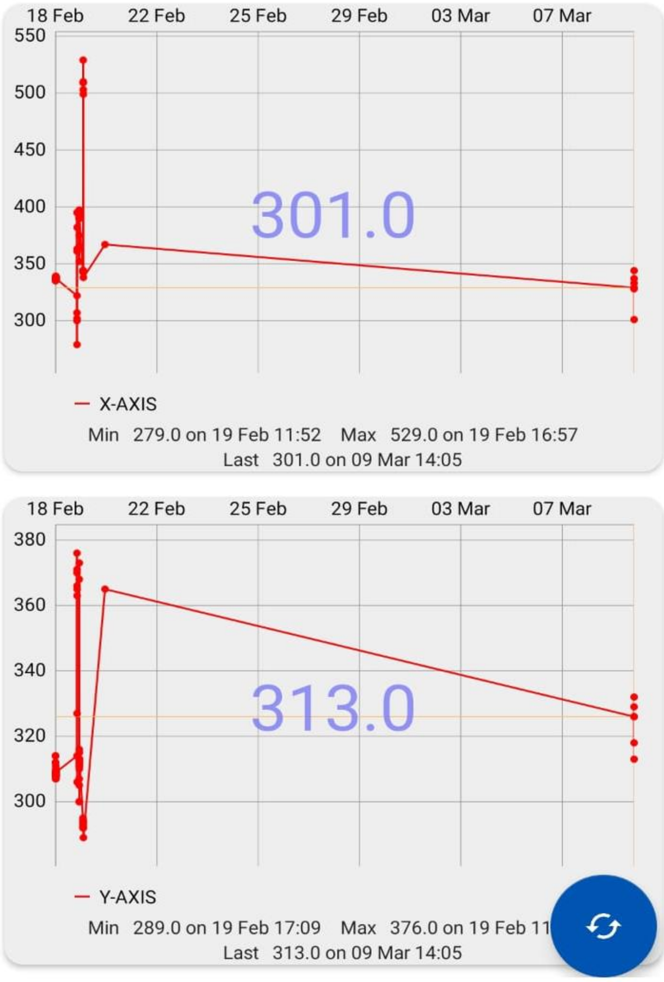

Fig-10: Graphical Representation of Tilt Analysis of a Vehicle

6.CONCLUSIONS

A cost-effective, portable, and compact accident detection and alert system was effectively designed and deployed. This system triggers an alert to emergency authorities and registered next-of-kin within a maximum of 4 seconds upon surpassing set threshold values. The included traffic light controller can be utilized for emergency vehicles such as ambulances and fire brigades. The overall efficiency of this accident detection and rescue system is expected to significantly contribute to saving the lives of accident victims.

This system has limitations, including occasional false detections and RF communication interruptions due to interference. In future iterations, we suggest implementing LoRa transceivers for longer-range wireless communication. Additionally, we recommend enhancing the system to automatically shut down the vehicle engine upon accident detection to ensure the safety of accident victims. Integrating ultrasonic sensors could also mitigate human casualties in potential head-on collisions.

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REFERENCES

1. A. M. Abu-Mahfouz and G. P. Hancke, Extension to Simulate Localization System in Wireless Sensor Networks, Livingstone: IEEE African, 2011.
2. A. M. Syedul, J. Jalil and M. Reaz, "Accident detection and reporting system using GPS, GPRS and GSM technology," International Conference on Informatics, Electronics and Vision, pp. 640-643, 2012.
3. S. Iyyappan and V. Nandagopal, "Automatic accident detection and ambulance rescue with intelligent traffic light system," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 2, no. 4, pp. 1319-1325, 2013.
4. B. Prachi, D. Kasturi and C. Priyanka, "Intelligent Accident-Detection And Ambulance- Rescue System," International Journal of Scientific & Technology Research, vol. 3, no. 6, pp. 67-70, 2014.
5. E. Nasr, E. F. Kfoury and D. J. Khoury, "An IoT approach to vehicle accident detection, reporting, and navigation," International Multidisciplinary Conference on Engineering Technology, pp. 231 236, 2016.
6. B. R. Giridhar, "Traffic signals based on density with innovative clearance for ambulance," International Journal of Innovations in Engineering and Technology, vol. 7, 2016.
7. N. Kattukkaran, A. George and T. P. Haridas, "Intelligent Accident Detection and Alert System for Emergency Medical Assistance," International Conference on Computer Communication and Informatics, 2017.
8. R. Harshada, B. Tejas, V. Akshay, J. Ketan and M. Mihir, "Traffic density control," International Journal of Interdisciplinary Research, vol. 3, no. 4, 2017.
9. N. D. Ram, V. V. Krishna, D. K. Kalika and J. Kokilavani, "Smart Traffic Light Controller," Internal Journal of Latest Engineering and Management Research (IJLEMR), vol. 04, no. 03, pp. 83-89, 2019.
10. W. R. Mouleeshu, D. S. Niviya, E. G. Pearlstone, K. M. Sathish and A. M. Yashar, "Make Way: An Intelligent Real-Time Traffic Light Control System," International Journal of Engineering and Advanced Technology, vol. 9, no. 2, pp. 709- 712, 2019.