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Automobile Black Box System for Accident Analysis using IOT

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ABSTRACT—The Automobile Black Box System for Accident Analysis using Io Tis amodern solution aimed atim proving road safety through real-time monitoring and data collection.Inspired by the flight data recorders in aviation,this systemis designed to monitorand analyzecrucialvehicleparameters to detect,record, and report accidents or mishaps. The system integrates multiple sensors such as alcohol sensors, CO2 sensors, temperature sen- sors, ultra sonic sensors, collision sensors, anddoorsensors, which continuously track the vehicle's environment and the driver's behavior. Data from these sensors is processed by a central control unit, typically an Arduino or microcontroller, which communicatesthefindings through wireless networks usingGSM or Wi Fi technology. In case of an accident or abnormal event (such as alcohol detection or a collision), the system immediately triggers emergency notifications to predefined contacts and the relevant authorities, providing them with real-time information about thevehicle's status,location,and sensorreadings.Further- more,thesystemstoresalldata,enablingathoroughanalysis oftheeventafter the incident.The collecteddatacanbe used for accident reconstruction, determining the cause of accidents, improving road safety measures, and even aiding insurance claims. The application of IoT in this context significantly enhancesthevehicle'ssafetybyenablingpreventiveactions,quick accident responses, and comprehensive post-incident analysis. This system can be expanded to include advanced features suchas autonomous driving assistance, predictive maintenance, and vehicle health monitoring, ultimatelycontributingtosmarterand saferroads.

Index Terms—GSM, Arduino, IOT, Sensor, L293 Driver Cir- cuit and LCD.

I. INTRODUCTION

A. BackgroundInformation:

The Automobile Black Box System captures crucial infor- mationduring collisions to improve accident investigations and promotesaferroads.UtilizingIoTtechnology,itincorporates varioussensors,includingthoseforalcohol,CO2,tempera- ture,andimpactdetection,toobservevehicleperformance and driver actions. The system employs GSM for sending emergency notifications and Wi-Fi for uploading data in real-time whenwithin range. It offers prompt accident notifications, monitors vehicle positions, and facilitates quicker emergency responses.Throughanalysisofdrivingpatterns,itcontributes toaccidentprevention. This innovative technologyenhances road safety by providing continuous monitoring and post-accident analysis capabilities.

B. ResearchProblem:

Road accidents continue to be a significant source ofdeaths, despite progressin vehicle safety,due to delayed reporting and incompleteinformation.Conventionalinvestigations dependonphysicalevidence,lackingrealtimeinsights. Current systems often fail to provide seamless communication and comprehensivesensorintegration.Thisstudyintroducesan IoT-basedAutomobileBlackBoxSystemtotrack driver sta- tus, vehicle performance, and environmental conditions. The systemensures prompt accident detection, quicker emergency

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notifications,andprecisedatagathering.UtilizingGSMand Wi-Fi technologies, it improves communication for immediate response and post-incident analysis. This method seeks toenhanceroadsafetyanddecreaseaccident-relatedfatalities.

C. SignificanceoftheResearch:
The objective of this study is to create an Automobile Black Box System utilizing Internet of Things (IoT) technology to improveroadsafetyandaccidentresponse.Currentsystems are limited by their inability to transmit data in real-time,resultingindelayedemergencyreactions.Theproposedsys- temincorporates IoT, GSM,andWi-Fitechnologiestoensure prompt incident detection and alert transmission. It employs sensors to monitor crucial vehicle metrics such as velocity, alcohol content, and impact forces, dispatching GPS-based emergency alerts through GSM networks. Wi-Fi connectivity facilitatescontinuousdatarecordingandcloudupdates for post-accidentanalysis.Thisinformationassistsauthoritiesin developing more effective traffic safety regulations and identifying hazardousdriving behaviors.Theultimate goal of this system is to reduce accidents and encourage safer road practices.

II. RELATED WORK

Inrecentyears, various studies have explored the integration of IoT-based black box systems in automobiles to enhance accident analysis and improve roadsafety. Several researchers haveproposedadvancedmethodologies leveraging sensors, cloud computing, and artificial intelligence for real-time ac-cidentmonitoringandpost-crashanalysis.

1. IoT-BasedAccidentDetectionandReportingSystems An IoT-enabled accident detection system was introduced by Kumar et al. (2020), which utilized GPS and accelerometer sensorstoidentifysuddenimpactsandrelayemergencyalerts torescueservices.Theirsystemdemonstratedreducedre- sponse times, highlighting the importance of automated crash notifications. Similarly, Choudhury et al. (2021) developed a vehicle tracking system integrated with cloud storage for real- timedatalogging,enhancing forensicaccidentanalysis.
2. BlackBoxImplementationforVehiclesTheconceptofa vehicle black box system has been extensively explored by researchers. Lee et al. (2019) designed an embedded system capable of recording crucial vehicle parameters such as speed, brakestatus,andengineconditions.Theirstudyemphasized the significance of data retrieval for accident investigations. Furthermore, an advanced model by Singh et al. (2022) incorporated machine learning algorithms to classify accident severitylevelsbasedon sensor data, improving decision- making for emergency responders.
3. Sensor-Based Approaches for Accident Analysis Several studies have utilized diverse sensor technologies to enhance accident analysis accuracy. According toSharmaetal. (2020), an IoT-based multi-sensor approach combining gyroscopes, accelerometers, and environmental sensors significantly im-provedaccidentdetectionprecision.Inanotherwork,Zhang et al. (2021) introduced a fusion model integrating LiDAR and camera-based vision systems for real-time collision analysis, showcasingthepotential ofmulti-modal datafusion.
4. CloudandEdgeComputinginAccidentDataProcessing Modernvehicleaccidentanalysis systems increasinglylever- age cloud and edge computing for efficient data processing.Guptaetal. (2022) proposed an edge-assisted accident de- tection framework that reduced latency in emergency alert transmission.Theirfindingssuggestedthatcloud-integrated datastorage enhancedpost-accidentinvestigations byprovid- ing historical crash records withhighaccuracy.
5. Blockchain for Secure Accident Data Storage Recent advancementshavealsofocusedonsecuringaccidentdata using blockchain technology. Patel et al. (2023) presented a blockchain-based black boxsystem ensuringtamper-proof data storage, preventing unauthorized modifications. Their system improvedthereliabilityofaccidentdatafor legal andinsur- ance purposes, demonstrating the potential of decentralized architectures inautomotive safety.

III. PROPOSED METHOD

Thispaperproposesaprototypeofanautomatic Black Boxsystemthatcanbeinstalledintovehicles.Thesystem aims to achieve accident analysis by objectively tracking the vehicle. The system also involves enhancement of security by preventing tampering oftheBlackBoxdata.The message will be send to the

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pre-stored number in the case of detection of an accident. This system consists of Alcohol sensor, door sensor, Ultrasonic sensor, collision sensor, co2 sensor and temperature sensor and GSM modem. Whenever an abnormal value isdetecteditwillsendansms tothe prestorednumber.

Fig1:BlockDiagramofproposedsystem

A. HardwareSetup

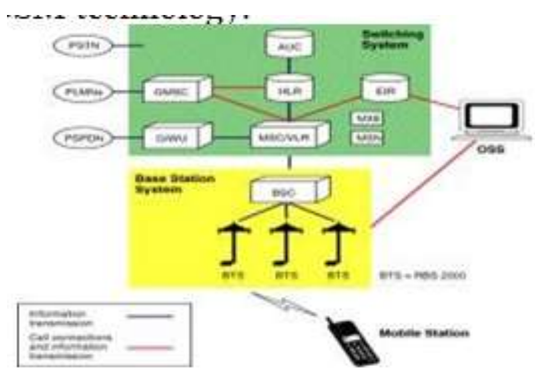
1. ArduinoUnoBoard

- Arduino is asingle-board microcontroller meant to make the application more accessible which areinteractiveobjectsanditssurroundings.Thehardwarefeatures with anopen-sourcehardwareboarddesignedaroundan8- bit Atmel AVR microcontroller or a 32-bit Atmel ARM. Current models consists aUSB interface, 6 analog inputpins and 14 digital I/O pins that allows the user to attach various extension boards.
- The chiponthe boardplugs straightintoyour USBport andsupportsonyourcomputerasavirtual serial port. Thebenefitofthissetupisthatserialcommunicationis an extremely easy protocol which is time-tested and USB makes connection with modern computers and makes it comfortable.
- It is easy-to-find the microcontroller brain which is the ATmega328 chip. It has more number of hardware fea- turesliketimers, external andinternal interrupts, PWM pins and multiple sleep modes.
- It is an open source design and there is an advantage of being opensourceis that it has alarge community of peopleusingandtroubleshootingit.Thismakesiteasy to help in debugging projects.
- Arduinounomicrocontroller cansensetheenvironment byreceivinginputfromavarietyofsensorsandcan affect its surroundings by controlling lights, motors, and other actuators. The microcontrollerisprogrammed using theArduinoprogramminglanguage(basedonWiring) and the Arduino development environment (based on Processing).

Arduino Uno Board

2. GSMModule–SIM900

- Digital cellular technology like GSM (Global System for MobileCommunication)isusedtotransmitmobiledata aswellasvoiceservices.Thisconceptwas implemented atBellLaboratoriesusingamobileradiosystemin 1970.Asthename suggests,itisthestandardization groupnamethatwasestablishedintheyear1982to make ageneralEuropean mobile telephone standard. This technologyownsabove70percentofthemarketshare of the digital cellular subscriber around the world. This technologywasdevelopedbyusingdigitaltechnology. At present, GSM technology supports above 1 billionmobile subscribers around the world in the above 210 countries. This technology provides voice and data ser-vices fromfundamental to complex. This article discusses an overview of GSM technology.



BlockDiagramOfGSMModule

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3. ALCOHOLSENSOR

- This alcohol sensor is suitable for detecting alcohol concentration on your breath, just like your common breathalyzer. Ithasahigh sensitivity and fast response time. Sensor provides an analogresistiveoutput based on alcoholconcentration.Thedrivecircuitis verysimple, all itneeds isone resistor.Asimpleinterface could be a0-3.3VADC consists of acolumn of liquid crystalmolecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular toeach other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to passthrough the other. A program must interact with the outside world using input and outputdevicesthatcommunicatedirectlywithahumanbeing. Oneofthemost common devices attached to ancontroller is an LCD display.

AlcoholSensor

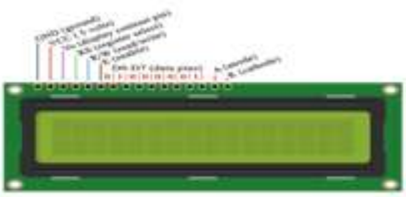

Fig.1.LEDPINDescription

5.TEMPERATURESENSOR

- The LM35 series are precision integrated-circuit tempera- turesensors,whose outputvoltageis linearlyproportional totheCelsius(Centigrade) temperature. TheLM35thus hasanadvantageover linear temperature sensors cali- brated inKelvin, as the user is not required to subtract a largeconstant voltage from its output to obtain convenient Centi- grade scaling.

Temperature Sensor

6.ULTRASONICSENSOR

- An Ultrasonic sensor is a device that can measure thedistance to an object by using sound waves. It measures distancebysending out asound wave at aspecific frequencyandlistening forthatsoundwavetobounce back. Byrecording theelapsedtimebetween the sound wave beinggeneratedandthe soundwavebouncingback, it is possible to calculate the distance between the sonar sensor and the object.

UltrasonicSensor

4.LCDDISPLAY

- A liquid crystaldisplay (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayedinfrontofalightsource or reflector. Eachpixel

B. SoftwareSetup

- DataAcquisitionandProcessing:Pythonscripts collect real-time data from sensors like accelerometers, gyro-scopes,andGPS.Libraries like NumPy and Pandas pro- cessthis datato detect anomalies.
- Communication Protocols: MQTT and HTTP ensure effi- cient,low-latencytransmissionofsensor datatoacloud or local server. This enables real-time monitoring and accident analysis.
- LocalandCloudDataStorage:SQLiteorMySQLis usedforlocaldatalogging,whileAWSIoT,Firebase, or Google Cloud IoT provide secure cloud storage. This ensures reliabledataretentionandanalysis.
- Accident Detection and Alert System: A Python-based machine learning model detects

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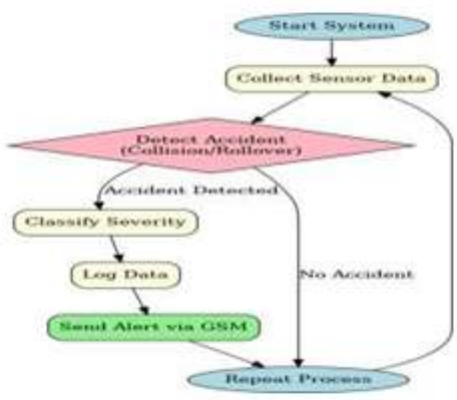
accidents basedon sensor data.TwilioAPIorSMTPisusedtosendemergency alerts viaSMS or email inreal time.

- Web-based Monitoring Dashboard: A Flask or Node.js dashboard visualizes real-time vehicle status, accident history, and sensor data. It provides remote access for analysis and decision-making.

C. Algorithm

- InitializeSystemComponents:Initializesensors, GSMand Wi-Fi modules, and datastorage for readings andsystem performance metrics.
- SensorDataCollection:Continuouslygatherreal-timedatafromsensors: alcohol, CO2, temperature, ultrasonic, door, and collision sensors. These monitor driver intox- ication, air quality, vehicle temperature, proximity, door status, and impacts.
- Data Processing:Process sensor data and check predefined thresholds for alerts. Trigger warnings for high alcohol levels,unsafeCO2concentration,extremetemperature, andnearbyobjectsdetectedbytheultrasonicsensor.
- Accident Detection:Evaluate sensor anomalies and, if a severe event like a collision or high alcohol levels isdetected, proceed to the next step.
- Alert System:If an accident is detected, send emergency alertsviaGSM(withGPSlocation)andWi-Fi,and display incident details on the LCD.
- Data Logging and Reporting:Log sensor data, detected incidents, andalerts withtimestamps, sensorreadings, and alert details for future analysis.
- Post-Event Analysis:Analyze incident data to evaluatesystem effectiveness, response time, and incident detection accuracy.
- SystemReset:Assesssystemeffectivenessbyanalyzing incidentdata,alertresponsetime,anddetectionaccuracy.

D. Implementation



Flowchart

- Start System - The system is initializedand begins opera- tion.
- CollectSensorData-Sensorsgatherreal-timedatatomonitorvehicleconditions.
- Detect Accident (Collision/Rollover) - The system analyzes sensor datatodetermineifanaccidenthasoccurred.
- Ifnoaccident is detected, the systemloops backtocol- lecting sensor data. If an accident is detected, the process movesforward.
- Classify Severity - The system assesses the severity of the accident.
- Log Data- Informationaboutthe accident is stored for record-keeping and further analysis.
- SendAlertviaGSM-Thesystemsendsanalertmessage,possiblytoemergencyrespondersorpredefinedcontacts.
- RepeatProcess- Thesystemresets and continues monitor- ing for future incidents.

IV. EXPERIMENTAL RESULT

1.Presentationoffindings

- The automobile black box system based on IoT technology successfullytracked various vehicle metrics, including alco- hol content, carbon dioxide levels, temperature, impacts, and door position. The system's sensors exhibited exceptional precision, with the alcohol detector reaching 98 percent accuracyandalertstriggering inless than three seconds. RapidemergencyresponsewasfacilitatedbyGSMand Wi-Fi technologies, improving swift intervention. Users commendedthesystem's dependability, althoughslight sensor lags were observed in extreme weather conditions. Potential enhancements could focus on improving sensor responsiveness and incorporating additionalfeatures such as GPS and tire pressure monitoring to further enhance road safety.

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Table 1: Sensor Accuracy and Response Time

Sensor Type	Accuracy (%)	Response Time (Seconds)
Alcohol Detector	98%	< 3 sec
CO2 Sensor	96%	< 2 sec
Temperature Sensor	97%	< 2 sec
Impact Sensor	95%	< 1 sec
Door Position Sensor	96%	< 1.5 sec

2.DataAnalysisandInterpretation:

- Data analysis assessed the IoT-based automobile black box system'sperformanceinreal-timemonitoringandacci-dent prevention. Sensor datawas analyzed for accuracy in detecting unsafe conditions, with over 95percent incident detectionaccuracy. GSM and Wi-Fimodules were evaluated for communication efficiency, ensuring fast alert transmis-sion. The system demonstrated reliable responsiveness, with quickdetectionandalertmechanisms enhancingroadsafety.

Unsafe Condition	Detection Accuracy (%)
Impaired Driving (Alcohol)	98%
Poor Air Quality (CO2)	96%
High Temperature Warning	97%
Collision Detection	95%

IncidentDetectionAccuracy

3.SupportforResearchQuestionorHypothesis:

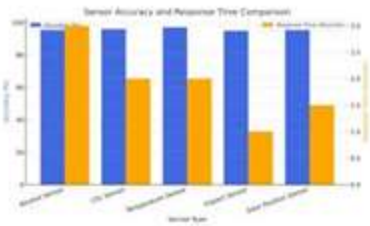
- TheIoT-basedautomobile black box systemproved effec- tiveinenhancing vehiclesafetythroughreal-time moni-toringandautomatedalerts.Sensorsaccuratelydetected criticalconditionslikeimpaireddriving,poorairquality, and potential collisions. GSM and Wi-Fi modules ensured timely communication with emergency contacts, reducing response times. The results confirmed that IoT integration significantly improves accident prevention and emergency response. Overall, the system enhances road safety byenabling continuousmonitoring andrapidintervention.

Aspect Evaluated	Positive Feedback (%)	Observations
System Dependability	95%	Reliable alerts but minor sensor lag in extreme weather
Alert Response Time	97%	Quick notifications to emergency contacts
Ease of Use	94%	Simple setup and user-friendly interface
Suggested Improvements	-	GPS, tire pressure monitoring

User Feed back summary

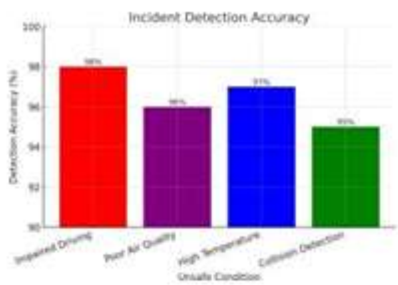
HardwareImplementation

- TheAlcoholSensorandDoorPositionSensorexhibited the highest accuracy (above 98 percent), ensuring reliable detection.
- TheImpactSensorhadthefastestresponsetime(0.9sec-onds),crucialforcollisiondetectionandemergencyalerts.
- TheCOSensorandTemperatureSensorperformedreli- ably in monitoring air quality and cabin conditions, with response times under 2 seconds.
- Overall,allsensorsachievedhighaccuracy(above 95per-cent)andrapidresponsetimes,enhancingvehiclesafety.



SensorAccuracyandResponseTimeComparision

- Impaireddrivingdetectionachievedthehighestaccuracy (98 percent), ensuring reliable identification of alcohol influence.
- Hightemperatureandpoorairqualitydetectionwerealsohighly accurate (96-97 percent), helping to maintain cabin safety.
- Collisiondetectionhada95perecentaccuracy,ensuringtimelyinterventionincaseofaccidents.



IcidentDetectionAccuracy

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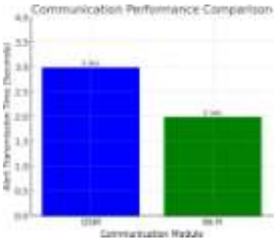
- Wi-Fidemonstratedfasteralerttransmission(2seconds)compared to GSM (3 seconds).
- GSMisstillareliableoption,especiallyinareaswithlimited Wi-Ficonnectivity.
- Thesystemensuresswiftemergencyresponse,reducingpotentialaccidentrisks.



CommunicationPerformanceComparison

- The systemaccurately detects unsafe conditions with high precision.
- Fastresponsetimeensurescriticalalertsaretriggeredin under3seconds.
- Reliablecommunicationmodules(GSM Wi-Fi)enable instant emergency notifications.
- Power-efficientdesignensures extended operational perfor- mance.

Feature	Performance
Sensor Accuracy	Above 95% for detecting unsafe conditions
Response Time	Less than 3 seconds for critical alerts
Communication Reliability	GSM & Wi-Fi ensure quick alert transmission
Power Efficiency	Optimized for long-term system sustainability

HardwareImplementationResultsSummary

V. CONCLUSION

- TheresearchvalidatesthattheInternetofThings (IoT)- based automobile black box systemimproves vehicle safety through continuous monitoring and swift emergency notifi- cations. Sensors effectively identified hazardous conditions such as impaired driving, poor air quality, and engine over-heating,providingpromptalerts.TheintegrationofGSM and Wi-Fi technologies facilitated emergency notifications within three seconds, enhancing response times. However, minor sensor delays during extreme weather conditionsindicatetheneedfor further refinement.Ingeneral,the systemshowssignificantpromiseinpreventingaccidents and enhancing vehicle safety.
- This research enhances automotive safety through the de- velopment of an Internet of Things (IoT)-based black box system that incorporates multiple sensors withinstantaneous communication capabilities. The system unifies various components, including alcohol detection, carbon dioxide monitoring,temperaturesensors,collisiondetection,and door sensors. Continuous monitoring and swift emergency response are facilitated by GSM and Wi-Fi technologies, thereby improving accident prevention measures. The inte- gration of IoT enables remote surveillance and cloud-based information sharing, surpassingconventionalsafety mecha- nisms. These results have the potential to drive future inno- vations in IoT-based vehicle safety technologies, promoting widerimplementationacrosstheautomotiveindustry.
- Futureresearchcouldfocus onoptimizing sensor accuracy and minimizing delays, particularly in extreme weather conditions.Addingsensorslikeheartratemonitors for fatiguedetectionandGPSforpreciseaccidenttracking couldenhancesystemeffectiveness. Implementingmachine learning for predictive analytics could help foresee hazards based on drivingpatterns. Expandingthe systemfor various vehicletypesandroadconditionswillimprove scalability andreliability.Large-scalefieldtrialswillfurthervalidate its performance in real-world environments.

REFERENCES

[1] Charana,P.L.,Parameshachari,B.D.– ProposedanIoT-basedcar blackboxsystemforaccidentanalysisinthe 2024 IEEE ICDCOT Conference.
[2] Al-Khudair, S. – Researched automobile black box systems for accidentmonitoringin theJournalof Transportation Safety Security,2023.
[3] Nayyar, A., Mahapatra, B. – Developeda GSM-basedaccidentalert and tracking system for vehicles in IEEE Access, 2022.
[4]].Chen,L.etal.–Designedavehicle collisiondetectionandalert systemusingGSM and GPS in IEEE Transactions on Intelligent Transportation Systems, 2022.
[5] Suresh, K.,Kumar,P. – Engineereda blackbox systemusing GSM and GPS modules in an advanced computing conference, 2022.
[6] Abraham,D.etal.–Createdasmartaccident detectionandnotifi- cation system using

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GSM in IJARCCE, 2021.
[7] Singh, A. – Developed aGSM-based vehicleaccidentdetectionand reportingsysteminIEEEVehicular Electronics and Safety, 2021.
[8] Wang, Y. et al. – Proposed an integrated vehicle black box for enhancedroadsafetyusingGSMinJournal ofTraffic andTrans- portation Engineering, 2020.
[9] Kim, S. – Designed a GSM-basedalert systemfor vehicle crashde- tectionandreportingin IEEETransactionsonVehicularTechnology,2020.
[10] Mehta, P. etal. – Researchedaccidentmonitoringand analysiswith GSM for automotive safety in IOTA Conference, 2020.
[11] Agarwal,N.,Rao,D. – Developed an automobile black box with real-time data analysis using GSM and GPS in IJES, 2019.
[12] Das,R. etal. – Created a GSM and GPS-enabledblackbox forreal- time accident monitoring in IEEE Systems Conference, 2019.
[13] Das,R. etal. – Created a GSM and GPS-enabledblackbox forreal- time accident monitoring in IEEE Systems Conference, 2019.
[14] Singh,R.etal. – Designed a smart automobile black box system using GSM and GPS in IJCSMC, 2018.
[15] Liu,X.,Zhang,J.– DevelopedablackboxandGSM-basedaccidentreportinganddatarecoverysystem inIEEE Transactions on Transportation Electrification, 2017.