AUTOMATIC DETECTION AND NOTIFICATION OF POTHOLES AND HUMPS ON ROADS TO AID DRIVERS

A PROJECT REPORT

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Under the guidance of,

DR. JAYANTHI KAMALASEKARAN

In partial fulfillment for the award of the degree of

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IN

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At

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

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PRESIDENCY UNIVERSITY

SCHOOL OF COMPUTER SCIENCE ENGINEERING

CERTIFICATE

This is to certify that the Project report **"AUTOMATIC DETECTION AND NOTIFICATION OF POTHOLES AND HUMPS ON ROADS TO AID DRIVERS"** being submitted by "SADIPARALA NAGA BHUSHAN REDDY, AKSHAY TADIKONDA, BACHU VENKATA BALA NAGENDRA BABU, CHINTA MARY KIRANMAYE" bearing roll numbers "20211CSE0486, 20211CSE0485, 20211CSE0498, 20211CSE0031" in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering is a Bonafide work carried out under my supervision.

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DECLARATION

We hereby declare that the work, which is being presented in the project report entitled **AUTOMATIC DETECTION AND NOTIFICATION OF POTHOLES AND HUMPS ON ROADS TO AID DRIVERS** in partial fulfillment for the award of Degree of **Bachelor of Technology in Computer Science and Engineering,** is a record of our own investigations carried under the guidance of **DR. JAYANTHI KAMALASEKARAN, Associate Professor, School of Computer Science Engineering, Presidency University, Bangalore.**

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ABSTRACT

Road conditions are a critical determinant of the safety and comfort of drivers and passengers. Poorly maintained roads, which are characterized by potholes and humps, pose a great risk to vehicles and human lives, causing accidents, damage, and increased maintenance costs. This research presents an innovative system for the automatic detection and notification of potholes and humps on roads to assist drivers in safe navigation. The system uses a combination of ultrasonic sensors, a DHT22 environmental sensor, and Bluetooth technology, integrated with an Arduino-based platform. Ultrasonic sensors detect the presence and dimensions of road irregularities, while the DHT22 sensor provides real-time temperature and humidity data to monitor environmental conditions.

To enhance user experience, the system integrates a Liquid Crystal Display (LCD) for local notifications and uses Bluetooth communication to transmit alerts to a mobile application. The prototype vehicle shows excellent pothole and hump detection accuracy. The system benefits in two ways: drivers get instant notifications and road maintenance authorities receive the data collected by the system. In doing so, it saves the vehicles from potential damage and accident risk during travel. Also, this will contribute to making smart city a success as the system is well suited for ITS integration. The design, implementation, and performance evaluation of the proposed system have been discussed to show its promising potential in revolutionizing road condition monitoring and driving safety.
Road conditions play a significant role in the safety and efficiency of transportation systems. Potholes and unmarked humps on roads can cause damage to vehicles, accidents, and increased maintenance costs for drivers and road authorities. This research focuses on developing an automatic detection and notification system for potholes and humps to assist drivers in identifying and avoiding road hazards. It will use ultrasonic sensors to measure road irregularities, an Arduino-based microcontroller for data processing, and Bluetooth communication to alert a mobile application. Moreover, it uses DHT22 for temperature and humidity monitoring to enhance environmental information in road condition analysis.

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LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS

CHAPTER-1
INTRODUCTION

1.1 OBJECTIVE OF PROJECT:

The main intention of this project is to create an automated detection and notification system about potholes and speed bumps on roads. This system enhances road safety and reduces accidents due to timely, accurate information that will be used to improve driving experiences. In utilizing modern technologies including sensors, GPS, and image processing, this project aims to remove the limitations and constraints of using traditional methods that are mostly labor-intensive, tedious, and inefficient for road monitoring.

A key goal is to provide real-time pothole and hump detection. This will be done by immediately notifying drivers, so they may adjust their driving behavior to avoid these hazards. The integration of advanced sensing technologies with communication systems would provide accurate information about the location and severity of road irregularities. Such information can prevent damage to vehicles, reduce accident risks, and optimize travel safety for road users.

1.2 PROBLEM STATEMENT:

Road conditions are very important for the safety and comfort of drivers and passengers. However, the existence of road irregularities, such as potholes and speed humps, has become a significant issue in many regions. Potholes are caused by wear and tear or poor maintenance, leading to vehicle damage, increased fuel consumption, and even severe accidents. On the other hand, ill-defined or unparticipating speed humps are likely to be a surprise for drivers, thus causing sudden braking, collisions, and discomfort. The absence of real-time information about such irregularities on the roads is one major challenge that is faced by the drivers, particularly in unfamiliar regions or during night driving.

These traditional methods of detecting and correcting road anomalies, like the manual road survey, take time, consume a lot of man-hours, and have the tendency to cause delays. More importantly, they are unable to give updates in real time, which may put drivers in jeopardy. Thus, with rising traffic volumes and expanding road networks, it has become necessary to evolve efficient systems that can automatically detect road anomalies and alert the drivers.

1.3 MOTIVATION:

The motivation for this project comes from the increasing need to address the challenges posed by poor road conditions, which have a significant impact on driver safety, vehicle performance, and the quality of transportation as a whole. Potholes and unmarked speed humps are common problems that drivers face around the world, especially in regions where road infrastructure maintenance is not up to par. These irregularities increase the risk of accidents and lead to higher repair costs for vehicles, delays in travel, and decreased fuel efficiency, affecting both individuals and communities.

The frequent reports of accidents caused by unexpected potholes or improperly marked speed humps bring to the fore the need for a solution. Traditional methods of identifying and fixing road irregularities are slow and inefficient, leaving drivers exposed to avoidable hazards for extended periods. This gap in road monitoring systems presents an opportunity to develop an innovative, automated approach to enhance road safety and efficiency.

1.4 SCOPE:

This project aims to develop an automated system that detects and notifies users of road irregularities such as potholes and speed humps. The scope includes leveraging advanced technologies such as sensors, image processing, and GPS to accurately identify these irregularities. The system will be designed to function reliably under various environmental conditions, including diverse lighting and weather scenarios, ensuring its applicability in real-world settings.

This is a very critical feature of this project: real-time alerts to drivers of observed defects. The alert will be delivered to the user via an in-vehicle interface or via a mobile application with detailed information regarding the location, severity, or type of defect in the road. The system expects to improve driving experiences and road safety by providing timely alerts.

1.4.1 Detection of Road Irregularities:

The area that the detection of road irregularities, like potholes and speed humps, is basically covered in this project. The advanced technologies, such as accelerometers, gyroscopes, ultrasonic sensors, cameras, will be utilized for precise recognition of potholes and other irregularities. Furthermore, the overall system processes data from these sensors to recognize anomalies in the road surface. For instance, accelerometers and gyroscopes can measure sudden vertical displacements or vibrations due to potholes or humps, while cameras and image processing techniques can visually classify these irregularities. Machine learning algorithms can further enhance the accuracy by distinguishing between true irregularities and false positives caused by shadows, debris, or other non-road-related elements. The system will be designed to work under diverse environmental conditions, including low light and adverse weather, to ensure reliable detection in all scenarios.

1.4.2 Real-Time Notification:

Once road irregularities are detected, the system shall give an instant alert to drivers. The alerts will be delivered through mobile applications, in-vehicle display systems, or connected devices. The notifications will include the location of the irregularity via GPS, its severity (shallow or deep potholes) and type (pothole or speed hump). The alerts will be designed to be non-intrusive but effective, ensuring the driver can act in time without being distracted. For instance, voice alerts, visual indicators, or vibration signals can be employed depending on the medium. This is real-time feedback that informs the driver of possible hazards ahead of time, giving them ample opportunities to adjust speed or maneuver with safety, which reduces the probability of accidents and damage to the vehicle.

1.4.3 Data Collection and Mapping:

Data detected will also be collected using a central hub in which every discovered pothole and hump is recorded based on severity and classification with geotagged coordinates to show GPS locators. That will always change to store more recent updates online with an auto-backup data service stored online to access map representations and actual condition graphics to describe every stretch of the roads. They provide up-to-date visual representation regarding road quality which helps the motorists plan safer, much better routes. As a historical depository, database will be consulted to carry on trend analysis against time. Example areas with probable recurring damage points and monitoring if road repairs turn out effective could be some application based on such observations. It'll be made accessible to road maintenance authorities, the urban planners along with other entities for decision support.

1.4.4 Scalability and Applicability:

The system will be designed to be scalable so that it can be applicable across diverse geographic regions and road types. Its modular architecture will make it possible to adapt to various deployment scenarios, ranging from urban highways to rural roads. Cost-effective sensors and open-source technologies will be used to make the solution affordable and feasible for wide-scale implementation. In addition, the system will be compatible with different vehicle types, from personal cars to public transportation and commercial vehicles. This scalability ensures that the system can be implemented in both developed and developing regions, addressing the unique challenges faced by different communities while maintaining efficiency and reliability.

1.4.5 Integration with Intelligent Transportation Systems (ITS):

To enhance overall traffic management, the system will explore integration opportunities with existing Intelligent Transportation Systems (ITS). By sharing data about road conditions and irregularities, the system can contribute to real-time traffic updates, optimized navigation, and enhanced vehicle-to-infrastructure (V2I) communication. For instance, the detected data could be used to reroute traffic around heavily damaged roads or areas under repair, reducing congestion and improving travel efficiency.

1.4.6 Support for Road Maintenance Authorities:

This system shall offer critical inputs to the maintenanceauthorities responsible for the roads in question.It also can be utilized for predictive purposes as regards its capability to pinpoint recurring damages to a specific spot so proactive action may be applied to avert the more significant issues from developing . It enhances road safety and improves efficiency in road maintenance operations, with a reduction in costs and thus providing a better driving experience to the users of the roads.

CHAPTER-2
LITERATURE SURVEY

2.1 Related work

The paper titled as "Smart Road Safety System using IoT and Vehicle Communication" focuses on leveraging Internet of Things (IoT) technology and vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I) communication to enhance road safety. By establishing a connected network of vehicles, sensors, and infrastructure, such systems can enable real-time sharing of critical information, such as road conditions, traffic congestion, and potential hazards.

This approach aims to minimize accidents by delivering timely alerts to drivers and authorities, allowing for proactive responses to emerging dangers. The integration of IoT ensures continuous monitoring and data exchange, while communication technologies facilitate seamless coordination among vehicles and infrastructure. As a result, this system not only improves individual vehicle safety but also contributes to smarter traffic management and overall road safety.[1]

The paper titled as "A Research of Pavement Potholes Detection Based on Three-Dimensional Project Transformation" focuses on leveraging Internet of Things (IoT) technology and vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I) communication to enhance road safety. By establishing a connected network of vehicles, sensors, and infrastructure, such systems can enable real-time sharing of critical information, such as road conditions, traffic congestion, and potential hazards. This approach aims to minimize accidents by delivering timely alerts to drivers and authorities, allowing for proactive responses to emerging dangers. The integration of IoT ensures continuous monitoring and data exchange, while communication technologies facilitate seamless coordination among vehicles and infrastructure. As a result, this system not only improves individual vehicle safety but also contributes to smarter traffic management and overall road safety.[2]

The paper titled as "Real-Time Hazard Detection Using IoT" focuses on the development of intelligent systems that utilize Internet of Things (IoT) technology to identify and respond to road hazards in real time. These systems integrate IoT-enabled sensors, devices, and communication networks to continuously monitor the environment, detect potential threats such as debris, potholes, or adverse weather conditions, and provide instant alerts to drivers and road authorities.

The core concept involves the deployment of smart sensors on roads, vehicles, or infrastructure to gather and analyze data. The system processes this data using cloud or edge computing to identify hazards and disseminates warnings to nearby vehicles or control centers via IoT communication protocols. This real-time responsiveness enhances road safety by enabling proactive measures to avoid accidents and mitigate risks, making IoT an essential component in modern transportation systems.[3]

The paper titled as “Road Hazard Detection and Sharing with Multimodal Sensor Analysis on Smartphones” explores the use of smartphones as a cost-effective and widely accessible platform for detecting and sharing road hazards. By leveraging the multiple sensors embedded in modern smartphones, such as accelerometers, gyroscopes, GPS, and cameras, the system can identify road anomalies like potholes, speed bumps, or slippery surfaces.

The study emphasizes the integration of multimodal data from these sensors to improve the accuracy and reliability of hazard detection. Once detected, the information is shared in real-time with other road users and authorities through cloud-based platforms or vehicle-to-everything (V2X) communication. This collaborative approach not only enhances situational awareness for drivers but also aids in road maintenance planning by providing detailed hazard maps. The research demonstrates how everyday technology can contribute to smarter and safer transportation networks.[4]

The paper titled as “Real-Time Road Surface Condition Detection Using Vibration Sensors “focuses on employing vibration sensors to monitor and assess road surface conditions dynamically. Vibration sensors, typically mounted on vehicles, measure the variations in vibrations caused by irregularities in the road surface, such as potholes, cracks, and bumps.

This approach uses real-time data processing techniques to analyze the vibration patterns and correlate them with specific types of road anomalies. The system enables timely detection and reporting of hazardous conditions, facilitating quick responses to potential risks. By providing continuous and automated road surface monitoring, this method supports the development of smarter transportation systems, improving safety and reducing maintenance costs for both vehicles and infrastructure.[5]

The paper titled as “Wireless Sensor Network for Road Condition Monitoring” explores the application of wireless sensor networks (WSNs) to continuously monitor and evaluate road conditions. This system employs a network of interconnected sensors deployed along roads or embedded in vehicles to collect real-time data on surface irregularities, structural wear, and environmental factors affecting road safety. The study highlights how WSNs facilitate efficient data transmission to central systems for analysis and decision-making. These networks enable scalable, cost-effective monitoring of large road networks, reducing reliance on manual inspections. By providing timely alerts about deteriorating road conditions, such systems aid in proactive maintenance planning, enhance traffic safety, and improve the overall efficiency of transportation infrastructure management.[6]

The paper titled as “Dynamic Road Hazard Detection and Prevention Systems Using Wireless Communication**”** focuses on leveraging wireless communication technologies to detect, analyze, and prevent road hazards in real time. This system relies on vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication protocols to share information about dynamic road conditions, such as sudden obstacles, slippery surfaces, or accidents. The study emphasizes the integration of wireless sensor networks, IoT devices, and advanced data processing algorithms to identify hazards and disseminate warnings promptly. These systems aim to reduce response times, enhance driver awareness, and prevent accidents by enabling vehicles and infrastructure to work collaboratively. By dynamically adapting to changing road conditions, this approach significantly contributes to the safety and efficiency of modern transportation systems.[7]

“Smart Road System: An Efficient Approach to Road Safety” explores the implementation of advanced technologies to create intelligent road systems that enhance traffic safety and efficiency. This approach integrates smart sensors, IoT devices, and communication networks to monitor road conditions, manage traffic flow, and detect hazards in real time.
The system emphasizes proactive measures, such as alerting drivers to potential dangers, optimizing traffic signals, and providing data-driven insights for road maintenance and planning. By combining real-time data collection with intelligent analysis, the smart road system creates a connected infrastructure that reduces accidents, minimizes congestion, and supports safer driving experiences. This research highlights the potential of leveraging modern technology to transform traditional roadways into smarter, safer, and more efficient transportation networks.[8]

"A Novel Approach for Pothole Detection Using Image Processing and IoT" presents an innovative solution for identifying and monitoring potholes on road surfaces by combining image processing techniques with Internet of Things (IoT) technology. This approach utilizes cameras or imaging sensors mounted on vehicles or infrastructure to capture high-resolution images of the road surface. The captured images are then processed using advanced image processing algorithms to detect potholes and other surface anomalies.

Once potholes are detected, IoT devices can transmit the data to a central system or cloud platform, where it is analyzed and shared with authorities or other vehicles in real-time. This enables quick response times for repairs and enhances road safety by warning drivers of potential hazards. By automating the pothole detection process, this approach provides an efficient, cost-effective, and scalable solution to improving road maintenance and safety.[9]

"Development of Pothole Detection System Using Deep Learning and Image Processing" focuses on leveraging deep learning techniques in combination with image processing to detect potholes on road surfaces with high accuracy. This approach involves training deep neural networks, particularly convolutional neural networks (CNNs), on large datasets of road images to automatically identify potholes and other surface defects.

The system utilizes advanced image processing algorithms to enhance the quality of images, segment road surfaces, and highlight anomalies such as cracks, depressions, and potholes. By applying deep learning models, the system can not only detect these defects but also classify their severity, enabling prioritization of repairs. This method offers significant improvements in detection speed and accuracy compared to traditional manual inspection methods, making it an essential tool for proactive road maintenance and safety enhancement.

2.1 Table of literature survey

Title of Paper	Author(s)	Year	Method Used	Result Obtained	Drawbacks of the Method
Real-Time Pothole Detection Using Smartphones with Accelerometers	Mednis, A., Strazdins, G., Zviedris, R., et al.	2011	Accelerometers in smartphones to detect vibrations and vertical displacements caused by potholes.	Effective real-time pothole detection with reasonable accuracy; cost-effective and scalable solution.	High false positives, speed dependency, environmental factors affecting accuracy, no real-time notifications.
The Pothole Patrol: Using a Mobile Sensor Network for Road Surface Monitoring.	Eriksson, J., Girod, L., Hull, B., et al.	2008	Mobile sensor networks using accelerometers in vehicles to detect and map road surface conditions.	Scalable solution for large-scale road condition monitoring; provided detailed road surface maps.	High computational requirements; lacked real-time notification system for drivers.
Pothole Detection in Asphalt Pavement Using Stereo Vision	Koch, C., Brilakis	2011	Stereo vision system to analyze depth data and texture irregularities for detecting potholes.	Achieved high accuracy in controlled environments; effectively measured pothole dimensions.	Computationally intensive; struggled in real-time detection and adverse weather conditions.

Neri cell: Rich Monitoring of Road and Traffic Conditions Using Mobile Smartphones	Mohan, P., Padmanabhan, V. N., et al.	2013	Smartphones with accelerometers, GPS, and cameras to monitor road and traffic conditions.	Cost-effective solution; provided multi-dimensional insights into road conditions and traffic patterns.	Challenges in detecting subtle irregularities; inconsistent performance in low-light conditions.
Hybrid Sensor-Based System for Road Condition Monitoring	Mallick, A., Das, S., et al.	2016	Integration of accelerometers, cameras, and GPS to detect and map road irregularities.	Improved classification accuracy; provided geotagged data for detailed road condition mapping.	Increased system complexity and cost; challenges in scalability for widespread deployment.
IoT-Based Real-Time Notification System for Road Safety	George, J PriyankT	2020	IoT-enabled system using cloud services to deliver real-time alerts about road irregularities.	Enhanced driver safety through timely notifications; improved awareness of road conditions.	Dependence on network connectivity; limited applicability in remote or poorly connected areas.

Road Condition Monitoring System Using Multi-Sensor Fusi	2018	Ravi, T., Kumar, M. P., et al.	Fusion of accelerometers, cameras, and machine learning for detecting and classifying road irregularities.	Reduced false positives; provided accurate insights into road conditions with effective classification.	High computational power requirements; limited real-time performance due to processing demands.
Vision-Based Pothole Detection Using Deep Learning Techniques	2019	Singh, A., Patel, M., Sharma, K.	Deep learning models with image processing to identify potholes from road images.	High detection accuracy under controlled lighting and weather conditions; effective for real-time monitoring.	Performance affected by poor lighting, shadows, and occlusions; high computational requirements.
IoT-Driven Smart Road Monitoring and Maintenance System	2020	Desai, R., Verma, T., Rao, P.	IoT devices with sensors and cloud computing for continuous monitoring and automated reporting of road conditions.	Real-time alerts and detailed analytics for road maintenance; scalable for urban environments.	Dependent on stable internet connectivity; high initial setup cost for IoT infrastructure.

A Smartphone-Based System for Automated Detection of Road Irregularities	2017	Ghosh, S., Kumar, S., Gupta, R.	Accelerometers and GPS in smartphones to detect road irregularities and map their locations.	Successfully detected potholes and bumps with geotagged data for mapping; low-cost and user-friendly system.	Limited accuracy at high speeds; inconsistent performance on uneven road materials.

CHAPTER-3
RESEARCH GAPS OF EXISTING METHODS

3.1 Limited Real-Time Capabilities:

The numerous systems designed for pothole and hump detection do little to account for one of the most important elements in road safety, such as immediate warnings to the drivers. Being able to give warnings to the driver about impending irregularities in roads is one way of avoiding accidents, lowering damage to vehicles, and giving them a better riding experience. However, existing detection methods are based on post-processed data collected and analyzed after the fact, which introduces a significant delay in alerting the drivers. Such a lag reduces the utility of such systems in scenarios where immediate action is required, such as braking or maneuvering to avoid a pothole or hump.

3.2 High Dependence on Environmental Factors:

One of the biggest drawbacks in present systems related to pothole and hump detection is high dependence on environmental factors that may severely influence its performance and reliability. Such a system particularly comprises vision-based methods, making them vulnerable to alterations in lightings, weathers, and surface conditions. Some typical scenarios where most cameras fail at capturing clear photographs are nighttime conditions or low-level lighting. Further, adverse environmental conditions such as rain, snow, or mist impede the full visibility of roads, and obstructions such as potholes, humps, and possibly irrelevant obstructions by water puddle or debris render it challenging to differentiate between road features and system image-based devices. Shadows cast by trees or vehicles will be added as complication factors and high rates of false positives or negatives.

3.3 False Positives and Classification Challenges:

One of the main challenges in pothole and hump detection systems is that most of them are prone to false positives and cannot function with high accuracy due to inherent difficulties in classification and distinguishing road anomalies from normal ones. False positives relate to the system identifying normal features on the road or benign irregularities as potholes or humps. In many existing systems, shadows, water puddles, road repairs, or even slight vibrations from vehicle movement on smooth surfaces may produce false detections. These kinds of errors are typical for vision-based detection methods dependent on cameras and image processing algorithms. In those systems, something like poor illumination, shadows formed by trees or other vehicles passing by, or debris on the street may confuse the algorithm and provide false alerts.

3.4 Lack of Integration with Intelligent Transportation Systems (ITS):

The present gap in pothole and hump detection systems is that it lacks integration with more comprehensive Intelligent Transportation Systems (ITS). ITS refers to a thorough use of information and communication technologies to enhance the management of traffic, road safety, and efficiency of transportation. Many pothole detection solutions stand alone as independent systems. However, their latent potential lies in ITS networks. This allows for leveraging the large amount of data ITS can generate, such as real-time traffic conditions, vehicle movements, and weather information, for more holistic understanding and correlated responses toward road safety.

3.5 Incomplete Mapping and Data Sharing:

The current pothole and hump detection systems have significant research gaps in terms of incomplete mapping and ineffective data sharing, which severely limit their usefulness and scalability. While some systems can detect road anomalies, they often fail to create comprehensive, real-time maps of road conditions that cover large geographic areas. While these may record information related to certain places or highways, they do not share a centralized and integrated database from which isolated data may be gathered for broader-scale analysis or aggregation. Existing systems lack the capability of generating an accurate, updated view of road conditions for an entire region or network.

3.6 Dependence on Connectivity:

Another significant limitation in many existing pothole and hump detection systems, especially those that rely on continuous connectivity for IoT-based or cloud computing data processing and sending alerts, is the heavy reliance on continuous connectivity. Most of these systems require stable and fast internet for the transmission of sensor data, processing in the cloud, and further provision of instant notifications to the driver. In cities where high-speed internet coverage is prevalent, this is probably not going to be a huge issue. In most rural areas and in less-developed countries, internet penetration being poor, such a system's utility will be adversely affected.

3.7 High Cost and Resource Requirements:

Another significant limitation of many existing pothole and hump detection systems, which are often IoT-based or employ cloud computing for data processing and notifications, is their heavy reliance on continuous connectivity. Such systems frequently require a stable and high-speed internet connection for the transmission of sensor data for processing in the cloud and to deliver real-time notifications to drivers. This may not be a significant problem in urban areas with well-developed internet infrastructure. However, in rural or remote regions with poor network coverage or in developing countries where internet connectivity is sparse, the effectiveness of these systems would be highly affected. Where the cellular networks or Wi-Fi are unreliable.

3.8 Lack of Standardization:

There is no standard protocol or framework for the implementation of automatic pothole and hump detection systems. Variability in methodologies, hardware, and data processing approaches leads to inconsistent results, making it difficult to compare or combine data from different systems. Standardization efforts could streamline development and improve interoperability.

3.9 Lack of Road Maintenance Feedback:

Most systems are excellent at detecting road anomalies but do not offer actionable insights for road maintenance authorities. Few solutions report severity levels, prioritize repairs, or predict future deterioration based on historical data. The integration of predictive analytics with monitoring systems could significantly enhance their utility for road management.

3.10 Scalability Challenges:

Most current systems are region-specific or limited in scale. Scaling up such systems to monitor road conditions at the national or global level raises challenges in data handling, infrastructure requirements, and coordination among multiple stakeholders. Scalability solutions that are both accurate and cost-effective remain largely unexplored.

CHAPTER-4

PROPOSED MOTHODOLOGY

4.1 Multi-Sensor Fusion for Enhanced Detection Accuracy:

However, the proposed approach avoids all these limitation by using a multi-sensor-based fusion system. Accelerometers, gyroscopes, GPS modules, and cameras are used for data acquisition. Combining these sensors guarantees a better pothole and hump detection since each type of sensor possesses distinct merits which must be complimented by their limitation. Accelerometers and gyroscopes can note actual live data associated with the vibrations of a vehicle. Such data might give information on road anomalies. However, the cameras or vision-based systems provide visual verification, thus giving greater precision in identifying specific road features. Adding GPS allows tagging geospatial data; thus, the system is able to pinpoint where anomalies were detected to have reference information later and to warn drivers about dangers up ahead.

4.2 Edge Computing for Real-Time Processing:

Real-time processing of sensor data is essential for timely notifications, but it can be computationally expensive. The proposed solution utilizes edge computing, which involves processing data locally on the vehicle or at roadside units, instead of relying solely on cloud servers. By performing data analysis on the edge, the system reduces the latency associated with cloud computing and ensures near-instantaneous hazard detection. This also reduces the system's reliance on a constant internet connection, making it suitable for places with poor or intermittent network coverage.

4.3 Machine Learning Algorithms for Classification:

The machine learning algorithm trained on sensor data and images from realworld road cond itions differentiates among several classes of anomalies, such as potholes, humps, and other anomalies. Using labeled training data from supervised machine learning models (such as Support Vector Machines or Convolutional Neural Networks), the supervised models are trained to identify patterns in sensor data and images to improve classification accuracy and reduce false positives. These models optimize for both high accuracy and computationally efficient requirements, allowing it to be operated in real time even on relatively resource-constrained devices. It will be constantly updated with newer data to achieve continuous learning and further improvement in classification of anomalies so that it responds to different road and environmental conditions.

4.4 Real-Time Driver Notifying and Mapping Road Conditions:

Once a pothole or hump has been detected, the system provides a real-time notification to the driver through in-vehicle interface, such as a mobile application or a dashboard display. Notifications will not only inform the user of the danger but also of how to move safely on that road, including danger level and necessary speed reduction warnings. Simultaneously, the data gathered from the system is sent to a central cloud platform (if connectivity is available) or stored locally for later synchronization. This data can be used to create dynamic, up-to-date maps of road conditions, which are shared with relevant authorities and other drivers, thus contributing to a more comprehensive road safety network.

4.5 Cloud-Based Data Aggregation and Analytics:

The system will make use of cloud-based data aggregation for long-term monitoring and proactive road maintenance. The system will forward the collected data to the cloud when network connectivity is available while relying on edge computing for real-time notifications. This data will then be analyzed for patterns and trends in road conditions, such as hotspots for frequent pothole occurrences or regions that require a higher maintenance priority. The predictive analytics feature will allow road authorities to prepare for any anticipated road problems early enough to help them undertake preventative measures rather than reactive repairs. Another feature is generating detailed reports and visualizations on road maintenance by agencies, to help optimize resources and long-term infrastructure investments.

4.6 User-Centric Feedback Mechanism:

A mechanism of user feedback would also be implemented, allowing the drivers to rate the accuracy and usefulness of pothole notifications. The ratings would then be used to fine-tune the machine learning models to enhance the user experience as well as make the system more reliable. Moreover, drivers can manually report anomalies in roads.

4.7 Integration of Computer Vision and Sensor Data Fusion:

The proposed system will combine computer vision with sensor data fusion to provide a more accurate and robust detection mechanism. Vision-based sensors, which are cameras, will be integrated with accelerometers, gyroscopic sensors, and GPS to gather a complete set of road condition data. Computer vision algorithms, such as deep learning-based object detection models like Convolutional Neural Networks, will be used to identify potholes, humps, and other irregularities by processing real-time images captured by cameras installed in vehicles.

4.8 Adaptive Learning-Based Classification System:

An adaptive machine learning model will be used to classify and recognize various types of road anomalies, including potholes, speed bumps, and other irregularities. The system will use a dynamic learning algorithm, such as Reinforcement Learning or Deep Neural Networks, to continue improving its accuracy over time by analyzing new data from diverse road conditions and environmental settings.

4.9 Decentralized Data Processing with Blockchain for Secure Data Sharing:

One of the major challenges in most pothole detection systems is the centralized data processing, which often requires high computational resources and has limitations regarding real-time data transmission. The proposed methodology addresses this by incorporating decentralized data processing using edge computing and blockchain technology.

CHAPTER-5
OBJECTIVES

5.1 Real-Time Detection and Notification of Road Irregularities:

Goal: One of the major challenges in most pothole detection systems is the centralized data processing, which often requires high computational resources and has limitations regarding real-time data transmission.

Benefit: By offering drivers timely warnings, the system will help prevent accidents and injuries, ultimately improving overall road safety.

5.2 Enhanced Accuracy of Hazard Detection:

Goal: The use of multi-sensor fusion (accelerometers, cameras, GPS, etc.) with machine learning techniques will ensure accurate detection and classification of road anomalies. The system will try to reduce false positives and negatives by intelligently analyzing sensor data from multiple sources.

Benefit: Accurate classification ensures that only genuine road anomalies are flagged, preventing unnecessary distractions for drivers.

5.3 Secure and Transparent Data Sharing:

Goal: The use of blockchain technology or other secure protocols for tamper-proof records of detected road anomalies would ensure secure data transmission and storage. The system will allow the secure sharing of road condition data with relevant authorities, traffic management centers, and other stakeholders.

Benefit: Data sharing protocols will ensure that user privacy is maintained while still providing valuable information to improve road safety and maintenance efforts.

5.4 Efficient Data Management and Feedback Mechanism:

Goal: Creating an aggregation and analytics platform for collected road condition data from multiple vehicles and sensors, and including mechanisms for user
feedback to improve the accuracy of detections over time using historical data as well as from drivers.

Benefit: Continuous Improvement: Feedback from users helps refine detection algorithms, making the system more reliable and accurate over time.

5.5 Low-Cost and Scalable Solution for Road Condition Monitoring:

Goal: Develop a cost-effective and scalable solution that can be easily deployed across different regions, irrespective of the quality of the infrastructure or budget constraints. The system should adapt to varying road conditions and be able to work in both urban and rural settings.

Benefit: Lower costs and scalability ensure that the system can be implemented in both developed and developing regions, improving road safety globally.

5.6 Proactive Hazard Identification and Prevention:

Goal: To implement a proactive system that identifies and reports road irregularities, ensuring drivers are notified before encountering them.

Benefit: Timely alerts reduce the risk of vehicle wear and tear caused by sudden impact with potholes or humps.

5.7 Leveraging IoT and Cloud Computing for Broader Data Accessibility:

Goal: To deploy IoT-enabled devices and cloud-based systems for seamless data collection, storage, and sharing across a distributed network.

Benefit: Cloud integration allows data sharing across multiple regions, creating a unified road condition monitoring network.

5.8 Sustainable and Environmentally Friendly Implementation:

Goal: To design a system that operates efficiently with minimal resource consumption, ensuring long-term environmental sustainability.

Benefit: By optimizing sensors and processing units, the system reduces power consumption, extending the life of hardware and reducing its carbon footprint.

CHAPTER-6
SYSTEM DESIGN & IMPLEMENTATION

6.1 System Architecture:

- **Sensing Layer**
  It is responsible for gathering information regarding road conditions using sensors. Accelerometers, gyroscopes, GPS modules, and cameras are some of the devices used. The data collected includes vibration patterns, spatial coordinates, and real-time images/videos.
- **Processing Layer**
  It is responsible for analyzing data gathered from the sensing layer. Onboard microcontrollers, edge computing units, and cloud servers are used. Algorithms process sensor data to detect anomalies in roads, classify them, and validate their severity.
- **Communication Layer**
  Relays messages to the drivers and communicates data with the central systems. It uses cellular networks, Wi-Fi, or V2X communication technologies**.**

6.2 GPS and Mapping System:

The GPS module determines the exact location of detected potholes and humps and integrates the information with a mapping service.

- Precise latitude and longitude tagging of anomalies.
- Integration with mapping platforms such as Google Maps or OpenStreetMap.

Role in the System:

- Enables real-time hazard location updates and route adjustment for drivers.

6.3 Dynamic Hazard Mapping with Crowdsourced Data:

- **Data Aggregation**: Use cloud platforms to aggregate data from multiple vehicles.
- **Anomaly Verification:** Validate anomalies reported by multiple vehicles to ensure accuracy.
- **Map Updates:** Integrate with mapping services like Google Maps or OpenStreetMap

for dynamic updates.

6.4 Integration with Vehicle-to-Everything (V2X) Communication:

The system utilises V2X communication technologies in transmitting real-time data on hazards and hazards information with other vehicles and roadside infrastructure plus traffic management systems. This permits a cooperative model of road safety.

Implementation

- V2V communication: A car shares discovered abnormalities with neighboring peers.
- V2I Integration: Data to roadside units (RSUs) for traffic management and maintenance planning.
- V2N Connectivity: Upload hazard data into central networks for analysis and mapping.

6.5 GPS and Mapping System:

The GPS module determines the exact location of detected potholes and humps and integrates the information with a mapping service.

Key Features:

- Precise latitude and longitude tagging of anomalies.
- Integration with mapping platforms such as Google Maps or OpenStreetMap.

Role in the System:

- Enables real-time hazard location updates and route adjustment for drivers.

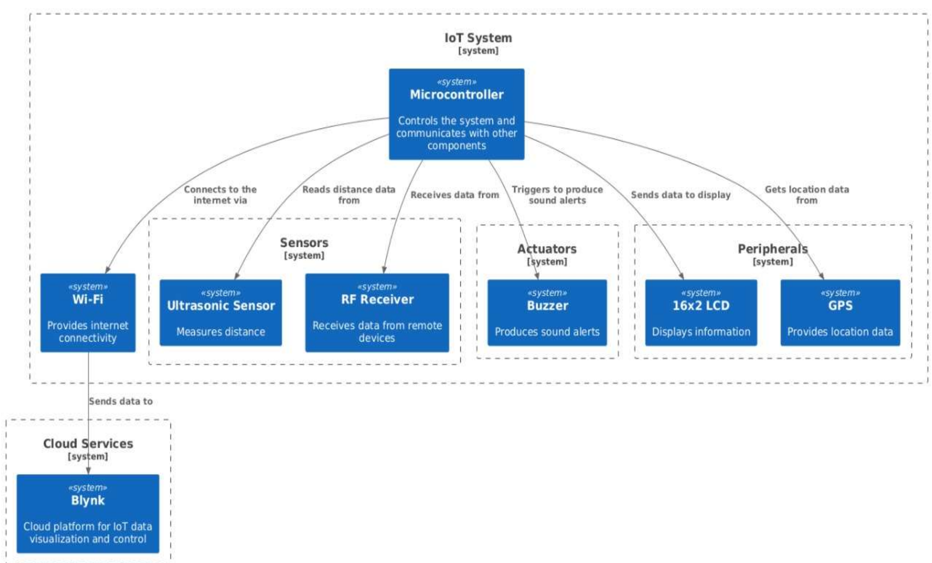

Figure 6.1 Block diagram of System Design

6.6 Data Processing and Analysis Unit:

This unit processes sensor data to identify and classify road anomalies in real time.

Technologies Used:

- Edge Computing: Onboard processing of data for immediate detection and notification.
- Machine Learning Models: Algorithms trained to differentiate between potholes, humps, and noise caused by normal road conditions.

Role in the System:

- Reduces false positives and ensures efficient anomaly detection.

6.7 Communication Module:

The communication module facilitates data transfer between the system's components and external entities.

Technologies Used:

- **Cellular Networks (4G/5G)**: For uploading data to cloud servers.
- **V2X Communication**: Enables vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication for sharing real-time hazard data.
- **Wi-Fi/Bluetooth**: For localized data sharing.

Role in the System:

- Ensures seamless notification delivery to drivers and data sharing with central systems.

6.8 Driver Notification System:

This system informs drivers about detected potholes and humps in their route.

Key Features:

- **Mobile Application**: Displays road hazard alerts on the driver's smartphone or in-car infotainment system.
- **Audio Alerts**: Non-distracting voice notifications to warn drivers.
- **Severity Indicators**: Color-coded or icon-based representation of the severity of anomalies.

Role in the System:

- Improves driver awareness and helps in making safer driving decisions.

CHAPTER-7

TIMELINE FOR EXECUTION OF PROJECT

(GANTT CHART)

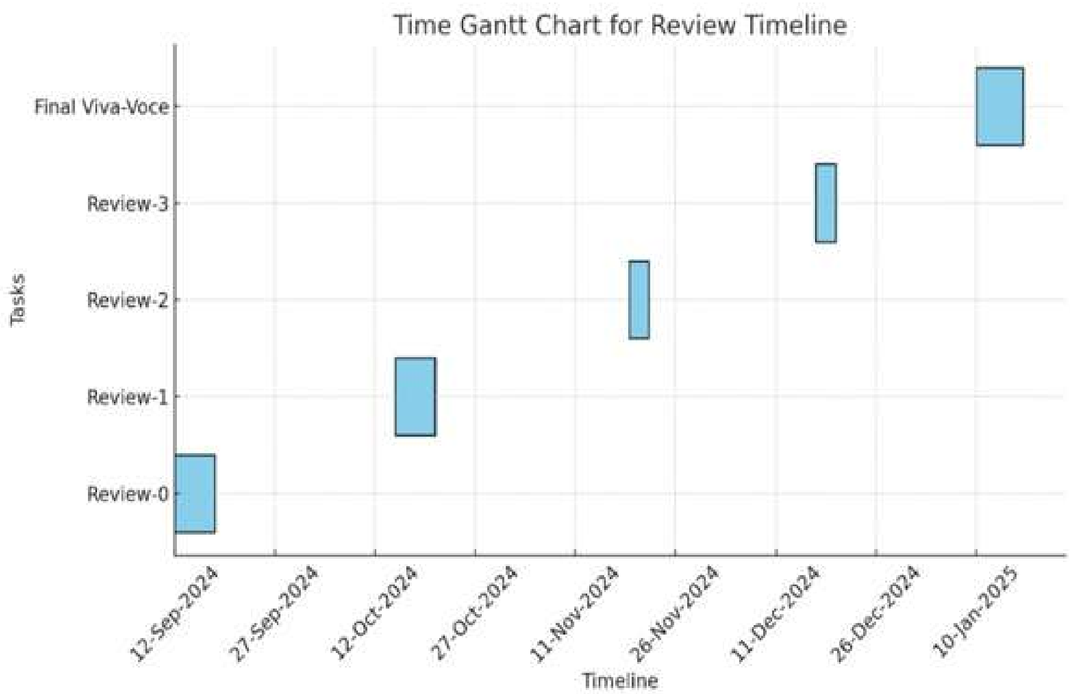

Figure 7.1 Timeline for execution of project

CHAPTER-8
OUTCOMES

Several tangible and impactful results of the implementation of an Automatic Detection and Notification System for Potholes and Humps include delivering enhanced road safety, better maintenance of infrastructure, and an overall efficiency of transportation systems.

8.1 Enhanced Road Safety:

- **Real-Time Notifications:** Immediate alerts to drivers about upcoming potholes and humps prevent accidents caused by sudden braking or loss of control.
- **Improved Situational Awareness:** Drivers are better prepared to adjust their speed and manoeuvre safely around road anomalies.
- **Reduced Vehicle Damage:** Early warnings minimize the risk of damage to vehicle components like tires, suspensions, and undercarriages.

8.2 Accurate and Comprehensive Road Condition Monitoring:

- **High Detection Accuracy:** Advanced sensors and machine learning models ensure reliable identification of potholes and humps with minimal false positives.
- **Detailed Road Maps:** It has the capability of generating real-time maps with exact locations of anomalies, thus being a resourceful tool for both drivers and road authorities.
- **Coverage Expansion:** Scalable deployment allows the system to track road conditions in vast geographic regions.

8.3 Data-Driven Infrastructure Maintenance:

- **Prioritized Repairs:** Road authorities can use the obtained data to identify which areas require priority maintenance.
- **Cost Efficiency:** Proactive identification of road issues reduces repair costs by addressing problems before they worsen.
- **Data analytics:** Historical road condition data aids in infrastructure planning and policy-making.

8.4 Improved Driving Experience:

- **Reduced Stress:** Drivers experience smoother and safer journeys with fewer unexpected road hazards.
- **Dynamic Route Optimization:** Integration with navigation systems allows drivers to avoid hazardous routes entirely.

8.5 Support for Intelligent Transportation Systems (ITS):

- **Seamless Integration:** This system avails into real-time data that can be passed on to ITS for enhanced traffic management and, hence road safety measures.
- **Autonomous vehicle enablement:** Road anomalies identified are input-critical to the navigation and decision-making mechanism of autonomous vehicles.

8.6 Crowdsourced Road Condition Data:

- **Community Engagement:** Vehicles equipped with the system contribute to a collective effort to improve road safety.
- **Data Sharing:** Crowdsourced data benefits drivers, urban planners, and transportation authorities.

8.7 Environmental and Economic Benefits:

- **Fuel Efficiency:** Smoother driving reduces fuel consumption, lowering emissions and saving costs.
- **Extended Vehicle Lifespan:** Preventing damage to vehicles reduces the need for frequent repairs or replacements.

CHAPTER-9
RESULTS AND DISCUSSIONS

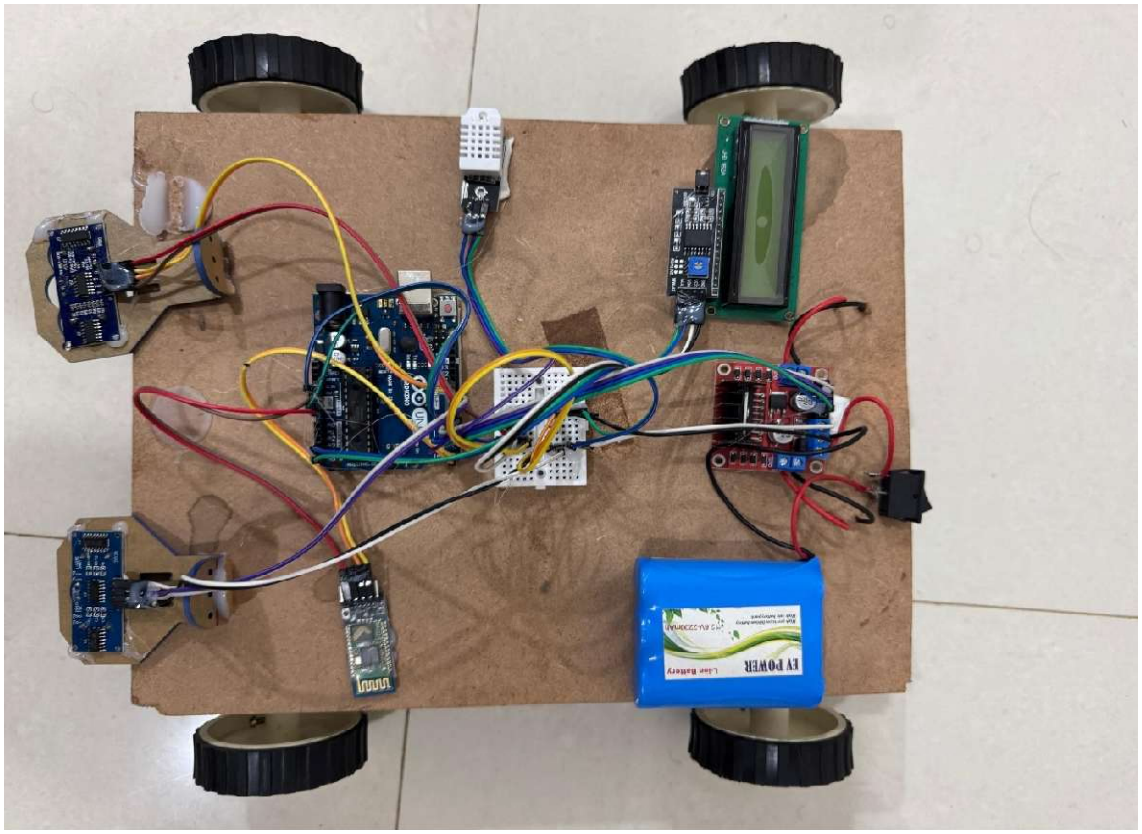

Figure 9.1.Overview of project

9.1 Arduino Uno Microcontroller (Center):

- It acts as the central processing unit. It collects data from sensors, analyzes it, and sends signals to connected modules.

9.2 LCD Display (Top Left):

- It is used to show real-time information like detected potholes or humps, system status, or measurements.

9.3 Battery Pack (Top Right):

- It provides power to the system. The labeled lithium battery suggests a rechargeable power source for portability.

9.4 Motor Driver Module (Top Center):

- Controls the motors attached to the wheels for movement, probably making the vehicle move over roads.

9.5 Ultrasonic Sensors (Bottom):

- Mounted at the front to detect the height or depth of road irregularities (humps or potholes).

9.6DHT Sensor (Left Side):

- Probably used to measure environmental conditions like temperature and humidity, which may affect road conditions.

9.7 Bluetooth Module (Right Side):

- Facilitates wireless communication, probably for sending notifications to a mobile app or remote system.

9.8 Breadboard and Wires (Center):

- Used for connections between components during prototyping.

CHAPTER-10
CONCLUSION

The Automatic Detection and Notification System for Potholes and Humps offers a huge step toward the enhancement of road safety and infrastructure maintenance. With modern technologies like sensors, GPS, machine learning, and real-time communication, the system can detect road irregularities and alert the drivers and the concerned road authorities on time. This technology will directly face issues of road anomalies such as vehicular damages, accidents, and inefficiently performed road maintenance activities. This provides real-time alert systems so that drivers will get necessary precautionary measures in avoiding these anomalies in the road. Data acquired by this system is used for planning the priority for road authorities while maintaining infrastructures in cost-effective manners.

The integration of the system with Intelligent Transportation Systems (ITS) and its scalability to urban and rural environments point to its great potential for mass adoption. With the advancement of the system, the inclusion of advanced technologies such as IoT, AI-based analytics, and crowd sourced data sharing will further enhance the accuracy, reliability, and applicability of the system. In conclusion, such a system develops the road quality of transport yet also offers even smarter and efficient infrastructure to come up safely- making the project a really indispensable tool towards making modern transportation and an important key driver in enhancing urban sustainability development.

CHAPTER-11
REFERENCES

[1]. A. Gupta, S. Jain, and S. Rathi, (2018) "Smart Road Safety System using IoT and Vehicle Communication," Proceedings of the 4th International Conference on Computing and Network Communications, pp. 112-116.

[2]. He Youquan, Wang Jian, Qiu Hanxing, Zhang Wei, Xie Jianfang,(2011) “A Research of Pavement Potholes Detection Based on Three-Dimensional Project Transformation”, In Proceedings of International Congress on Image and Signal Processing, pp.1805-1808.

[3]. S. Roy, M. R. Mondal, and S. Paul, (2019)"Real-Time Hazard Detection Using IoT," IEEE Sensors Journal, Vol. 19, No. 12, pp. 4450-4458.

[4]. Faith Orhan, P. Erhan Eren, (2013) “Road Hazard Detection and Sharing with Multimodal Sensor Analysis on Smartphones”, In Proceedings of International Conference on Next Generation Mobile Apps, Services and Technologies, pp. 56-61.

[5]. D. Zhang, Z. Li, and Y. Zhang, (2015) "Real-time Road Surface Condition Detection using Vibration Sensors," Proceedings of IEEE Conference on Intelligent Transportation Systems, pp. 2452-2456.

[6]. B. T. Jones, and C. F. Wilcox, (2012) "Wireless Sensor Network for Road Condition Monitoring," Proceedings of the International Symposium on Autonomous Systems, pp. 431 436.

[7]. L. Bai, F. Li, and G. Yao, (2016)"Dynamic Road Hazard Detection and Prevention Systems Using Wireless Communication," Proceedings of IEEE Intelligent Vehicles Symposium, pp. 385-390.

[8]. M. A. Gohil, A. Bansal, and M. S. Bansal, (2019) "Smart Road System: An Efficient Approach to Road Safety," Journal of Traffic and Transportation Engineering, Vol. 7, No. 1, pp. 45-53.

[9]. K. S. Mishra, R. K. Meena, and R. C. Patel, (2015)"A Novel Approach for Pothole Detection Using Image Processing and IoT," International Journal of Computer Applications, Vol. 107, No. 4, pp. 14-21.

[10]. J. L. Singh, K. A. Singh, and M. K. Singh, (2018) "Development of Pothole Detection System Using Deep Learning and Image Processing," Proceedings of IEEE International.

APPENDIX-A

PSUEDOCODE

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <DHT.h>

// Define Ultrasonic Sensor pins
#define TRIG1 7
#define ECHO1 8
#define TRIG2 9
#define ECHO2 10

// Define DHT22 pin
#define DHTPIN 2
#define DHTTYPE DHT22

// Set up the DHT sensor
DHT dht(DHTPIN, DHTTYPE);

// Set up the LCD screen (I2C address is usually 0x27 or 0x3F, depending on your LCD
model)
LiquidCrystal_I2C lcd(0x27, 16, 2);
// Define motor control pins for L298N
#define IN1 3
#define IN2 4
#define IN3 5
#define IN4 6

// Variables for ultrasonic sensors
long duration1, distance1;
long duration2, distance2;

// Variables for DHT22
float temperature, humidity;

// Bluetooth command variable
String datain;

void setup() {
  // Initialize serial communication
Serial.begin(9600);

  // Initialize ultrasonic sensor pins
  pinMode(TRIG1, OUTPUT);
  pinMode(ECHO1, INPUT);
  pinMode(TRIG2, OUTPUT);
```

```
  pinMode(ECHO2, INPUT);

  // Initialize DHT22 sensor
  dht.begin();

  // Initialize LCD
  lcd.begin(16, 2);
  lcd.init();
  lcd.backlight();

  // Set motor control pins as outputs
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);
}

void loop() {
  // Read Bluetooth data for movement control
  if (Serial.available()) {
    while (Serial.available() > 0) {
      char c = Serial.read();  // Read the incoming Bluetooth data
      datain += c;
    }

    // Execute movement based on Bluetooth command
    if (datain == "R") { // Move Forward
      MoveForward();
    }
    else if (datain == "L") { // Move Backward
      MoveBackward();
    }
    else if (datain == "B") { // Turn Left
      turnLeft();
    }
    else if (datain == "F") { // Turn Right
      turnRight();
    }
    else if (datain == "S") { // Stop Motors
      stopMotors();
    }
    datain = ""; // Reset command string after execution
}

  // Read ultrasonic sensors for potholes and humps
  distance1 = getPotholeDistance(); // Pothole detection
  distance2 = getHumpDistance(); // Hump detection

  // Read temperature and humidity from DHT22
  readDHT();
```

```
  // Check if the sensor readings are valid
  if (isnan(temperature) || isnan(humidity)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }

  // Display Road Condition (Pothole, Hump, or Normal)
  lcd.setCursor(0, 0);
  if (distance1 > 20) {
    lcd.print("Pothole Detected ");
    Serial.println("Pothole Detected");
  }
  else if (distance2 < 5) {
    lcd.print("Hump Detected ");
    Serial.println("Hump Detected");
  }
  else {
        lcd.print("Normal Road     ");
    Serial.println("Normal Road");
  }

  // Display Temperature and Humidity
  lcd.setCursor(0, 1);
  lcd.print("T:");
  lcd.print(temperature);
  lcd.print("C H:");
  lcd.print(humidity);
  lcd.print("%");
delay(1000); // Delay for stability and to avoid flickering
}

// Function to get distance from pothole ultrasonic sensor
long getPotholeDistance() {
  // Send a 10us pulse to trigger the ultrasonic sensor
  digitalWrite(TRIG1, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIG1, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG1, LOW);

  // Read the duration of the pulse
  duration1 = pulseIn(ECHO1, HIGH);

  // Calculate the distance in cm
  long distance = (duration1 / 2) * 0.0344;
  return distance;
}

// Function to get distance from hump ultrasonic sensor
```

```
long getHumpDistance() {
  // Send a 10us pulse to trigger the ultrasonic sensor
  digitalWrite(TRIG2, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIG2, HIGH);
  delayMicroseconds(10);
digitalWrite(TRIG2, LOW);

  // Read the duration of the pulse
  duration2 = pulseIn(ECHO2, HIGH);

  // Calculate the distance in cm
  long distance = (duration2 / 2) * 0.0344;
  return distance;
}

// Function to read temperature and humidity from DHT22 sensor
void readDHT() {
  temperature = dht.readTemperature();  // Get temperature in Celsius
  humidity = dht.readHumidity();  // Get humidity percentage
}

// Function to move the car forward
void MoveForward() {
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  Serial.println("Moving Forward");
}

// Function to move the car backward
void MoveBackward() {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, HIGH);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, HIGH);
  Serial.println("Moving Backward");
}

// Function to turn the car left
void turnLeft() {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, HIGH);
  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);
  Serial.println("Turning Left");
}

// Function to turn the car right
```

```
void turnRight() {
  digitalWrite(IN1, HIGH);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, HIGH);
  Serial.println("Turning Right");
}

// Function to stop the motors
void stopMotors() {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
  Serial.println("Motors Stopped");
}
```

APPENDIX-B
SCREENSHOTS

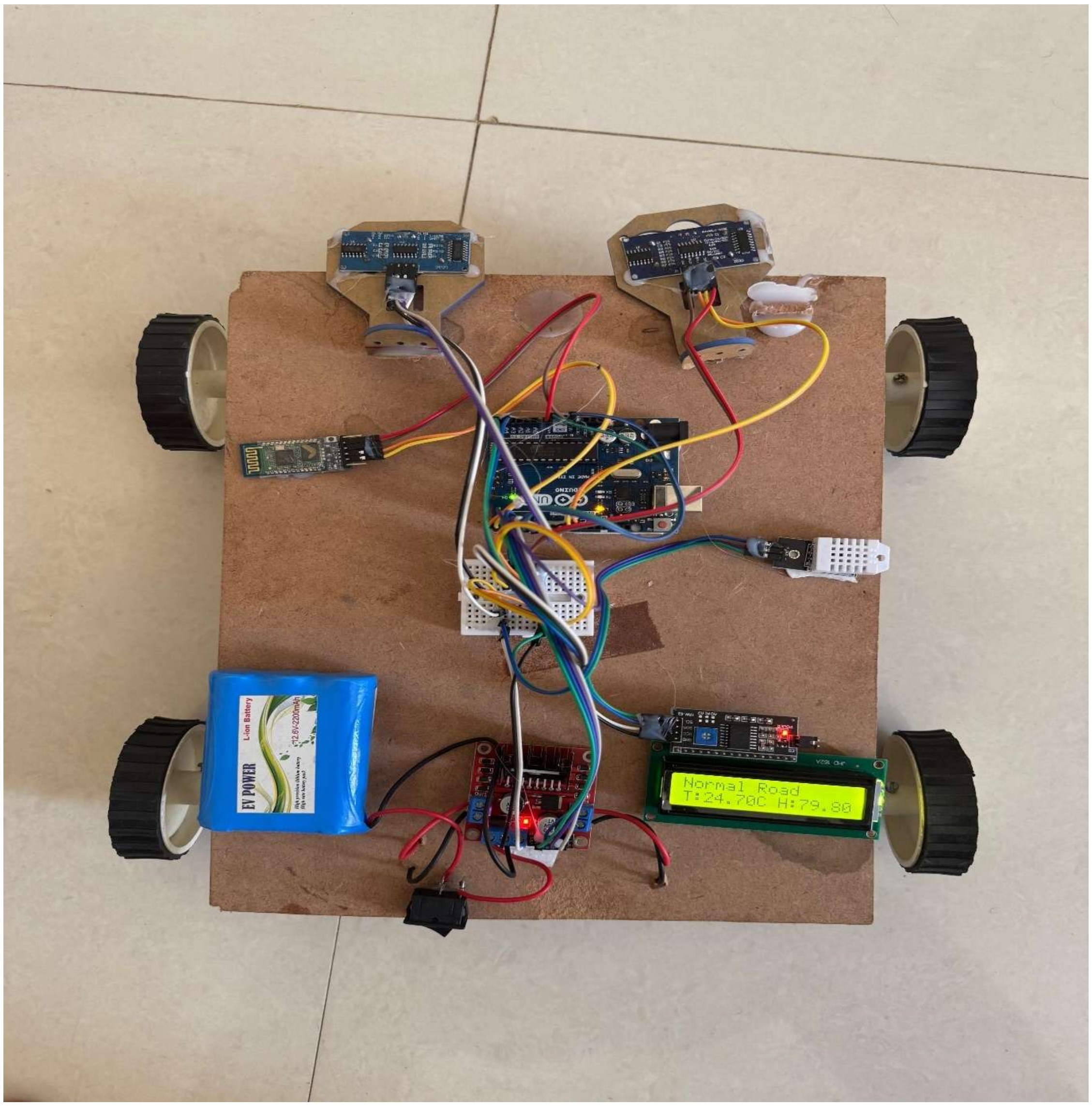

Figure 10.1 Normal road

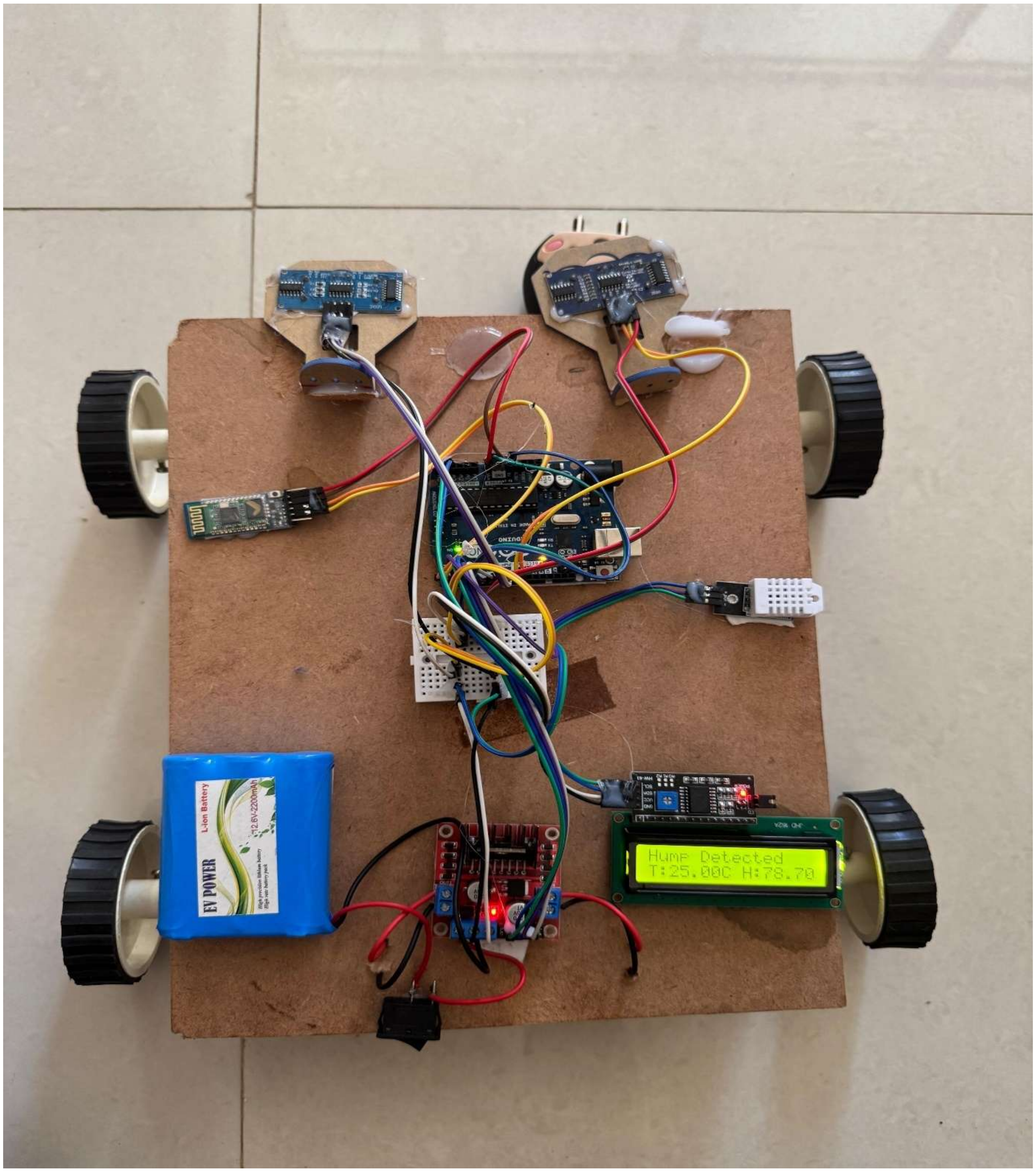

Figure 10.2 Hump detected

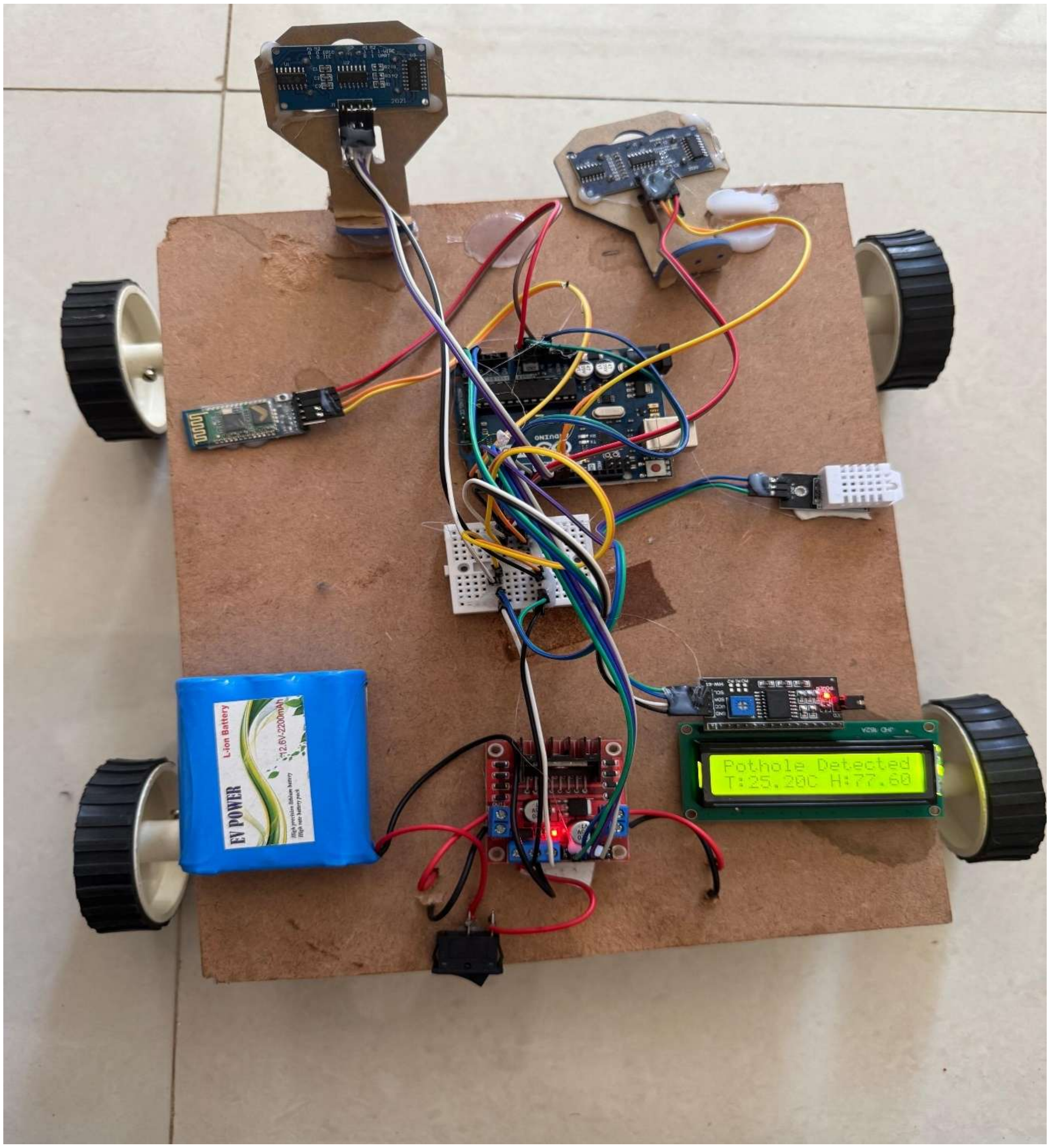

Figure 10.3 Pothole detected

APPENDIX-C
ENCLOSURES


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Sustainable Development Goals (SDGs)

Automatic detection and notification of pot holes and humps on road to aid drivers aligns most closely with SDG 3(Good Health and well-Being)SDG 9(Industry, Innovation,and Infrastructure) SDG 4(Quality Education)SDG17(partner ships for the goals)

Potentially Relevant SDGs for Your Project

1. SDG 3: Good Health and Well-being

Your project is about enhancing healthcare by designing a machine-learning-based system to cluster patients according to medical conditions, improve diagnostics, and aid doctors and researchers. This falls directly under ensuring healthy lives and promoting well-being.

2. SDG 9: Industry, Innovation, and Infrastructure

Develop an innovative health solution based on advanced technology such as machine learning which is in the course of promoting resilient infrastructure and fostering innovation.

3. SDG 4. Quality Education

If your project goes directly to support education for medical professionals or researchers by providing insights for case-control studies, clinical trials, and observational research, then it supports quality education.

4. SDG 17. Partnerships for the Goals

If it is collaboration involving the academia, industries, or other healthcare professionals, your project will contribute toward a stronger partnership.