SEMI-AUTONOMOUS SMART ELECTRIC VEHICLE USING AI BASED DRIVING ASSISTANCE

submitted in partial fulfillment of the requirements

of the Degree of

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

by

Mihir Umesh Karkera	**Roll No.B-814**
Abhishek Kiran Kulapkar	**Roll No.B-818**
Vedant Sandeep Pimple	**Roll No.B-829**
Priti Amarendra Bharti	**Roll No.B-807**

Supervisor

Dr. Poonam N. Sonar

MANJARA CHARITABLE TRUST

RAJIV GANDHI INSTITUTE OF TECHNOLOGY, MUMBAI

(Permanently Affiliated to University of Mumbai)

Department of Electronics and Telecommunication Engineering

University of Mumbai

2023-24

CERTIFICATE

This is to certify that the report entitled **Semi-Autonomous smart electric vehicle using AI based Driving assistance** submitted by **Mihir Umesh Karkera Abhishek Kiran Kulapkar , Vedant Sandeep Pimple , Priti Amarendra Bharti** to Rajiv Gandhi Institute of Technology,Mumbai in partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Applied Electronics & Instrumentation Engineering is a bonafide record of the project work carried out by them under my/our guidance and supervision. This report submitted to Mumbai University

Dr. Poonam N. Sonar
Supervisor

Dr. Sanjay D. Deshmukh
Head of Department

Dr. Sanjay U. Bokade
Principal

PROJECT REPORT APPROVAL FOR B.E.

This Project report entitled **Semi-Autonomous smart electric vehicle using AI based Driving assistance** submitted by **Mihir Umesh Karkera , Abhishek Kiran Kulapkar , Vedant Sandeep Pimple , Priti Amarendra Bharti** is approved for the degree of Bachelor of Engineering in Electronic and Telecommunication Engineering From University of Mumbai,in academic year 2023-24

Examiners

1. Internal ______________________

2. External ______________________

Date:

Place : Mumbai

DECLARATION

We, the undersigned, declare that the project report **Semi-Autonomous smart electric vehicle using AI based Driving assistance** submitted for partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering of Rajiv Gandhi Institute of Technology, Mumbai, is a bonafide work done by me under supervision of Dr. Poonam N. Sonar . We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately citedand referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been takenwhen needed.

Mihir Karkera(Roll No.B814)	(__________________)
AbhishekKulapkar (Roll No.B818)	(__________________)
VedantPimple(Roll No.B829)	(__________________)
Priti Bharti(Roll No.B807)	(__________________)

Date:

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ABSTRACT

In our research, we propose a practical methodology design and implementation of a semi-autonomous smart electric vehicle (EV) equipped with advanced features such as AI-based pothole detection, a robust battery management system (BMS), self-parking capability, and intelligent headlight intensity control. The primary objective of this research is to enhance the safety, efficiency, and user experience of electric vehicles through the integration of cutting-edge technologies.The AI-based pothole detection system utilizes sensors and machine learning algorithms to continuously monitor the road surface for hazards such as potholes, cracks, or debris. By analyzing real-time sensor data, the system can accurately identify potential road hazards and provide timely warnings to the driver or take proactive measures to mitigate their impact on vehicle performance and passenger comfort.The battery management system plays a critical role in optimizing the performance and longevity of the vehicle's battery pack. Through advanced algorithms and predictive analytics, the BMS monitors various parameters such as temperature, voltage, and current to ensure safe and efficient operation of the battery. By dynamically adjusting charging rates and load distribution, the system maximizes the battery's lifespan while ensuring sufficient energy availability for propulsion and onboard systems.Self-parking technology enables the vehicle to autonomously navigate parking spaces and execute precise maneuvers without human intervention. By integrating sensor fusion, path planning algorithms, and vehicle dynamics modeling, the system can identify suitable parking spaces, calculate optimal trajectories, and park the vehicle safely and efficiently, enhancing convenience and reducing driver workload in congested urban environments.

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Chapter 1
INTRODUCTION

A semi-autonomous smart electric vehicle that utilizes AI for pothole detection, incorporates a battery management system, enables self-parking, and includes headlight intensity control involves several interconnected systems working together to enhance the vehicle's functionality and safety.Pothole detection using AI involves equipping the vehicle with sensors, such as cameras to scan the road surface continuously. These sensors capture data about the road condition, including potholes, cracks, or uneven surfaces. The AI algorithm processes this data in real-time, identifying potential hazards like potholes based on predefined criteria such as depth, width, and location.The battery management system is crucial for optimizing the performance and longevity of the vehicle's battery. It monitors various parameters such as temperature, voltage, and current of each battery cell. By continuously analyzing this data, the system can ensure that the battery operates within safe limits, preventing overcharging, overheating, or over-discharging, which can damage the battery and reduce its lifespan .Self-parking technology enables the vehicle to park itself without the need for direct human intervention. Utilizing sensors, cameras AI algorithms, the vehicle can detect suitable parking spaces, calculate the optimal trajectory, and maneuver into the parking spot safely and accurately. This feature enhances convenience for the driver, especially in crowded urban environments where parking spaces are limited [1].Headlight intensity control adjusts the brightness of the vehicle's headlights based on external conditions such as ambient light levels, oncoming traffic, and weather conditions. By automatically adapting the headlight intensity, the system improves visibility for the driver while minimizing glare for other road users, enhancing overall safety during nighttime driving or adverse weather conditions.Integrating AI with pothole detection allows the vehicle to react proactively to road hazards, such as adjusting suspension settings or providing warnings to the driver. When a pothole is detected, the AI system can analyze its severity and recommend appropriate actions to mitigate potential damage to the vehicle or discomfort to the passengers. The AI algorithm for pothole detection relies on machine learning techniques to continuously improve its accuracy and reliability over time. By training the algorithm with a diverse dataset of road conditions and pothole characteristics, it can learn to distinguish between normal road features and potential hazards more effectively, reducing false positives and improving overall performance.In addition to detecting potholes, the AI system can also predict their formation based on factors such as weather conditions, traffic patterns, and road maintenance history. By analyzing historical data and real-time inputs, the system can anticipate where potholes are likely to occur in the future, allowing the vehicle to adjust its behavior preemptively to avoid or minimize their impact [2].The battery management system employs advanced algorithms to optimize charging and discharging cycles, taking into account factors such as battery chemistry, temperature, and usage patterns. By dynamically adjusting charging rates and load distribution, the system maximizes the battery's lifespan and performance while ensuring that energy is available when needed for propulsion and onboard systems[3].Self-parking functionality relies on a combination of sensor fusion, path planning algorithms, and vehicle dynamics modeling to navigate complex environments safely and efficiently. By analyzing sensor data in real-time and simulating various parking scenarios, the system can generate optimal trajectories and execute precise maneuvers to park the vehicle with minimal clearance and without colliding with obstacles .Headlight intensity control uses feedback from ambient light sensors, oncoming vehicle detection, and weather sensors to adjust the brightness and beam pattern of the headlights accordingly. By dynamically adapting to changing conditions, the system enhances visibility for the driver while minimizing glare and reducing energy consumption[4] .

Chapter 2

LITERATURE REVIEW

2.1 BATTERY MANAGEMENT SYSTEM DESIGN

The paper proposes Battery Management System (BMS) design is a crucial aspect of modern energy storage systems, ensuring efficient utilization and longevity of batteries. The primary function of a BMS is to monitor and manage various parameters of the battery pack, including voltage, current, temperature, and state of charge (SOC). To achieve this, the BMS employs a combination of hardware and software components tailored to the specific requirements of the battery technology being utilized.At the hardware level, the BMS typically consists of sensors, actuators, and control circuitry. Sensors measure the vital parameters of the battery cells, providing real-time data to the BMS . Actuators, such as relays or switches, are used to control the charging and discharging processes based on the feedback received from the sensors. The control circuitry processes this data and implements algorithms to ensure safe and optimal operation of the battery pack.In addition to hardware the software aspect of BMS design is equally important[5].BMS software includes algorithms for cell balancing, state estimation, fault detection, and thermal Cell balancing algorithms ensure that individual cells within the battery pack are charged and discharged evenly, maximizing overall pack capacity and lifespan. State estimation algorithms predict the SOC and state of health (SOH) of the battery based on measured parameters, allowing for accurate battery management decisions.Furthermore, fault detection algorithms continuously monitor the battery pack for abnormalities, such as overvoltage, overcurrent, or overheating, triggering appropriate safety measures if necessary. Thermal management algorithms regulate the temperature of the battery pack by controlling cooling or heating systems, preventing thermal runaway and ensuring optimal performance under various operating conditions. Overall, effective Battery Management System design involves integrating hardware and software components to monitor, control, and optimize the performance of battery packs, ultimately enhancing safety, reliability, and longevity of energy storage systems The Battery Management System (BMS) plays a pivotal role in ensuring the safe and efficient operation of battery packs used in various applications such as electric vehicles, renewable energy storage systems, and portable electronics. The design of a BMS involves a comprehensive approach that encompasses hardware, software, and system integration. At its core, the BMS is responsible for monitoring the individual cells within the battery pack, balancing their state of charge (SOC), and protecting against overcharging, overdischarging, and thermal runaway events. The hardware components of a BMS include sensors, microcontrollers, communication interfaces, and protection circuitry. Sensors are used to measure parameters such as cell voltage, current, and temperature, providing real-time data to the microcontroller. The microcontroller processes this data and executes control algorithms to ensure the safe and optimal operation of the battery pack. Communication interfaces, such as CAN (Controller Area Network) or BMS-specific protocols, facilitate communication between the BMS and external systems such as vehicle control units or energy management systems. Protection circuitry, including fuses and circuit breakers, safeguard the battery pack against faults and abnormal operating conditions.The software aspect of BMS design encompasses a range of functionalities aimed at maximizing the performance and lifespan of the battery pack. This includes cell balancing algorithms, which distribute charge evenly among individual cells to prevent overcharging or undercharging. State estimation algorithms predict the SOC, SOH, and remaining useful life of the battery based on measured parameters and historical data, enabling accurate monitoring and management. Additionally, fault detection algorithms continuously monitor the battery pack for abnormalities and trigger appropriate safety measures, such as isolating faulty cells or reducing charge/discharge rates.Successful BMS design requires seamless integration of hardware and software components, coupled with rigorous testing and optimization. Integration involves ensuring compatibility between various components, selecting appropriate sensing and control strategies, and designing robust communication protocols. Optimization focuses on improving efficiency, reliability, and safety while minimizing cost and complexity. This iterative process may involve simulation studies, prototype testing, and field validation to validate the performance of the BMS under different operating conditions. Ultimately, a well-designed BMS enhances the overall performance, safety, and longevity of battery packs, contributing to the advancement of electrification and energy storage[6].

2.2 SELF PARKING

In the realm of self-parking systems, technological advancements have revolutionized the automotive industry, offering convenience, safety, and efficiency to drivers worldwide. These systems utilize a combination of sensors, cameras, and advanced algorithms to autonomously guide a vehicle into a parking space with minimal input from the driver. The design of self-parking systems encompasses various components, each playing a crucial role in ensuring seamless operation.At the heart of self-parking technology lies the sensor network, which typically includes ultrasonic sensors, cameras, and radar. These sensors work collaboratively to detect obstacles, measure distances, and identify suitable parking spaces. Through the fusion of data from multiple sensors, the system generates a comprehensive real-time view of the vehicle's surroundings, enabling precise maneuvering even in tight spaces.In addition to sensors, the design of self-parking systems incorporates sophisticated algorithms responsible for path planning and control. These algorithms analyze sensor data, assess environmental conditions, and calculate optimal trajectories to navigate the vehicle safely into the parking spot. By leveraging machine learning and artificial intelligence techniques, these algorithms continually improve their performance, adapting to diverse parking scenarios and enhancing accuracy over time.Furthermore, the integration of human-machine interfaces (HMIs) plays a pivotal role in enhancing user experience and ensuring intuitive interaction with the self-parking system. Through intuitive graphical interfaces and auditory feedback, HMIs provide drivers with real-time feedback on the parking process, fostering trust and confidence in the autonomous capabilities of the vehicle.Overall, the design of self-parking systems represents a harmonious fusion of sensor technology, advanced algorithms, and user-centric interfaces, aimed at delivering seamless and hassle-free parking experiences for drivers.As automotive manufacturers continue to innovate in this space, the evolution of self-parking technology is poised to redefine urban mobility, making parking challenges a thing of the [7] past.

2.3 HEADLIGHT INTENSITY CONTROL

Headlight intensity control is a crucial aspect of vehicle safety and comfort, aiming to optimize visibility while minimizing glare for both the driver and other road users. Various methods and technologies have been proposed and implemented to achieve effective headlight intensity control. One prominent approach involves the utilization of adaptive lighting systems, which dynamically adjust the intensity and direction of the headlights based on environmental factors such as ambient light conditions, vehicle speed, and the presence of oncoming traffic. By continuously monitoring these parameters, adaptive lighting systems can automatically regulate the brightness of the headlights to ensure optimal visibility without causing discomfort or hazards to other road users.Another aspect of headlight intensity control involves the incorporation of advanced sensors and imaging technologies. These systems utilize sensors such as cameras, LiDAR, and radar to detect surrounding objects, road conditions, and the position of other vehicles. By processing the data from these sensors in real-time, the headlight control system can intelligently adjust the beam pattern and intensity to provide maximum illumination where it is needed most, while also avoiding glare and reflections that could impair visibility for other drivers.Furthermore, advancements in LED and laser lighting technologies have revolutionized headlight design and performance. LED headlights offer improved energy efficiency, durability, and flexibility in beam control compared to traditional halogen or xenon lamps. Laser headlights, on the other hand, provide even greater luminance and range, enabling precise beam shaping and adaptive lighting functions [8]. By leveraging these cutting-edge lighting technologies, headlight intensity control systems can deliver superior visibility and safety benefits for drivers in various driving conditions, from urban streets to rural highways and adverse weather scenarios.In addition to technological innovations, regulatory standards and guidelines play a significant role in shaping the development and deployment of headlight intensity control systems. Organizations such as the International Commission on Illumination (CIE) and regulatory bodies in different regions establish criteria and requirements for headlight performance, including brightness limits, beam patterns, and glare control measures. Compliance with these standards ensures that headlight intensity control systems not only enhance driver visibility and safety but also adhere to legal and safety regulations to promote harmonized road traffic conditions worldwide [9].

2.4 POTHOLE DETECTION USING AI

Potholes pose significant risks to road users and infrastructure. Traditional methods of identifying and repairing potholes are often time-consuming and inefficient. To address this issue, researchers have explored the application of Artificial Intelligence (AI) techniques for pothole detection. By leveraging AI algorithms, such as computer vision and machine learning, it becomes possible to automate the detection process, thereby improving road safety and maintenance efficiency.Computer Vision Techniques One of the key components of AI-based pothole detection systems is computer vision. This technology enables machines to interpret and analyze visual information from images or video footage. In the context of pothole detection, computer vision algorithms can be trained to recognize the distinctive features of potholes, such as their shape, size, and texture.Through techniques like object detection and segmentation, AI models can accurately identify potholes in real-time, even under varying environmental conditions [10].Machine Learning Models Machine learning plays a crucial role in enhancing the accuracy and reliability of pothole detection systems. By feeding large datasets of annotated images to machine learning algorithms, these models can learn to distinguish between different types of road anomalies, including potholes, cracks, and bumps. Through techniques like supervised learning, the AI system can continuously improve its performance over time, making it more adept at detecting potholes with high precision and low false-positive rates.Benefits and Future Outlook The integration of AI into pothole detection offers several benefits, including faster response times, reduced maintenance costs, and improved road safety. Furthermore, as AI technology continues to advance, we can expect even more sophisticated pothole detection systems to emerge, capable of detecting and predicting road defects with unprecedented accuracy. By harnessing the power of AI, authorities can proactively address infrastructure issues, ensuring smoother and safer roads for all [11].

Chapter 3
PROBLEM STATEMENT

In a fast moving society with every second important a drivers most tedious and time consuming job while driving a vehicle is parking which is made simpler by employing Self Parking technology While driving during the night headlights are an important feature of any vehicle but also poses a danger to the driver driving on the opposite lane. Headlights causes discomfort to the individual passing from the opposite lane this problem is solved using Head light intensity control Battery Management Systems (BMS) have limitations in accurately monitoring battery health, balancing cell voltages, and maximizing battery utilization. There is a need to develop an advanced BMS that can optimize battery performance and Optimize battery charging and discharging strategies to improve energy efficiency and maximize the driving range.Incorporate safety features to detect and prevent potential

3.1 OBJECTIVE

The objective of this project is to develop a cutting-edge semi-autonomous smart electric vehicle with AI-based driving assistance systems that enhance safety, efficiency, and user experience while contributing to the advancement of sustainable transportation.Energy Efficien electric vehicles are often more energy-efficient than ICE vehicles. The project can focus on promoting energy-efficient transportation as a means of reducing energy consumption. drive The automotive feature of this project ensures a safer drive as well as reduces human error ensuring lesser maintenance cost and a decrease in the accident rates. AI Assistance The AI assistance further reduces the load on the driver and makes a nerve racking drive into an uncomplicated and cheerful experience. Reducing Greenhouse Gas Emissions

One of the primary objectives of EVs is to reduce the environmental impact of transportation by replacing traditional internal combustion engine (ICE) vehicles with vehicles powered by electricity. Scalability and Integration: Ensure that the AI-based driving assistance systems can be integrated with future updates and improvements. Explore opportunities for collaboration with other smart city initiatives and infrastructure for seamless integration. Sustainability and Environmental Impact : It reduces the vehicle's carbon footprint through energy-efficient driving and the use of renewable energy sources. Aim for a significant reduction in greenhouse gas emissions compared to traditional vehicles. Autonomous Parking: Achieve full autonomy for parking, including parallel and perpendicular parking in various environments.

The objective of this extend is to create a cutting- Develop lighting frameworks that alter to street conditions, activity, and natural components. thing User-Customized Profiles Empower clients to make personalized driving profiles, altering vehicle behavior to person inclinations. thing Real-time Activity Examination Utilize AI calculations to analyze real-time activity information and give energetic course proposals to maintain a strategic distance from congestion

Chapter 4

METHODOLOGY

4.1 SEMI-AUTONOMOUS SMART ELECTRIC VEHICLE WITH AI BASED DRIVING ASSISTANCE

The working of the proposed Semi Autonomous Electric Vehicle with AI based Driving assistance given in following block diagram fig 4.1 .The block diagram consist of three major features of the SSEV which are battery management system, adaptive headlights, self parking system various peripherals are connected to the system to support each feature .The controller used for BMS is STM32, for self parking system is ATmega32A and for adaptive headlight is Arduino UNO

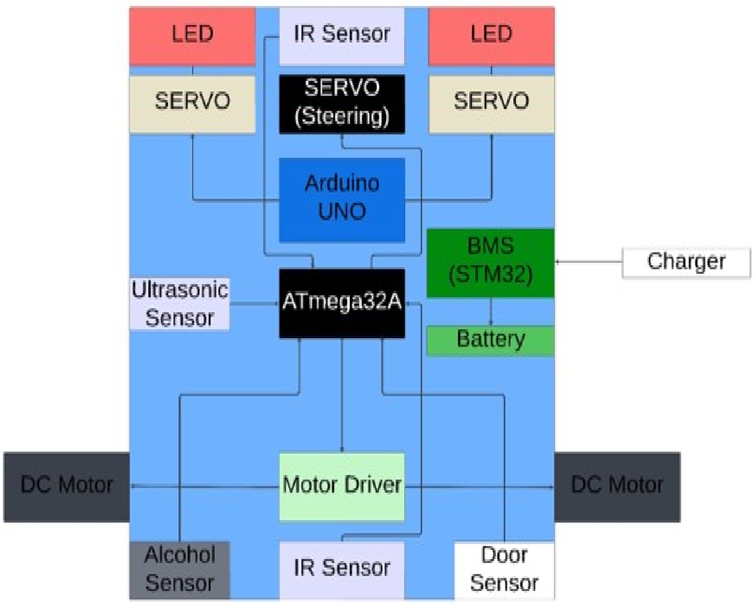

Figure 4.1: Block Diagram of SSEV

4.2 BATTERY MANAGEMENT SYSTEM DESIGN

The BMS consist of STM32 which acts as the controller, voltage sensor for monitoring the voltage levels of the lithium ion cells, current sensor ACS712 for monitoring the incoming and outgoing current in the battery pack. It also consist of DHT-11 which acts as a temperature sensor which alerts the system if the temperature rises above a certain threshold. The BMS offers certain features for charging and discharging of the battery pack. It can also discharge the battery pack if needed.The charging function can be implemented in two modes fast and slow. For maintaining the battery life at its maximum potential slow charging is preferred. Fast charging is only preferred and when the user is on the go. The system consist of three relays which assist in switching between charging discharging and load management. The current system is capable of handling three lithium ion a LCD display of 20x4 was used to display the contents such as voltage, current, temperature also the menu and settings can be selected with the assistance of the display. While manufacturing the lithium ion batteries are not at same voltage levels. So while charging and discharging some cells may charge fully faster than the others while some cells may discharge fully quicker than the other cells. This may caused imbalance in the voltage level of complete battery pack. This may reduce the life expectancy of the battery pack.The battery pack helps in leveling the voltage level of individual cells in a battery pack maintain a constant value .

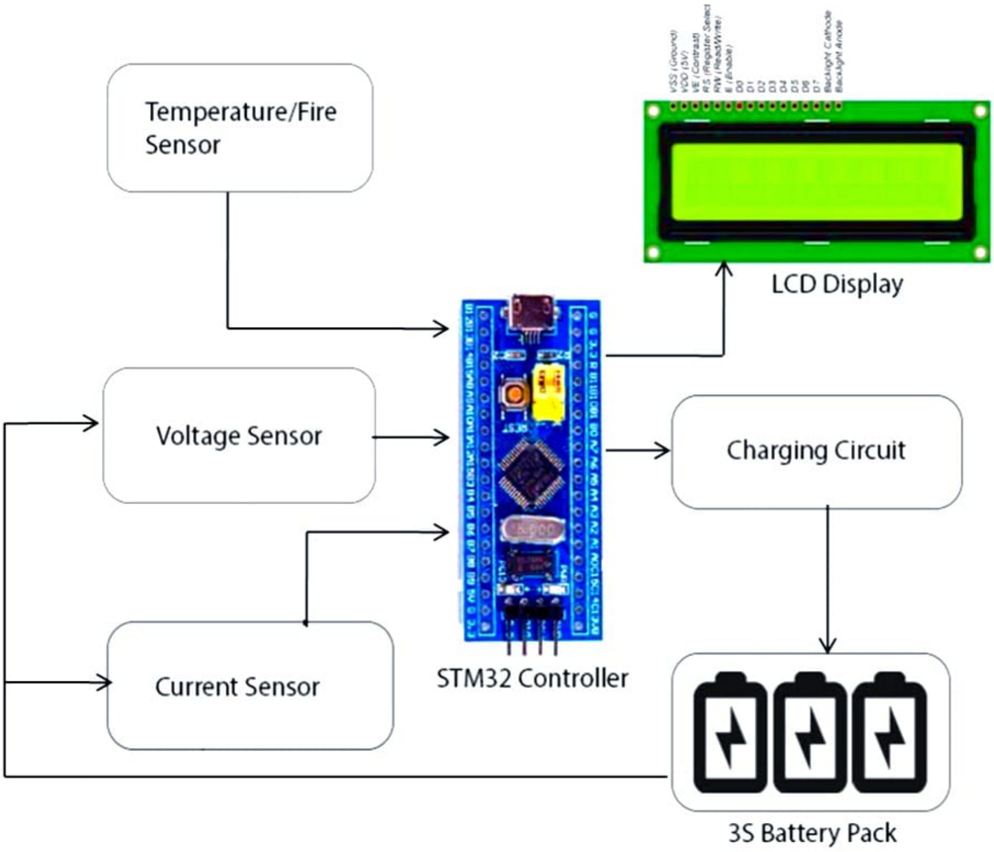

Figure 4.2: Block Diagram of BMS

4.3 SELF-PARKING

Self parking system consist of an ATmega32A which works as a controller for the system,it consists of two IR sensors to detect obstacles in the front and the back of the vehicle. A door sensor to check whether the door is opened or closed, An alcohol sensor to detect whether the driver has consumed alcohol or not. An ultra sonic range finder to detect the vacant spaces in parking lot, A LCD display to display the various information during the execution of the self parking. A motor driver to control the DC motors and the servo motor to control the steering mechanism[12] . Once the power is supplied to the system it initialises the peripherals once this is done it will continuously check the door sensor and the alcohol sensor if they are in okay condition if it is not that means if the door is open or if the driver has consumed alcohol then than vehicle will not operate. The ultrasonic range finder also measure the object distance continuously in search of vacant space. If the door is opened the system detects it and warning beeps are produced until the done is closed. If the driver a consumed alcohol the system detects it and warning beeps are produced. For Auto parking there is a button to implement the process as soon as the button is pressed the vehicle moves forward looking for a vacant space using the ultrasonic range finder as soon as it detects an appropriate space “Distance Found” is displayed on the LCD display and the vehicle moves a bit forward and stops then Parking starts by reversing into the spot using the steering once parked it can also un-park by pressing the same button used for parking the vehicle will repeat the process in reverse. If there is no parking spots of the appropriate distance the vehicle will not park and distance not found will be displayed on the LCD display [13].

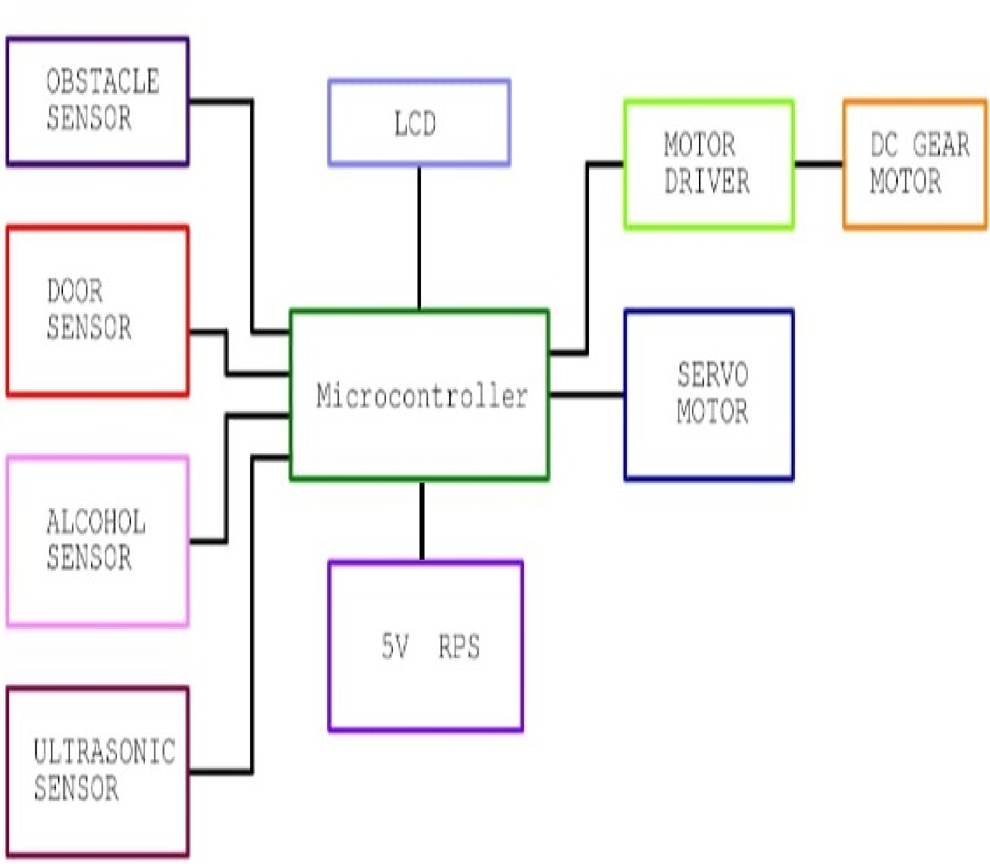

Figure 4.3: Block Diagram of Self Parking Car

4.4 ADAPTIVE HEADLIGHT

In the Adaptive Headlight system Arduino Uno is used as a controller for receiving data from Small single-board computers Raspberry Pi or your personal computer's camera and controlling the Led Matrix Module. Two Led Matrix Module IC MAX7219 are used for the two headlights spliting the light, One Potentiometer for steering wheel simulation, One Small single-board computers Raspberry Pi with Module Camera Mini Raspberry or your personal computer with computer's webcam for object detection, Two Servo motors for controlling rotation of two Led Matrix Module IC MAX7219. As soon as the camera detects an incoming vehicle LED matrix is adjusted according to the position of the vehicle protecting the driver on the opposite lane from suffering from the glare caused due to headlights

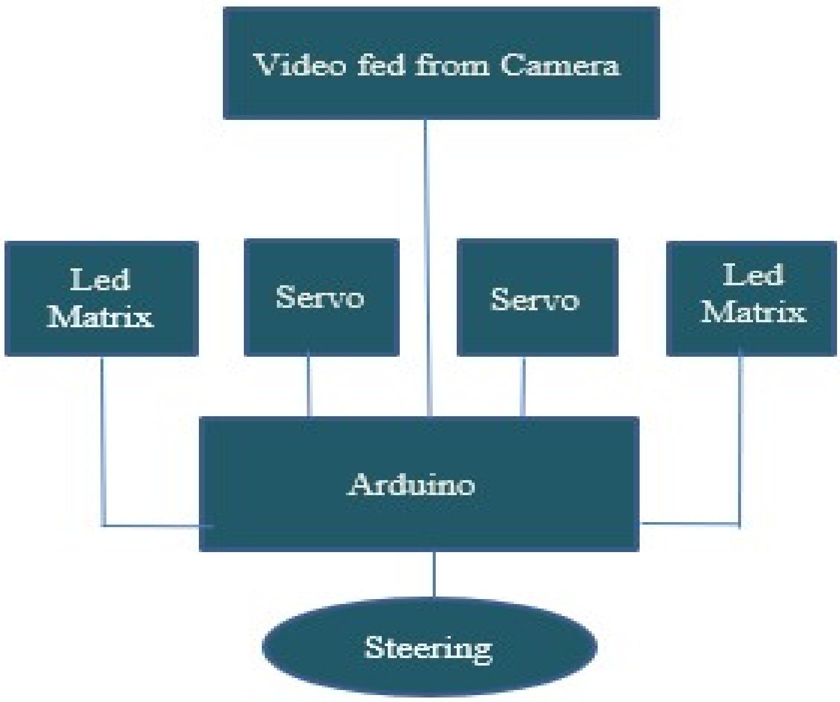

Fig.4: Adaptive Headlight

Figure 4.4: Block Diagram of Headlight intensity control

4.5 POTHOLE DETECTION USING AI

Produce a dataset of images having potholes in them. Online databases, road- view prints, and cameras installed on buses are some exemplifications of the sources you can use. Use bounding boxes to annotate each image with the potholes. For this purpose, you can use labelling programs similar as VGG Image Commentator or LabelImg. The YOLOv4 paradigm requires that the prints be resized to a set size. Image pixel values should be regularized. Organize your data into sets for training and testing. Still, you may train from scrape or use a pre-trained YOLOv4 model, If you have a big labelled dataset use transfer literacy to fine- tune the model using your dataset. Exercising a system for deep literacy, like TensorFlow, make the model. Install IVcam on your desktop or laptop and mobile device. Make use of hotspot to connect the laptop to the camera mobile phone. Make sure the smartphone camera is firmly in place so that it can record the areas of the road where potholes may appear. Install AnyDesk on the laptop and the phone that is on display. Using AnyDesk, connect the laptop to the mobile device that is displaying the pothole detection code. Use the pothole detection code on the mobile phone's display while it's connected to the laptop via Anydesk. Put the phone's display in a handy spot within the vehicle so you can easily monitor the pothole detecting findings. Keep an eye on the mobile phone's displayed video stream to see the pothole detecting outcomes.

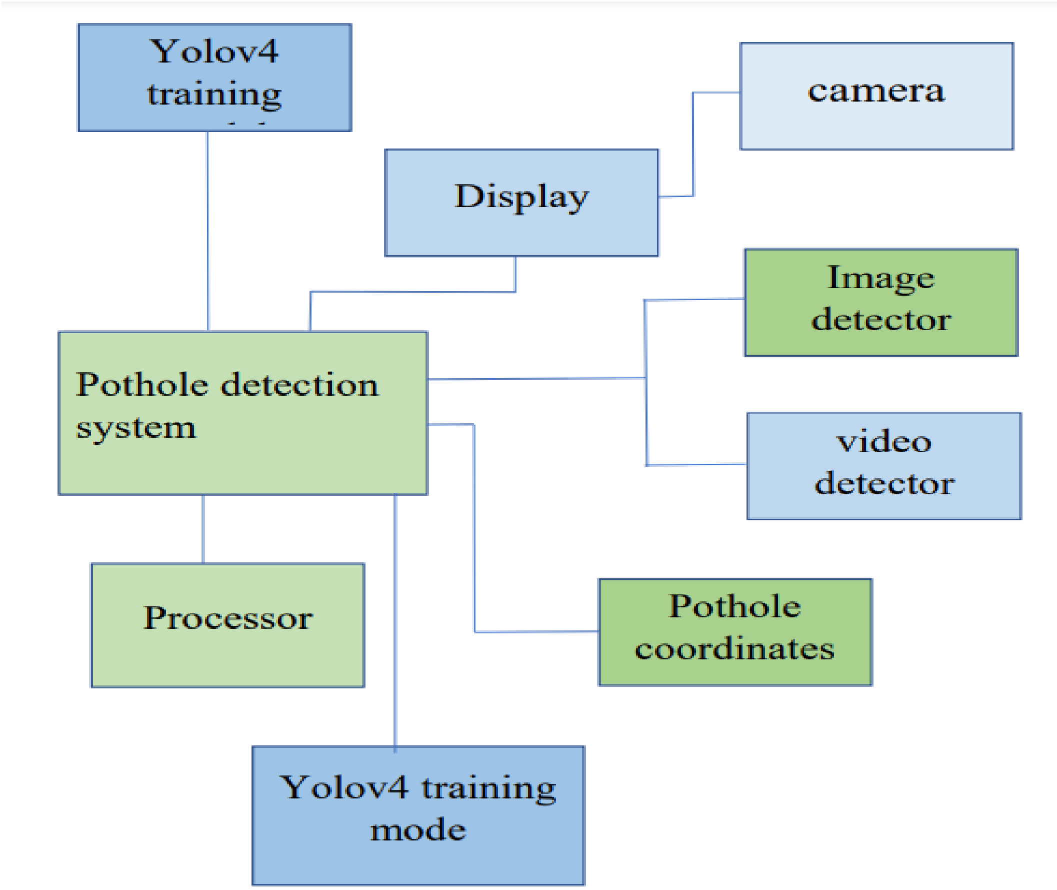

Figure 4.5: Block Diagram of Pothole Detection Using AI

Chapter 5

COMPONENTS

5.1 STM32 MICROCONTROLLER

STM32 microcontrollers by STMicroelectronics are a effective family based on 32-bit ARM Cortex-M centers, advertising a extend of handling control, memory, and built-in highlights. They come in different arrangement with distinctive clock speeds (up to 480 MHz for high-performance alternatives) and memory capacities (streak and SRAM) to cater to a wide run of applications, from basic gadgets to complex mechanical frameworks.

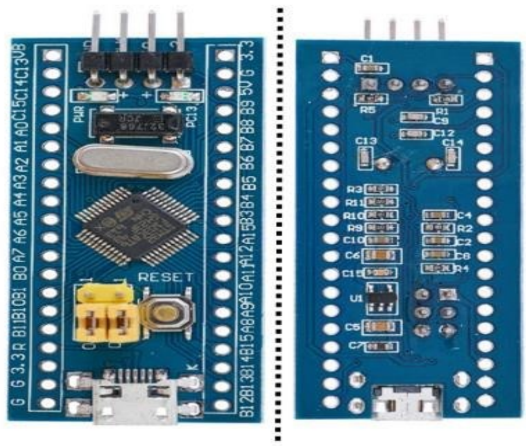

Figure 5.1: STM32 microcontroller

5.2 DHT11 HUMIDITY SENSOR

The DHT11 humidity sensor is a popular choice for measuring humidity levels in various environments. Its specifications make it suitable for a range of applications, from home automation to industrial monitoring. The sensor operates at a voltage range of 3.3V to 5V, making it compatible with most microcontrollers and development boards. This versatility allows for easy integration into electronic projects without the need for additional voltage regulation circuitry.

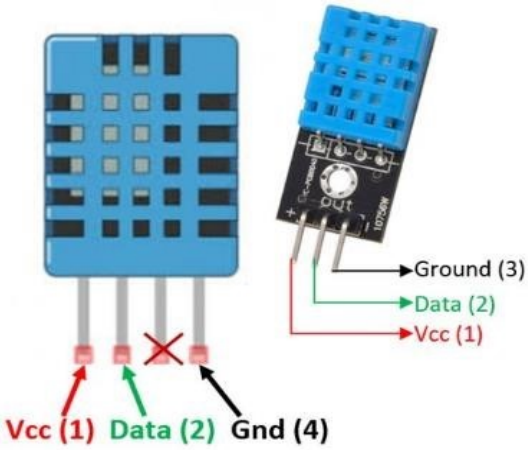

Figure 5.2: DHT11 temperature sensor

5.3 CURRENT SENSORS

The current sensor is a critical component in electrical systems, providing crucial data for monitoring and controlling current flow. These sensors come in various types, including Hall effect, resistive, and electromagnetic, each with its own set of specifications and applications. One common specification is the current measurement range, which typically spans from milliamps to hundreds of amps, catering to a wide range of current monitoring needs. Additionally, current sensors offer high accuracy, often with values as low as a few milliamps, ensuring precise measurement even in low-current applications.

Figure 5.3: current sensors

5.4 VOLTMETER SENSOR

Voltage sensors are fundamental components in electrical systems, providing vital information about voltage levels for monitoring and control purposes. These sensors come in different types, including resistive, capacitive, and electromagnetic, each tailored to specific applications and environments. One essential specification of voltage sensors is the measurement range, which typically spans from a few volts to several hundred volts, accommodating a wide range of voltage monitoring needs. Additionally, voltage sensors offer high accuracy, often with values as low as millivolts, ensuring precise measurement even in low-voltage applications.

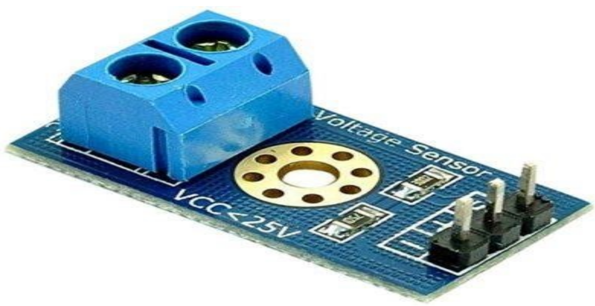

Figure 5.4: Voltmeter sensors

5.5 16×2 LCD DISPLAY

A 16x2 LCD display is a liquid crystal display module that consists of 16 columns and 2 rows, providing a total of 32 characters to be displayed at once. Each character is typically made up of a 5x8 pixel matrix, allowing for the representation of alphanumeric characters, symbols, and simple graphics. The display operates by controlling the polarization of liquid crystals using electrical signals, which in turn modulate the passage of light to create visible characters on the screen.In terms of specifications, a 16x2 LCD display typically features a standard HD44780 controller, which facilitates easy interfacing with microcontrollers or other devices.

Figure 5.5: 16×2 LCD display

5.6 IR SENSOR

An infrared (IR) sensor is a device that detects infrared radiation emitted by objects. These sensors are commonly used in various applications, including security systems, automatic doors, and temperature measurement devices. One of the key specifications of an IR sensor is its detection range, which refers to the distance over which the sensor can accurately detect infrared radiation. This range can vary depending on the design and sensitivity of the sensor. Some sensors have a short-range detection capability, suitable for close proximity applications, while others have a longer range, allowing them to detect objects at greater distances.

Figure 5.6: IR sensor

5.7 ULTRASONIC SENSOR

An ultrasonic sensor is a device that measures the distance to an object by emitting ultrasonic sound waves and then calculating the time it takes for the waves to bounce back. These sensors typically consist of a transmitter that emits ultrasonic waves and a receiver that detects the waves after they've reflected off an object. The distance to the object can be calculated based on the time difference between the emission and reception of the waves, using the speed of sound in air as a constant.

Figure 5.7: ultrasonic sensor

5.8 ALCOHOL SENSOR

The alcohol sensor is a crucial component in various applications, especially in breathalyzer devices aimed at detecting alcohol levels in individuals. Its specifications typically include sensitivity, response time, accuracy, and operating voltage range. Sensitivity refers to the sensor's ability to detect even trace amounts of alcohol vapor in the surrounding air, usually measured in parts per million (ppm). A higher sensitivity ensures more accurate and reliable detection. Response time indicates how quickly the sensor reacts to changes in alcohol concentration, with faster response times enabling prompt and real-time measurements.

Figure 5.8: alcohol sensor

5.9 DC MOTOR

DC (direct current) motors are widely used in various applications, from small household appliances to industrial machinery, owing to their simplicity and controllability. The specifications of a DC motor typically include voltage rating, current rating, speed, torque, and efficiency. The voltage rating indicates the maximum voltage the motor can safely handle without damage, ensuring compatibility with the power supply. Similarly, the current rating specifies the maximum current the motor can draw during operation, influencing the choice of power source and associated circuitry.

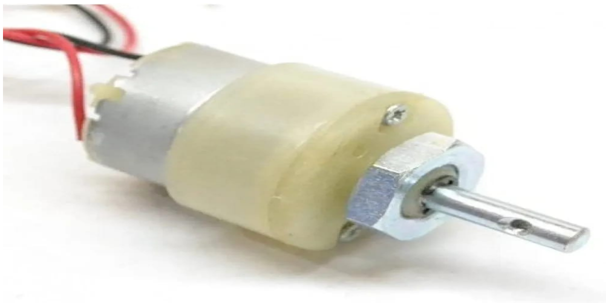

Figure 5.9: DC motor

5.10 MOTOR DRIVER

Motor drivers are like translators between microcontrollers and motors. They receive control signals from microcontrollers (often in the form of PWM signals) and translate them into power suitable for driving the motor. This allows for control over the motor's direction, speed, and sometimes even braking. Motor driver specifications vary depending on the motor type (DC, stepper, etc.) and power requirements. Common specifications include input voltage range, maximum output current, and features like overcurrent protection and integrated control circuits.

Figure 5.10: Motor driver

5.11 DOOR SENSOR

A door sensor, also known as a door contact sensor or entry sensor, is a device used to detect the opening and closing of doors or windows. It consists of two main components: a magnet and a sensor. The magnet is typically attached to the moving part of the door, while the sensor is mounted on the door frame or adjacent surface. When the door is closed, the magnet and sensor are in close proximity, creating a closed circuit. When the door is opened, the magnet moves away from the sensor, breaking the circuit and triggering an alert or notification.Door sensors are commonly used in security systems to detect unauthorized entry or to monitor the comings and goings of individuals in a building.

Figure 5.11: Door sensor

5.12 ATMEGA32

The ATmega32 is a popular 8-bit microcontroller developed by Atmel, now a part of Microchip Technology. It belongs to the AVR family of microcontrollers and is based on the Enhanced RISC (Reduced Instruction Set Computing) architecture. With a wide range of built-in features and peripherals, the ATmega32 is widely used in various embedded systems applications, including industrial automation, consumer electronics, robotics, and more.Featuring a high-performance 8-bit CPU running at speeds up to 16 MHz, the ATmega32 offers 32KB of Flash memory for program storage and 2KB of SRAM for data storage. It also includes a rich set of peripherals, such as multiple timers/counters, serial communication interfaces (USART, SPI, and I2C), analog-to-digital converters (ADC), and digital I/O pins.

Figure 5.12: ATmega32

5.13 SERVO MG996R

High-performance and well-known for its outstanding torque and accurate control is the MG996R servo motor. Built for robotics, automation, and other applications where dependable motor movement is needed, the MG996R offers remarkable performance and adaptabilityIt offers dependable and precise motion control because to its sturdy design, powerful torque of up to 11 kg/cm, and fast reaction time. This servo motor is easy to integrate into any projects and gives versatility in working with different control systems.

Figure 5.13: servo MG996R

5.14 LED MATRIX

It is a dot LED matrix Module incorporating MAX7219 Driver chip. An individual module features 8×8 LED's, each controlled very accurately by the MAX7219 driver to generate the color pattern required. Furthermore, connecting the two modules is quite simple. Only link the new module's input pins to the output pins of the former breakout board. Micro-controllers and LED matrices are interfaced using the MAX7219 Dot Led Matrix Module MCU Control LED Display Module, a serial input common-cathode driver. This module can be attached to any micro-controller via a 4-wire serial interface. It is possible to address each output without having to restart the whole screen.

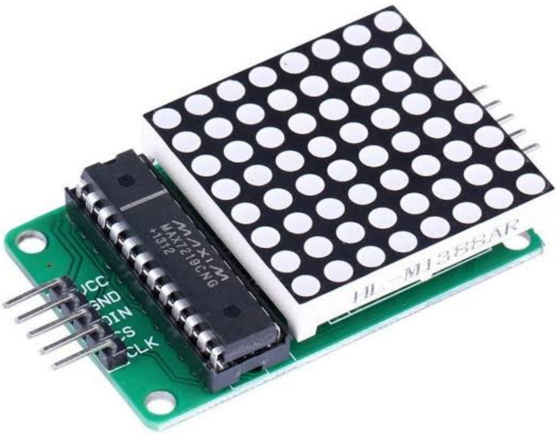

Figure 5.14: Led Matrix

5.15 ARDUINO UNOR

The Arduino Uno is a popular microcontroller board based on the ATmega328P microcontroller.The Uno has a variety of input and output pins, making it suitable for controlling sensors, actuators, and other electronic components. It can be programmed using the Arduino Integrated Development Environment (IDE), which uses a simplified version of C and C++ languages. The Uno is known for its ease of use and strong community support. the specifications for the Arduino Uno:Microcontroller: ATmega328P Operating Voltage: 5V Input Voltage (recommended): 7-12V Input Voltage (limits): 6-20V Digital I/O Pins: 14 (of which 6 provide PWM output) Analog Input Pins: 6

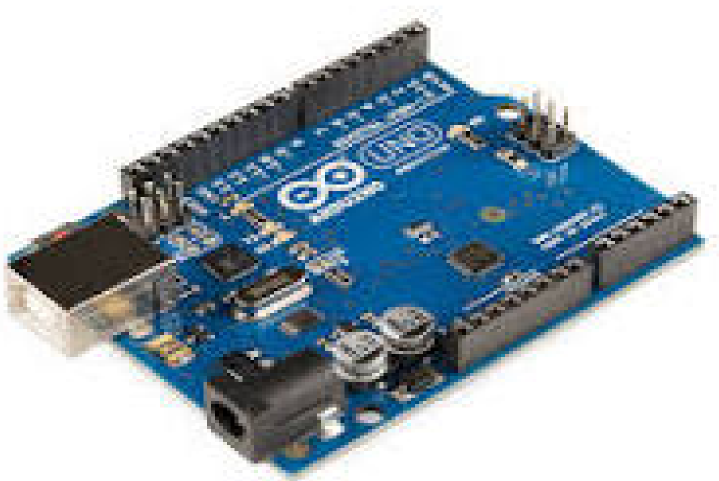

Figure 5.15: Arduino Uno

5.16 20X4 LCD

A 20x4 LCD module is a type of liquid crystal display (LCD) commonly used in electronics projects and devices. The ”20x4” designation means it has 20 character positions in each of its 4 rows, allowing it to display up to 80 characters at once. These modules are popular for displaying text-based information such as sensor readings, menu options, or system status updates in microcontroller-based projects like Arduino or Raspberry Pi. They typically have a standard interface such as HD44780, making them easy to integrate into various projects Display Size: 20 characters per row, 4 rows. Character Size: Typically 5x8 pixels per character. Interface: Usually compatible with HD44780 or equivalent standard.

Figure 5.16: 20x4 LCD

5.17 10K

A 10k potentiometer, also known as a potentiometric resistor, is a type of variable resistor that is frequently used in electronic circuits to modify resistance or control the voltage across a circuit. There are three terminals on it: a middle terminal (wiper) and two outside terminals. The resistance between one of the outer terminals and the middle terminal can be changed by turning the potentiometer's knob, which also modifies the resistance between the other outer terminal and the middle terminal.

Figure 5.17: 10k

5.18 MG 90

mg 90 Torque: Typically around 2 kg-cm to 3 kg-cm, depending on the model and operating voltage. Speed: Typically around 0.10 sec/60° at 4.8V or 0.08 sec/60° at 6V. Operating Voltage: Usually supports a wide range of operating voltages, commonly 4.8V to 6V. Weight: Typically around 13 to 15 grams. Dimensions: Compact size, typically around 22mm x 12mm x 22.5mm. Rotation Range: Typically 180 degrees (90 degrees each side of center). Type: Analog servo motor. Construction: Metal gears for durability and precision. Control Interface: Typically controlled by PWM (Pulse Width Modulation) signals, commonly used with microcontrollers like Arduino.

Figure 5.18: mg 90

Chapter 6

RESULT AND DISCUSSION

6.1 SSEV HARDWARE

The SSEV implements all its functions without any error or delay. The self parking system can be implemented in any car with low cost. The dimensions have to be adjusted for implementation in a live size model. The system detects open and closed doors as well as if there is presence of alcohol in the air in the vicinity of the vehicle. The parking process is also completed smoothly with bumping into the obstacles. The BMS system gives accurate reading of the voltage, current and temperature parameters and the fast charging and slow charging features function as expected.

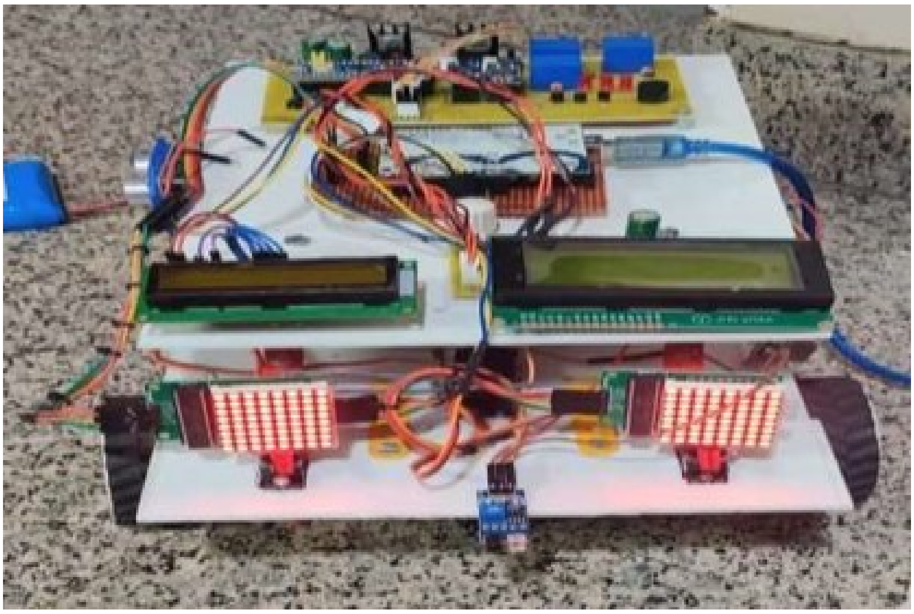

Figure 6.1: SSEV Hardware

6.2 SELF PARKING

When the parking distance is detected, a visual display on the vehicle's dashboard or screen notifies the driver of the proximity to an object or obstacle. This feature is typically enabled by sensors located on the front and/or rear bumpers of the vehicle. The display may show a graphical representation of the vehicle and surrounding objects, along with distance markers to indicate how close the vehicle is to obstacles.This helps the driver maneuver safely into parking spaces without colliding with nearby objects. After successfully parking the vehicle, a display con-

Figure 6.2: Display when parking distance is found

firmation is shown to inform the driver that the parking process is complete. This display may include a message such as "Parking Complete" or an icon indicating the status of the parking system. Additionally, the display may provide information on whether the parking brake has been engaged or if the vehicle is securely parked. This feature ensures that the driver is aware that the vehicle is safely parked and can exit the vehicle with confidence [14].

Figure 6.3: Display when vehicle is parked

While searching for a vacant parking space, the display on the vehicle's dashboard or screen assists the driver by indicating the availability of parking spots. This display may use color-coded symbols or text to represent occupied and vacant parking spaces in parking lots or along the roadside. Some advanced systems can even provide real-time updates on parking availability based on data from sensors or connected networks. This feature helps drivers save time and reduce frustration by quickly identifying areas with available parking.

Figure 6.4: Display while finding vaccant place

6.3 BATTERY MANAGEMENT SYSTEM

Battery Management System (BMS) charging features are functionalities integrated into electric vehicle charging systems to optimize the charging process and ensure the longevity and safety of the vehicle's battery. These features may include fast charging capabilities, adaptive charging algorithms to adjust charging rates based on battery condition and temperature, charging schedule optimization to take advantage of off-peak electricity rates, and remote monitoring and control of charging sessions via smartphone apps or vehicle telematics systems. Additionally, BMS charging features may incorporate safety mechanisms to prevent overcharging, over-discharging, and overheating of the battery pack, thus extending its lifespan and maintaining its performance over time.

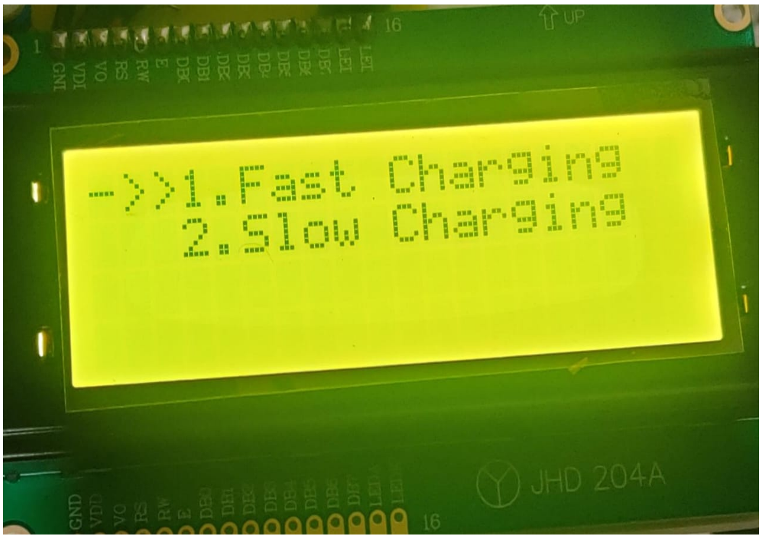

Figure 6.5: BMS charging features

6.4 ADAPTIVE HEADLIGHT SYSTEM HARDWARE

In the adaptive Headlight system the matrix is adjusted as per the movement of the car in front the moment of the headlight while steering is optimal to cover blind spots.

Figure 6.6: Apdative Headlights results

6.5 POTHOLE DETECTION USING AI

Detecting potholes with over 90percentage accuracy is a commendable feat, showcasing the advancement in technology for road safety. However, occasional identifications, such as mistaking manhole covers for potholes, highlight the need for further refinement in the detection system. This could involve improving the algorithm to distinguish between different road features more accurately.

Figure 6.7: Pothole Detected

The decision to place the camera at a higher angle on the car for detecting potholes proves to be a strategic move. It enhances the efficiency of detection compared to when the camera is positioned at a lower angle. This adjustment likely provides a better perspective and coverage of the road surface, leading to more reliable identification of potholes while reducing false positives like the detection of manhole covers. Overall the progress in pothole detection technology underscores the ongoing efforts to enhance road safety through innovative solutions . By addressing challenges like misidentifications and optimizing camera placement, we can further improve the accuracy and effectiveness of pothole detection systems, contributing to smoothe . Utilizing image, video, or live camera feeds for pothole detection

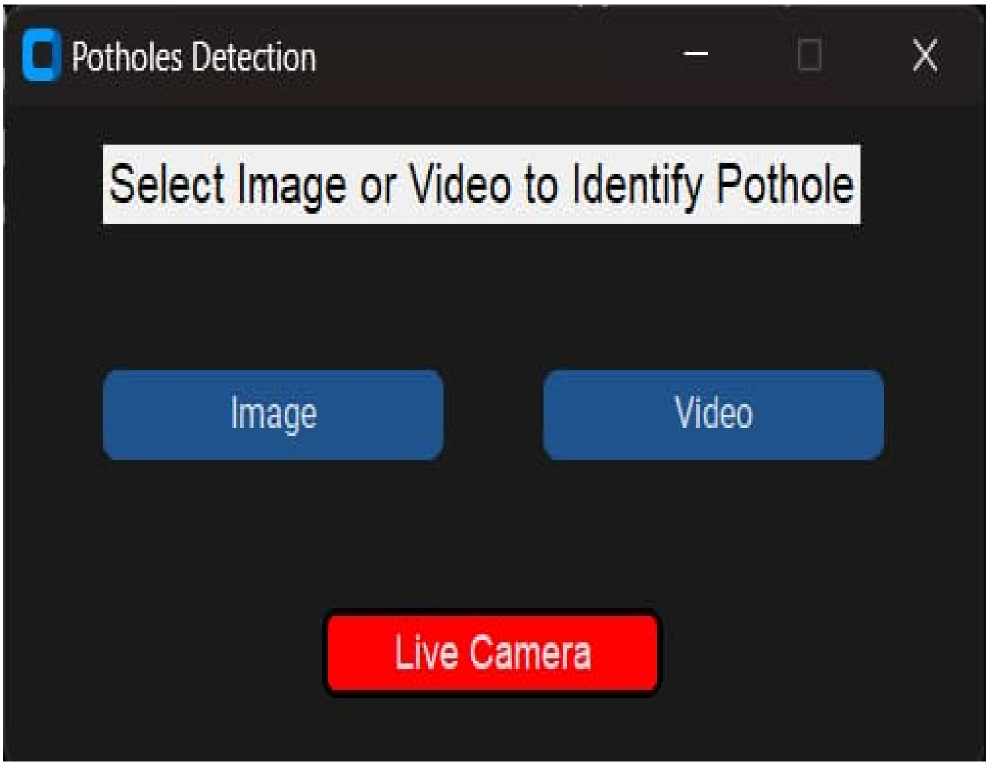

Figure 6.8: Application Interface of pothole detection system

presents a promising approach in ensuring timely identification and mitigation of road hazards. Images offer snapshots of road conditions, enabling automated analysis to pinpoint potholes accurately. Video footage provides a dynamic view, allowing for continuous monitoring and real-time detection of potholes as they appear. Live camera feeds offer the most immediate and comprehensive perspective, facilitating instant response to newly formed potholes and enhancing overall road safety measures.By integrating these technologies into existing infrastructure, authorities can establish proactive measures for road maintenance and repair [15]. Images and videos can be processed using machine learning algorithms to identify and prioritize potholes based on severity and location.

Live camera feeds, when deployed strategically, enable constant surveillance of high-risk areas, allowing for swift interventions to prevent accidents and minimize traffic disruptions. This holistic approach to pothole detection not only enhances road safety but also streamlines maintenance operations, ultimately leading to more resilient and sustainable transportation networks .

Figure 6.9: Pothole Detection Using AI setup

Chapter 7

ALGORITHM

7.1 SELF PARKING

Start

• Initializes various components such as buzzer, LED, LCD display, sensors (IR sensors, ultrasonic range finder, alcohol sensors, door sensors), motors, servos and timers.

• Initializes external interrupts.

• Performs an initialization test for alcohol sensors and door sensors.

• Displays the title on the LCD.

• Ente rs an infinite loop.

• Checks flags Flags.Moni and Flags.AutoPark.

•If Flags.Moni is set, it checks alcohol consumption, door status, and measures distance.

• If Flags.AutoPark is set, it beeps, then checks if the vehicle is parked or not. If parked, it initiates the unparking procedure otherwise, it initiates the autoparking procedure.

• Initializes variables for parking distance and iteration count.

• Clears the LCD display and displays a message indicating that it's searching for a parking space.

• Moves forward while measuring the distance.

• If a suitable parking space is found, it calls the ParkVehicle() function to park the vehicle.

• If no suitable space is found, it displays a message indicating that no parking space is available.

• Clears the LCD display and displays a message indicating that a parking space is found.

• Beeps twice.

• Moves forward for a fixed duration to position the vehicle. • Executes a series of manoeuvres to park the vehicle, such as moving backward, turning left, turning right, etc.

• Displays a message indicating that the vehicle is parked.

• Clears the LCD display and displays a message indicating that it's unparking.

• Moves backward for a fixed duration.

• Executes a series of manoeuvres to unpark the vehicle, such as turning right, turning left, moving forward etc.

• Displays a message indicating that the vehicle is unparked. • Checks alcohol consumption and door status using respective sensor readings.

• If abnormality is detected, it displays a corresponding message on the LCD and sets flags accordingly.

• If no abnormality is detected, it clears the LCD message and resets flags.

7.2 BATTERY MANAGEMENT SYSTEM

Start

• Initializes pin modes for buttons, current and voltage sensor pins, relays, and buzzer.

• Initializes the DHT sensor and LCD display.

• Displays a startup message on the LCD.

• Turns off the relays and buzzes the buzzer for a short duration as a startup indication.

• Reads sensor values and updates the LCD display with battery monitoring information (current, voltage, temperature).

• Checks button presses to navigate through the menu.

• If the ”enter” button is pressed, it enters the menu for charging or discharging.

• If the ”back” button is pressed, it exits the submenu or resets charging parameters.

• If the ”up” or ”down” buttons are pressed, it toggles between charging modes (fast/slow) or charge/discharge modes.

• Based on the menu selection and button presses, it either starts the charging or discharging process or exits the loop.

• Reads temperature and voltage values from the DHT sensor and voltage sensor, respectively.

• Converts voltage readings to actual voltage values.

• Reads current values from the ACS712 current sensor and converts them to actual current values.

• Checks for high temperature conditions and triggers an alert if necessary.

• Enters the discharge mode and continuously monitors battery parameters.

• Updates the LCD display with current, voltage, and mode information.

• Controls relays to switch to discharge mode.

• Allows the user to exit the discharge mode by pressing the ”back” button.

• Enters the charge mode and continuously monitors battery parameters.

• Updates the LCD display with current, voltage, and mode information.

• Controls relays to switch to charge mode.

• Allows the user to exit the charge mode by pressing the ”back” button or automatically stops charging when the battery is fully charged.

• Notifies the user when the battery is fully charged.

• Sounds the buzzer and displays a message on the LCD.

• Waits for any button to be pressed to continue.

• Alerts the user when the battery temperature is high.

• Sounds the buzzer and displays a message on the LCD.

• Waits for any button to be pressed to continue.

7.3 ADAPTIVE HEADLIGH

Start

• The code initializes serial communication, two servos, and a LedControl library for controlling the MAX7219 LED display driver. It also sets up pin modes and configurations.

• Different byte arrays represent various LED patterns for different modes such as normal mode, left area mode, mid area mode, and right area mode. These patterns define which LEDs are turned on or off to create specific lighting effects.

• Initializes serial communication, attaches the servo motors, sets up the LedControl

object, sets LED brightness, and clears the LED displays. • Continuously checks for serial input.

• If specific commands are received ("left", "mid", "right"), it clears the LED displays and sets the appropriate LED patterns for left, mid, or right areas.

• Reads an analog sensor connected to pin A0 to determine the angle of rotation (For steering).

• Maps the sensor value to a servo angle and rotates the servos accordingly.

• The loop repeats these steps indefinitely.

• Reads an analog sensor value (ADC0) to determine the angle of rotation.

• Maps the sensor value to an angle between 0 and 180 degrees.

• Rotates the servo motors based on the mapped angle value. If the angle exceeds certain thresholds (145 or 55 degrees), the servo angles are clamped to prevent them from excee

• Masking function takes a region of interest (ROI) as input, converts it to grayscale, applies Gaussian blur, thresholding, and Canny edge detection to create a binary mask representing the edges of objects within the ROI.

• ROI Processing Functions process the ROIs to detect and analyse contours within each ROI.

• They use the Mask function to create a mask for each ROI and then find contours in the mask.

• Based on the contours' areas and positions, these functions determine if specific conditions (such as the presence of objects representing low beam headlights) are met within each ROI.

• If the conditions are met, corresponding actions are taken, such as drawing bounding boxes around detected objects and sending signals to an Arduino via serial communication.

• Establishing serial communication with an Arduino board connected to the computer via a USB port.

• It sends commands (bytes) to the Arduino based on the conditions detected in the ROIs.

• The script captures frames from a video file or a live feed sent from a camera using OpenCV's VideoCapture function.

• It divides each frame into three ROIs (left, mid, and right) corresponding to different areas of the captured scene.

• It continuously processes each frame by calling the ROI processing functions using multithreading to achieve parallel processing.

• The main thread draws rectangles around each ROI on the displayed frame for visualization purposes.

• The script exits the loop when the 'q' key is pressed, releases resources, and closes windows.

end

7.4 POTHOLE DETECTION USING AI

Start

• Obtaining pothole-filled images through street-view pictures, online databases,or by capturing images with cameras mounted on cars.

• Use labeling tools such as LabelImg or VGG Image Annotator to annotate each image with bounding boxes to indicate any potholes.

• Modify the annotated pictures' dimensions in accordance with the YOLOv4 model's fixed size.

• Normalize the representation of pixel values.

• Using Jupyter and Python, split the dataset into training and testing sets for the intent of analyzing the model.

• If you have a large labeled dataset, you can alternately train from scratch or choose a pre-trained YOLOv4 model.

• Apply transfer learning to further refine the model using your dataset.

• For model training, utilize a deep learning framework like RoboFlow or TensorFlow.

• Write a real-time pothole detecting Python program. • To process images, use libraries like OpenCV and Set YOLOv4 inference functioning.

• Set up IVcam on your computer and camera smartphone (Smartphone B).

• Utilize the hotspot to connect the camera smartphone (Smartphone B) to the laptop.

• Determine that the smartphone (Smartphone B) with the camera is firmly in place to record the area of the road where potholes can appear.

• Set up AnyDesk on the laptop and the smartphone (SmartphoneA) which will be used for display.

• Use AnyDesk to connect the laptop to the smartphone (Smartphone A) which is displaying the pothole detection code.

• Set up the smartphone (Smartphone A) display in an accessible location within the vehicle so you can easily monitor the pothole identifying the results.

• Use smartphone A to run the pothole detecting code on the laptop.

• When the laptop is linked to the display smartphone (Smartphone A) via AnyDesk, the identified potholes will be shown in real time.

• To see the pothole recognition results, a video feed was shown on the smartphone (Smartphone A).

• Press Q on the smartphone's keyboard to close the display window and stop the code.

• End.

COST ESTIMATION

sr no	Component	Cost	Quantity	Total
1	MAX7219 Dot Led Matrix	120	2	240
2	Servo Motor MG90S	230	3	690
3	Servo Motor MG996R	320	1	320
4	Arduino Uno	574	1	574
5	10K Potentiometer	10	3	30
6	ATmega32A	230	2	460
7	16x2 LCD	150	1	150
8	L293D Motor Driver	65	2	130
9	DC Motor	125	2	250
10	MQ-3 Alcohol Detector	288	1	288
11	HC-SR04-Ultrasonic Range Finder	110	2	220
12	IR Proximity/Obstacle Detecting Sensor Module	130	2	260
13	MC-38 Magnetic Switch alarm system (Door sensor)	37	1	37
14	LM2576	26	1	26
15	IN5819	5	1	5
16	0.1 uF	3	1	3
17	100 nH	25	1	25
18	100 uF-25V	5	1	5
19	1000 uF-16V	10	1	10
20	100 nF	2	5	10
21	Tactile Push Button Switch	2	2	4
22	8 Mhz Crystal Oscillator	8	1	8
23	22 pF	3	2	6
24	Buzzer	50	1	50
25	LED	69	1	69
26	Dead Axle	75	2	150
27	USBasp	220	2	440
28	Wheel	40	4	160
29	General purpose PCB	30	10	300
30	plus acrylic	MISCELLANEOUS		
32	nut bolts			
33	wood block			500
34	connecting wire			
35	berg connector male and female			
36	BMS (BATTERY MANAGEMENT SYSTEM	7238	1	7238
37	20x4 lcd display	359	2	718
	total			13376

Chapter 8

CONCLUSION AND FUTURE SCOPE

CONCLUSION

The integration of Al-driven pothole detection, advanced battery management systems, self-parking capability, and intelligent headlight intensity control represents a significant advancement in the development of smart electric vehicles. These tech nologies collectively enhance safety, efficiency, and convenience for drivers and passengers. By detecting potholes and other road hazards in real-time, the Al-based system helps drivers avoid potential accidents and damage to their vehicles, contributing to overall road safety. Additionally, the robust battery management system ensures the optimal performance and longevity of the vehicle's battery, addressing concerns about range anxiety and battery degradation commonly associated with electric vehicles. Furthermore, self-parking capability and intelligent headlight intensity control streamline the driving experience, reducing driver workload and enhancing convenience, especially in urban environments. These features make electric vehicles more accessible and user-friendly, ultimately accelerating the transition towards sustainable transportation solutions. Overall, the integration of these tech nologies marks a significant step towards safer, more efficient, and environmentally friendly mobility.

FUTURE SCOPE

Semi-autonomous smart electric vehicles with Al pothole detection, advanced battery management systems, self-parking capability, and intelligent headlight in- tensity control is promising. One area of potential growth lies in further advancements in Al algorithms and sensor technologies. As Al continues to evolve, future vehicles could become even smarter and more capable of accurately detecting and reacting to road hazards in real-time, thereby enhancing safety and reducing accidents further.Additionally, there is scope for the integration of renewable energy sources and energy harvesting technologies to enhance the sustainability of electric vehicles. By incorporating solar panels or kinetic energy recovery systems, future vehicles could generate additional power to supplement their onboard batteries, extending their range and reducing dependence on external charging infrastructure. This could significantly increase the appeal of electric vehicles and accelerate their adoption worldwide. Moreover, as autonomous driving technology continues to ma- ture, future smart electric vehicles could become fully autonomous, offering pas- sengers the ability to relax or work while the vehicle handles all aspects of driving, including navigation, parking, and avoiding road hazards. This would not only im- prove convenience and productivity but also further enhance safety by reducing hu- man error and driver fatigue. Overall, the future scope for semi-autonomous smart electric vehicles is vast, with endless possibilities for innovation and improvement in safety, efficiency, and sustainability

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Summary

SAVED DRAFT

Semi-Autonomous Smart Electric Vehicle with AI based Drive Assistance

Mihir Karkera
Department of Electronics and Telecommunication
MCT Rajiv Gandhi Institute of Technology
Mumbai, India
mihirkarkera0987@gmail.com

Vedant Pimple
Department of Electronics and Telecommunication
MCT Rajiv Gandhi Institute of Technology
Mumbai, India
vedantPimple1912@gmail.com

Priti Bharti
Department of Electronics and Telecommunication
MCT Rajiv Gandhi Institute of Technology
Mumbai, India
pritibharti@gmail.com

Abhishek kulapkar
Department of Electronics and Telecommunication
MCT Rajiv Gandhi Institute of Technology
Mumbai, India
abhishekkulapkar@gmail.com

Dr.Poonam Sonar
Department of Electronics and Telecommunication
MCT Rajiv Gandhi Institute of Technology
Mumbai, India
poonam.sonar@mctrgit.ac.in

***Abstract*—In our research, we propose a practical methodology design and implementation of a semi-autonomous smart electric vehicle (EV) equipped with advanced features such as AI-based pothole detection, a robust battery management system (BMS), self-parking capability, and intelligent headlight intensity control. The primary objective of this research is to enhance the safety, efficiency, and user experience of electric vehicles through the integration of cutting-edge technologies.The AI-based pothole detection system utilizes sensors and machine learning algorithms to continuously monitor the road surface for hazards such as potholes, cracks, or debris. By analyzing real-time sensor data, the system can accurately identify potential road hazards and provide timely warnings to the driver or take proactive measures to mitigate their impact on vehicle performance and passenger comfort.The battery management system plays a critical role in optimizing the performance and longevity of the vehicle's battery pack. Through advanced algorithms and predictive analytics, the BMS monitors various parameters such as temperature, voltage, and current to ensure safe and efficient operation of the battery. By dynamically adjusting charging rates and load distribution, the system maximizes the battery's lifespan while ensuring sufficient energy availability for propulsion and onboard systems.Self-parking technology enables the vehicle to autonomously navigate parking spaces and execute precise maneuvers without human intervention.**

I. Introduction

A semi-autonomous smart electric vehicle that utilizes AI for pothole detection, incorporates a battery management system, enables self-parking, and includes headlight intensity control involves several interconnected systems working together to enhance the vehicle's functionality and safety.Pothole detection using AI involves equipping the vehicle with sensors, such as cameras to scan the road surface continuously. These sensors capture data about the road condition, including potholes, cracks, or uneven surfaces. The AI algorithm processes this data in real-time, identifying potential hazards like potholes based on predefined criteria such as depth, width, and location [15].The battery management system is crucial for optimizing the performance and longevity of the vehicle's battery. It monitors various parameters such as temperature, voltage, and current of each battery cell. By continuously analyzing this data, the system can ensure that the battery operates within safe limits, preventing overcharging, overheating, or over-discharging, which can damage the battery and reduce its lifespan [14].Self-parking technology enables the vehicle to park itself without the need for direct human intervention. Utilizing sensors, cameras, and AI algorithms, the vehicle can detect suitable parking spaces, calculate the optimal trajectory, and maneuver into the parking spot safely and accurately. This feature enhances convenience for the driver, especially in crowded urban environments where parking spaces are limited.Headlight intensity control adjusts the brightness of the vehicle's headlights based on external conditions such as ambient light levels, oncoming traffic, and weather conditions. By automatically adapting the headlight intensity, the system improves visibility for the driver while minimizing glare for drivers driving ahead as wellas on the opposite lane, enhancing overall safety during nighttime driving or adverse weather conditions.Integrating AI with pothole detection allows the

vehicle to react proactively to road hazards, such as adjusting suspension settings or providing warnings to the driver. When a pothole is detected, the AI system can analyze its severity and recommend appropriate actions to mitigate potential damage to the vehicle or discomfort to the passengers.
The AI algorithm for pothole detection relies on machine learning techniques to continuously improve its accuracy and reliability over time. By training the algorithm with a diverse dataset of road conditions and pothole characteristics, it can learn to distinguish between normal road features and potential hazards more effectively, reducing false positives and improving overall performance.In addition to detecting potholes, the AI system can also predict their formation based on factors such as weather conditions, traffic patterns, and road maintenance history. By analyzing historical data and real-time inputs, the system can anticipate where potholes are likely to occur in the future, allowing the vehicle to adjust its behavior preemptively to avoid or minimize their impact.The battery management system features algorithms to optimize charging and discharging cycles, taking into account factors such as battery chemistry, temperature, and usage patterns. By dynamically adjusting charging rates and load distribution, the system maximizes the battery's lifespan and performance while ensuring that energy is available when needed for propulsion and onboard systems.Self-parking functionality relies on a combination of sensor fusion, path planning algorithms, and vehicle dynamics modeling to navigate complex environments safely and efficiently. By analyzing sensor data in real-time and simulating various parking scenarios, the system can generate optimal trajectories and execute precise maneuvers to park the vehicle with minimal clearance and without colliding with obstacles [13].Headlight intensity control uses feedback from ambient light sensors, oncoming vehicle detection, and weather sensors to adjust the brightness and beam pattern of the headlights accordingly. By dynamically adapting to changing conditions, the system enhances visibility for the driver while minimizing glare and reducing energy consumption [7].

A. Self parking

Self parking system consist of an ATmega32A which works as a controller for the system,it consists of two IR sensors to detect obstacles in the front and the back of the vehicle. A door sensor to check whether the door is opened or closed, An alcohol sensor to detect whether the driver has consumed alcohol or not. An ultra sonic range finder to detect the vacant spaces in parking lot, A LCD display to display the various information during the execution of the self parking. A motor driver to control the DC motors and the servo motor to control the steering mechanism. [6] Once the power is supplied to the system it initialises the peripherals once this is done it will continuously check the door sensor and the alcohol sensor if they are in okay condition if it is not that means if the door is open or if the driver has consumed alcohol then than vehicle will not operate. [6]The ultrasonic range finder also measure the object distance continuously in search of vacant space. If the door is opened the system detects it and warning beeps are produced until the done is closed. If the driver a consumed alcohol the system detects it and warning beeps are produced. For Auto parking there is a button to implement the process as soon as the button is pressed the vehicle moves forward looking for a vacant space using the ultrasonic range finder as soon as it detects an appropriate space "Distance Found" is displayed on the LCD display and the vehicle moves a bit forward and stops then Parking starts by reversing into the spot using the steering once parked it can also un-park by pressing the same button used for parking the vehicle will repeat the process in reverse. If there is no parking spots of the appropriate distance the vehicle will not park and distance not found will be displayed on the LCD display.

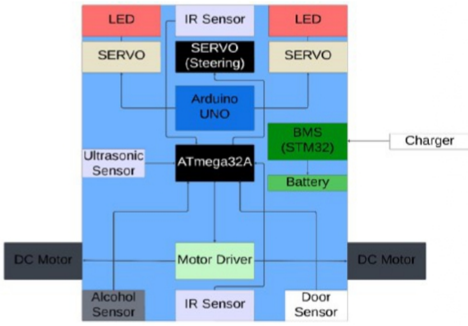

Fig. 1. Block Diagram of SSEV

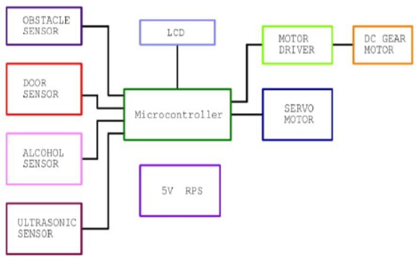

Fig. 2. Battery Management System

B. Battery Management System

The BMS consist of STM32 which acts as the controller, voltage sensor for monitoring the voltage levels of the lithium ion cells, current sensor ACS712 for monitoring the incoming and outgoing current in the battery pack. It also consist of DHT-11 which acts as a temperature sensor which alerts the system if the temperature rises above a certain threshold. The BMS offers certain features for charging and discharging of the battery pack. It can also discharge the battery pack if needed.The charging function can be implemented in two modes fast and slow. For maintaining the battery life at its maximum potential slow charging is preferred. Fast charging is only preferred and when the user is on the go [14]. The system consist of three relays which assist in switching between charging discharging and load management. The current system is capable of handling three Lithium ion a LCD display of 20x4 was used to display the contents such as voltage, current, temperature also the menu and settings can be selected with the assistance of the display. While manufacturing the lithium ion batteries are not at same voltage levels. So while charging and discharging some cells may charge fully faster than the others while some cells may discharge fully quicker than the other cells. This may caused imbalance in the voltage level of complete battery pack. This may reduce the life expectancy of the battery pack [3].The battery pack helps in leveling the voltage level of individual cells in a battery pack maintainig a constant value.

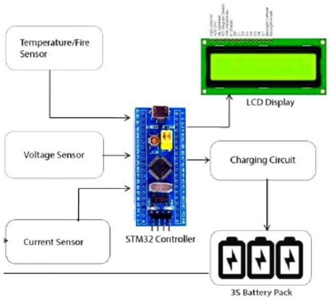

Fig. 3. Battery Management System

C. Adaptive Headlight system

In the Adaptive Headlight system Arduino Uno is used as a controller for receiving data from Small single-board computers Raspberry Pi or your personal computer's camera and controlling the Led Matrix Module. Two Led Matrix Module IC MAX7219 are used for the two headlights spliting the light, One Potentiometer for steering wheel simulation, One Small single-board computers Raspberry Pi with Module Camera Mini Raspberry or your personal computer with computer's webcam for object detection, Two Servo motors for controlling rotation of two Led Matrix Module IC MAX7219 [10]. As soon as the camera detects an incoming vehicle LED matrix is adjusted according to the position of the vehicle protecting the driver on the opposite lane from suffering from the glare caused due to headlights

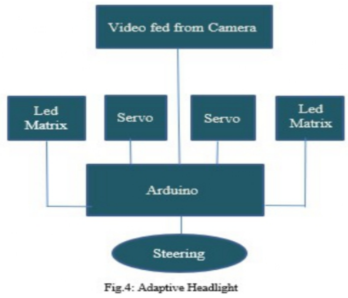

Fig. 4. Adaptive Headlight system

D. Pothole Detection Using AI

Produce a dataset of images having potholes in them. Online databases, road- view prints, and cameras installed on buses are some exemplifications of the sources you can use. Use bounding boxes to annotate each image with the potholes. For this purpose, you can use labelling programs similar as VGG Image Commentator or LabelImg. The YOLOv4 paradigm

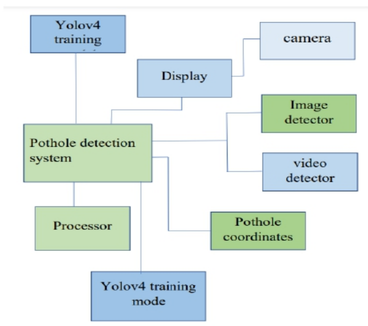

Fig. 5. Pothole Detection Using AI

requires that the prints be resized to a set size. Image pixel values should be regularized. Organize your data into sets for training and testing. Still, you may train from scrape or use a pre-trained YOLOv4 model, If you have a big labelled dataset use transfer literacy to fine- tune the model using your dataset. Exercising a system for deep literacy, like TensorFlow, make the model. Install IVcam on your desktop or laptop and mobile device. Make use of hotspot to connect the laptop to the camera mobile phone. Make sure the smartphone camera is firmly in place so that it can record the areas of the road where potholes may appear. Install AnyDesk on the laptop and the phone that is on display.Using AnyDesk, connect the laptop to the mobile device that is displaying the pothole detection code. Use the pothole detection code on the mobile phone's display while it's connected to the laptop via Anydesk 8. Put the phone's display in a handy spot within the vehicle so you can easily monitor the pothole detecting findings. Keep an eye on the mobile phone's displayed video stream to see the pothole detecting outcomes.

II. Problem Statement

In a fast moving society with every second important a drivers most tedious and time consuming job while driving a vehicle is parking which is made simpler by employing Self Parking technology While driving during the night headlights are an important feature of any vehicle but also poses a danger to the driver driving on the opposite lane.Headlights causes discomfort to the individual passing from the opposite lane this problem is solved using Head light intensity control Battery Management Systems (BMS) have limitations in accurately monitoring battery health, balancing cell voltages, and maximizing battery utilization.There is a need to develop an advanced BMS that can optimize battery performance and optimize charging and discharging strategies of the battery pack to improve energy efficiency and maximize the driving range. [5]Incorporate safety features to detect and prevent potential

A. objective

The objective of this project is to develop a cutting-edge semi-autonomous smart electric vehicle with AI-based driving assistance systems that enhance safety, efficiency, and user experience while contributing to the advancement of sustainable transportation.Energy Efficien electric vehicles are often more energy-efficient than ICE vehicles. The project can focus on promoting energy-efficient transportation as a means of reducing energy consumption. drive The automotive feature of this project ensures a safer drive as well as reduces human error ensuring lesser maintenance cost and a decrease in the accident rates. AI Assistance The AI assistance further reduces the load on the driver and makes a nerve racking drive into an uncomplicated and cheerful experience.Reducing Greenhouse Gas Emissions One of the primary objectives of EVs is to reduce the environmental impact of transportation by replacing traditional internal combustion engine (ICE) vehicles with vehicles powered by electricity.Scalability and Integration that the AI-based driving assistance systems can be integrated with future updates and improvements. Explore opportunities for collaboration with other smart city initiatives and infrastructure for seamless integration. Sustainability and Environmental Impact It reduces the vehicle's carbon footprint through energy-efficient driving and the use of renewable energy sources. Aim for a significant reduction in greenhouse gas emissions compared to traditional vehicles. Autonomous Parking Achieve full autonomy for parking, including parallel and perpendicular parking in various environments. The objective of this extend is to create a cutting- Develop lighting frameworks that alter to street conditions, activity, and natural-components.thing User-Customized Profiles Empower clients to make personalized driving profiles, alteringvehicle behavior to person inclinations. thing Real-time Activity Examination Utilize AI calculations to analyze real-time activity information and give energetic course proposals to maintain a strategic distance from congestion

III. RESULT AND DISCUSSION

Battery Management System (BMS) charging features are functionalities integrated into electric vehicle charging systems to optimize the charging process and ensure the longevity and safety of the vehicle's battery. These features may include fast charging capabilities, adaptive charging algorithms to adjust charging rates based on battery condition and temperature, charging schedule optimization to take advantage of off-peak electricity rates, and remote monitoring and control of charging sessions via smartphone apps or vehicle telematics systems. Additionally, BMS charging features may incorporate safety mechanisms to prevent over charging, overheating and over-discharging of the battery pack, thus extending its lifespan and maintaining its performance over time. In the

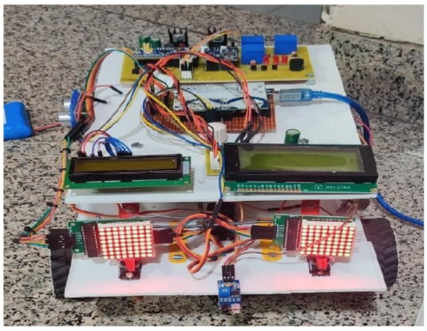

Fig. 6. SSEV Hardware

adaptive Headlight system the matrix is adjusted as per the movement of the car in front the moment of the headlight while steering is optimal to cover blind spots. When the parking distance is detected, a visual display on the vehicle's dashboard or screen notifies the driver of the proximity to an object or obstacle [4]. This feature is typically enabled by sensors located on the front and/or rear bumpers of the vehicle. The display may show a graphical representation

Fig. 7. Adaptive Headlight system Hardware

of the vehicle and surrounding objects, along with distance markers to indicate how close the vehicle is to obstacles. This helps the driver maneuver safely into parking spaces without colliding with nearby objects. [1]After successfully parking

Fig. 8. Display when parking distance is found

the vehicle, a display confirmation is shown to inform the driver that the parking process is complete. This display may include a message such as "Parking Complete" or an icon indicating the status of the parking system. Additionally, the display may provide information on whether the parking brake has been engaged or if the vehicle is securely parked. This feature ensures that the driver is aware that the vehicle is safely parked and can exit the vehicle While searching for

Fig. 9. Display when vehicle is parked

a vacant parking space, the display on the vehicle's dashboard or screen assists the driver by indicating the availability of parking spots. This display may use color-coded symbols or text to represent occupied and vacant parking spaces in parking lots or along the roadside. Some advanced systems can even provide real-time updates on parking availability based on data from sensors or connected networks [2]. This feature helps drivers save time and reduce frustration by quickly identifying areas with available parking.

Fig. 10. Display while finding vaccant place

Battery Management System (BMS) charging features are functionalities integrated into electric vehicle charging systems to optimize the charging process and ensure the longevity and safety of the vehicle's battery. [9] These features may include fast charging capabilities, adaptive charging algorithms to adjust charging rates based on battery condition and temperature, charging schedule optimization to take advantage of off-peak electricity rates, and remote monitoring and control of charging sessions via smartphone apps or vehicle telematics systems [12]. Additionally, BMS charging features may incorporate safety mechanisms to prevent overcharging, over-discharging, and overheating of the battery pack, thus extending its lifespan and maintaining its performance over time. Detecting potholes with over 90percentage accuracy is a

Fig. 11. BMS charging features

commendable feat, showcasing the advancement in technology for road safety. However, occasional identifications, such as mistaking manhole covers for potholes, highlight the need for further refinement in the detection system. This could involve improving the algorithm to distinguish between different road features more accurately. The decision to place the camera at a higher angle on the car for detecting potholes proves to be a strategic move. It enhances the efficiency of detection compared to when the camera is positioned at a lower angle. This adjustment likely provides a better perspective and coverage of the road surface, leading to more reliable identification of potholes while reducing false positives like the detection of manhole covers. Overall the progress in pothole detection

Fig. 12. Pothole Detected

technology underscores the ongoing efforts to enhance road safety through innovative solutions. By addressing challenges like identification's and optimizing camera placement [5]. we can further improve the accuracy and effectiveness of pothole detection systems, contributing to smoothe Utilizing image,

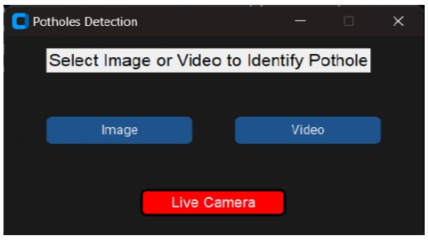

Fig. 13. Application Interface of pothole detection system

video, or live camera feeds for pothole detection presents a promising approach in ensuring timely identification and mitigation of road hazards. Images offer snapshots of road conditions, enabling automated analysis to pinpoint potholes accurately. Video footage provides a dynamic view, allowing for continuous monitoring and real-time detection of potholes as they appear. Live camera feeds offer the most immediate and comprehensive perspective, facilitating instant response to newly formed potholes and enhancing overall road safety measures.By integrating these technologies into existing infrastructure, authorities can establish proactive measures for road maintenance and repair. Images and videos can be processed using machine learning algorithms to identify and prioritize potholes based on severity and location. Live camera feeds, when deployed strategically, enable constant surveillance of high-risk areas, allowing for swift interventions to prevent accidents and minimize traffic disruptions [11].holistic approach to pothole detection not only enhances road safety but also streamlines maintenance operations, ultimately leading to more resilient and sustainable transportation networks.

IV. Conclusion

The integration of AI-driven pothole detection, advanced battery management systems, self-parking capability, and intelligent headlight intensity control represents a significant advancement in the development of smart electric vehicles. These technologies collectively enhance safety, efficiency, and convenience for drivers and passengers.By detecting potholes and other road hazards in real-time, the AI-based system helps drivers avoid potential accidents and damage to their vehicles, contributing to overall road safety. Additionally, the robust battery management system ensures the optimal performance and longevity of the vehicle's battery, addressing concerns about range anxiety and battery degradation commonly associated with electric vehicles.Furthermore, self-parking capability and intelligent headlight intensity control streamline the driving experience, reducing driver workload and enhancing convenience, especially in urban environments. These features make electric vehicles more accessible and user-friendly, ultimately accelerating the transition towards sustainable transportation solutions. Overall, the integration of these technologies marks a significant step towards safer, more efficient, and environmentally friendly mobility.

V. Future Scope

semi-autonomous smart electric vehicles with AI pothole detection, advanced battery management systems, self-parking capability, and intelligent headlight intensity control is promising. One area of potential growth lies in further advancements in AI algorithms and sensor technologies. As AI continues to evolve, future vehicles could become even smarter and more capable of accurately detecting and reacting to road hazards in real-time, thereby enhancing safety and reducing accidents further.Additionally, there is scope for the integration of renewable energy sources and energy harvesting technologies to enhance the sustainability of electric vehicles. By incorporating solar panels or kinetic energy recovery systems, future vehicles could generate additional power to supplement their onboard batteries, extending their range and reducing dependence on external charging infrastructure. This could significantly increase the appeal of electric vehicles and accelerate their adoption worldwide.Moreover, as autonomous driving technology continues to mature, future smart electric vehicles could become fully autonomous, offering passengers the ability to relax or work while the vehicle handles all aspects of driving, including navigation, parking, and avoiding road hazards. This would not only improve convenience and productivity but also further enhance safety by reducing human error and driver fatigue. Overall, the future scope for semi-autonomous smart electric vehicles is vast, with endless possibilities for innovation and improvement in safety, efficiency, and sustainability.

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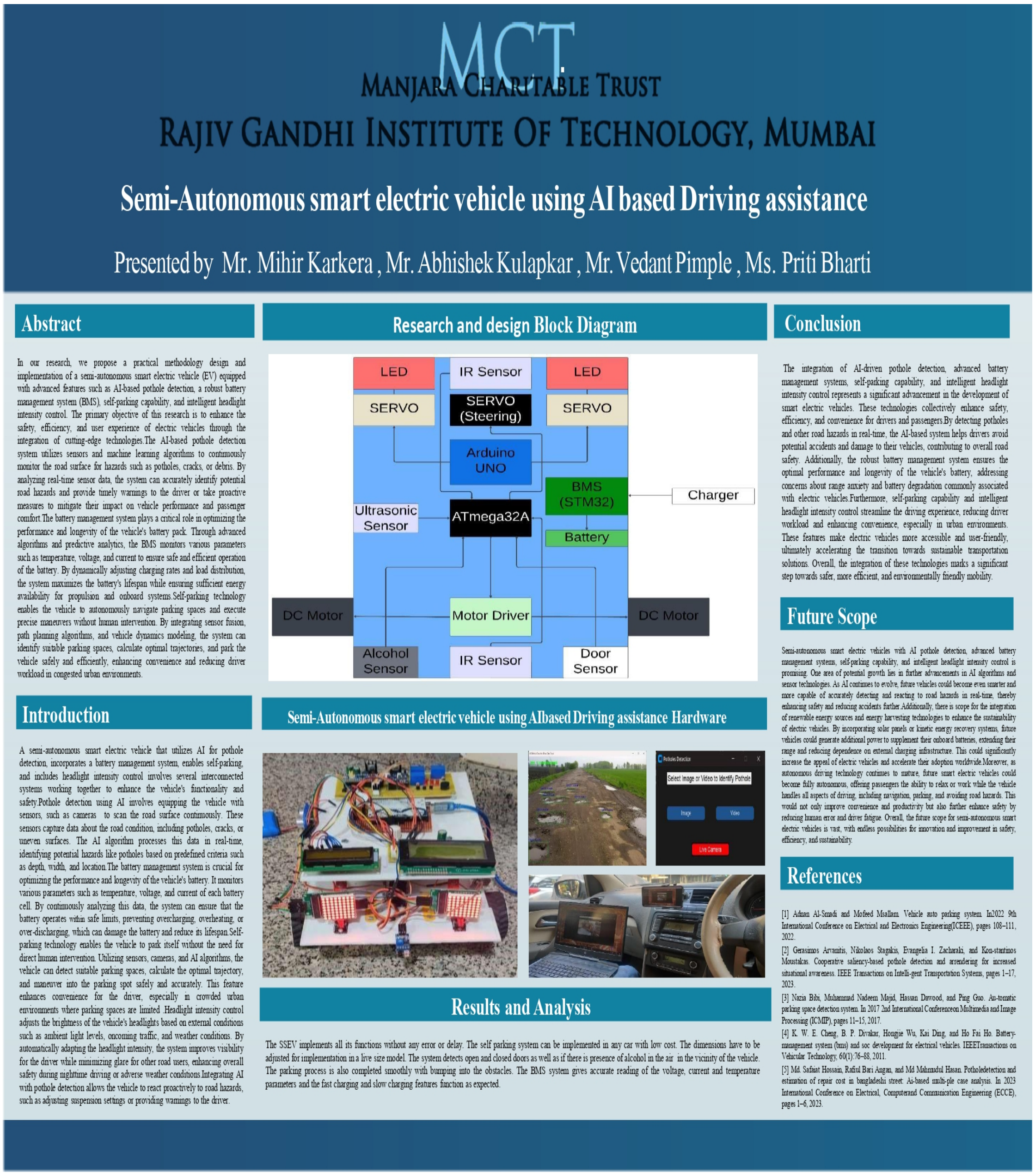
MCT
MANJARA CHARITABLE TRUST
RAJIV GANDHI INSTITUTE OF TECHNOLOGY, MUMBAI
Semi-Autonomous smart electric vehicle using AI based Driving assistance
Presented by Mr. Mihir Karkera , Mr. Abhishek Kulapkar , Mr. Vedant Pimple , Ms. Priti Bharti
Abstract
In our research, we propose a practical methodology design and implementation of a semi-autonomous smart electric vehicle (EV) equipped with advanced features such as AI-based pothole detection, a robust battery management system (BMS), self-parking capability, and intelligent headlight intensity control. The primary objective of this research is to enhance the safety, efficiency, and user experience of electric vehicles through the integration of cutting-edge technologies.The AI-based pothole detection system utilizes sensors and machine learning algorithms to continuously monitor the road surface for hazards such as potholes, cracks, or debris. By analyzing real-time sensor data, the system can accurately identify potential road hazards and provide timely warnings to the driver or take proactive measures to mitigate their impact on vehicle performance and passenger comfort.The battery management system plays a critical role in optimizing the performance and longevity of the vehicle's battery pack. Through advanced algorithms and predictive analytics, the BMS monitors various parameters such as temperature, voltage, and current to ensure safe and efficient operation of the battery. By dynamically adjusting charging rates and load distribution, the system maximizes the battery's lifespan while ensuring sufficient energy availability for propulsion and onboard systems.Self-parking technology enables the vehicle to autonomously navigate parking spaces and execute precise maneuvers without human intervention. By integrating sensor fusion, path planning algorithms, and vehicle dynamics modeling, the system can identify suitable parking spaces, calculate optimal trajectories, and park the vehicle safely and efficiently, enhancing convenience and reducing driver workload in congested urban environments.
Introduction
A semi-autonomous smart electric vehicle that utilizes AI for pothole detection, incorporates a battery management system, enables self-parking, and includes headlight intensity control involves several interconnected systems working together to enhance the vehicle's functionality and safety.Pothole detection using AI involves equipping the vehicle with sensors, such as cameras to scan the road surface continuously. These sensors capture data about the road condition, including potholes, cracks, or uneven surfaces. The AI algorithm processes this data in real-time, identifying potential hazards like potholes based on predefined criteria such as depth, width, and location.The battery management system is crucial for optimizing the performance and longevity of the vehicle's battery. It monitors various parameters such as temperature, voltage, and current of each battery cell. By continuously analyzing this data, the system can ensure that the battery operates within safe limits, preventing overcharging, overheating, or over-discharging, which can damage the battery and reduce its lifespan.Self-parking technology enables the vehicle to park itself without the need for direct human intervention. Utilizing sensors, cameras, and AI algorithms, the vehicle can detect suitable parking spaces, calculate the optimal trajectory, and maneuver into the parking spot safely and accurately. This feature enhances convenience for the driver, especially in crowded urban environments where parking spaces are limited .Headlight intensity control adjusts the brightness of the vehicle's headlights based on external conditions such as ambient light levels, oncoming traffic, and weather conditions. By automatically adapting the headlight intensity, the system improves visibility for the driver while minimizing glare for other road users, enhancing overall safety during nighttime driving or adverse weather conditions.Integrating AI with pothole detection allows the vehicle to react proactively to road hazards, such as adjusting suspension settings or providing warnings to the driver.
Research and design Block Diagram
LED
IR Sensor
LED
SERVO
SERVO (Steering)
SERVO
Arduino UNO
BMS (STM32)
Charger
Ultrasonic Sensor
ATmega32A
Battery
DC Motor
Motor Driver
DC Motor
Alcohol Sensor
IR Sensor
Door Sensor
Semi-Autonomous smart electric vehicle using AI based Driving assistance Hardware
Results and Analysis
The SSEV implements all its functions without any error or delay. The self parking system can be implemented in any car with low cost. The dimensions have to be adjusted for implementation in a live size model. The system detects open and closed doors as well as if there is presence of alcohol in the air in the vicinity of the vehicle. The parking process is also completed smoothly with bumping into the obstacles. The BMS system gives accurate reading of the voltage, current and temperature parameters and the fast charging and slow charging features function as expected.
Conclusion
The integration of AI-driven pothole detection, advanced battery management systems, self-parking capability, and intelligent headlight intensity control represents a significant advancement in the development of smart electric vehicles. These technologies collectively enhance safety, efficiency, and convenience for drivers and passengers.By detecting potholes and other road hazards in real-time, the AI-based system helps drivers avoid potential accidents and damage to their vehicles, contributing to overall road safety. Additionally, the robust battery management system ensures the optimal performance and longevity of the vehicle's battery, addressing concerns about range anxiety and battery degradation commonly associated with electric vehicles.Furthermore, self-parking capability and intelligent headlight intensity control streamline the driving experience, reducing driver workload and enhancing convenience, especially in urban environments. These features make electric vehicles more accessible and user-friendly, ultimately accelerating the transition towards sustainable transportation solutions. Overall, the integration of these technologies marks a significant step towards safer, more efficient, and environmentally friendly mobility.
Future Scope
Semi-autonomous smart electric vehicles with AI pothole detection, advanced battery management systems, self-parking capability, and intelligent headlight intensity control is promising. One area of potential growth lies in further advancements in AI algorithms and sensor technologies. As AI continues to evolve, future vehicles could become even smarter and more capable of accurately detecting and reacting to road hazards in real-time, thereby enhancing safety and reducing accidents further.Additionally, there is scope for the integration of renewable energy sources and energy harvesting technologies to enhance the sustainability of electric vehicles. By incorporating solar panels or kinetic energy recovery systems, future vehicles could generate additional power to supplement their onboard batteries, extending their range and reducing dependence on external charging infrastructure. This could significantly increase the appeal of electric vehicles and accelerate their adoption worldwide.Moreover, as autonomous driving technology continues to mature, future smart electric vehicles could become fully autonomous, offering passengers the ability to relax or work while the vehicle handles all aspects of driving, including navigation, parking, and avoiding road hazards. This would not only improve convenience and productivity but also further enhance safety by reducing human error and driver fatigue. Overall, the future scope for semi-autonomous smart electric vehicles is vast, with endless possibilities for innovation and improvement in safety, efficiency, and sustainability.
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