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# Smart Car Using IoT and Image Processing

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***Abstract*— Smart and automated cars are the future of the automobile industry. With the developing technology, automation is introduced in every sector due to its advantages like improved accuracy and precision over manual handling. Due to this very same reason automation is been introduced in cars as well. Nowadays many car manufacturing companies are automating many of the mechanisms in their vehicles to provide the best in-segment features and to give the customers an effortless experience of driving their vehicle. Also, as nowadays automation is introduced in these newly manufactured vehicles it has improved the safety and security of drivers.**

**Within this manuscript, a system is been envisioned that is an excellent example of how automation in cars can make them smart-car and solve many issues faced by drivers while driving. The setup is integrated with a range of impressive mechanisms devised through the amalgamation of diverse hardware and software elements. The configuration comprises an automatic wiper mechanism, parking alarm mechanism, lane detection mechanism, and also weather parameter sensing mechanism. All these mechanisms are contributing in some or another way to reducing the stress on the driver while driving the car The automated rain wiper system detects rainfall and automatically activates the rain wiper. The system is developed to mitigate driving distractions and permit drivers to concentrate on their primary task of driving. Parking alarm system assists drivers while parking their car and helps avoid any unusual circumstances. The weather parameters sensing mechanism senses the weather parameters around the car so that accordingly the driver can adjust A/C settings and also helps automate the driving. A Lane detection system is very useful nowadays so that the driver can keep an eye on the lane while driving, also it can assist in automated driving.**

***Keywords*— *Smart Car, IoT, Node-MCU ESP8266, Ultrasonic Sensor, Water Sensor, Rain Sensor, Arduino UNO, python, Image processing, Lane Detection, Open CV.***

## I. INTRODUCTION

Technology has started to evolve at a rapid pace since the incorporation of the Internet with machines. It has changed the way people perceive or communicate their day-to-day tasks. The intervention of the Internet has made all the devices ‘connected’ to one another through intense data exchange and constant communication. This has further led to the invention of Smart-Things. Nowadays we can see a lot of Smart-devices which include smart homes, smart agriculture, smart lighting, and smart industries. This invention has caught the attention of the Automobile Industry pretty heavily. The Concept of smart cars has become a big upcoming trend and the majority of car manufacturers have started to include this smart technology as a basic necessity in their latest products, giving rise to “Smart-Cars”. Smart Cars usually have automated technologies to help reduce unnecessary burdens and reduce distributed attention of the driver to things that don’t need much Cognital behavior. Cars nowadays have Automated Rain-Wipers which are activated the minute it starts raining. Automated parking systems or Supported Parking systems and Auto-Brake Systems with the help of cameras and sensors have proved to be the most reliable inventions of all time.

We have made one similar project based on the concept of the Smart-Car system. This project hosts various mechanisms like –

1) Automatic Wiper System: It incorporates a Rain sensor which in turn activates the wipers of the cars connected to the servo motor.
2) Automatic Parking System: We have connected an Ultrasonic Sensor interfaced with Arduino Uno to detect the distance of the car from the wall/obstacle behind to assist the driver in safer and more efficient parking.
3) Automatic Weather Parameter System: This system consists of a Node MCU to power other sensors like pressure, temperature, and rain sensor to compute the weather conditions outside the car and optimize the conditions inside the car.
4) Lane Detection using Python Library: An automatic lane detection system has been employed using the help of a camera module/ mobile camera which will help in safer travel and increase the overall security of the vehicle. It will detect the lane marks on either side of the road and notify the driver accordingly.
5) Object Detection using OpenCV: In addition to lane detection, we have also included object detection to sense the cars or traffic around the vehicle to notify the accidents.

Smart Cars offer a variety of advantages with the most base intention of increasing passenger safety so and reducing unsupervised accidents to some extent. This increased safety has caught the attention of so many manufacturers that they have started to replace traditional cars with smart cars. Shortly, due to the variety of advantages, smart cars will be a very promising industry in the future.

## II. LITERATURE SURVEY

In paper [1], Researchers have given comprehensive details about what is OpenCV and how it is used in various fields of image processing. The authors have developed a real-time image-processing application and have described it in the paper. From the paper, the reader understands that the purpose of image processing is to enable computers to understand the content of an image and OpenCV is a library that is used for image processing with its functions.

In paper [2], Researchers have envisioned a software system that uses the OpenCV library for lane detection in an autonomous vehicle. In the following paper, the discussion is been done on various topics such as why and how to choose grayscale instead of color, find edges in an image, select a region of interest, apply the Hough transform, and choose between polar and cartesian coordinates.

In paper [3], Researchers have envisioned a very advanced system that identifies road lanes and markings through the OpenCV library of Python. A detailed analysis is been given on how lane recognition system works in automated cars and why they are important to install. The following conclusion can be drawn from the paper, Lane recognition systems work by detecting lane boundaries on the road and warning the driver if they cross the wrong lane boundary.

In the paper [4], The authors cover a variety of topics ranging from the assistance of advanced AI algorithms and ML techniques in object recognition. It also demonstrates the flexibility of the tracking system for moving cameras, making it ideal for automotive security applications. Image identification uses techniques such as object recognition, identification, and segmentation. In short, the paper gives an overview of how easily an advanced level of object detection can be done using the OpenCV library of Python.

In the paper [5], The authors explain how object detection can be used in various fields such as facial recognition, character recognition, and in-vehicle computers. By reading this paper one can understand how Object recognition is related to visual computing and image analysis, which specifically aims at identifying and categorizing elements or occurrences belonging to specific categories (humans, plants, creatures, etc.) within digital images and videos.

In the paper [6], The authors in this paper describe and propose a system of smart cars with reactive windshield experience which can be personalized based on the users. This advanced windshield will display all the important parameters like car speed and temperature. They have combined pedestrian tracking techniques with a mobile-surveillance network including a third-car-appropriate app.

In the paper [7], The authors describe the implementation of radio technology paired with WIFI connectivity to collect information about drivers and passengers. The wireless solution presented has the ability to authenticate authorized operators by utilizing radio-based biometric data.

In paper [8], the authors explore different approaches to enhance parking systems in vehicles through the utilization of RFID technology. The primary elements employed include RFID scanners, RFID tags, computing devices, access barriers, and specialized software. The implementation of RFID sensors is suggested for streamlining the check-in and check-out processes of parking facilities. In short, the authors have proposed a way to substitute the current way of manual parking totally with RFID technology.

In paper [9], The paper highlights the importance of lane detection in traditional cars. It presents a way of detecting road lanes using the Hough Transform method.

In the paper [10], The paper proposes a smart headlight control system using Arduino depending on LDR and ultrasonic sensors. The LDR will receive the light intensity from the surrounding area and provide the appropriate data to Arduino which will in turn fluctuate the intensity of the headlights accordingly.

In the paper [11], the researchers introduced a system consisting of a microcontroller Node-MCU and a diverse array of sensors, including DHT-11, FC-37, BMP 180, LDR, and raindrop modules. These sensors were utilized to gauge weather parameters such as temperature, precipitation likelihood, humidity, and atmospheric pressure. The acquired data was continuously monitored, and an alert was generated based on the analysis.

In the paper [12], the authors elucidated a system that measures a wide range of weather parameters using distinct sensors, offering real-time weather data. Furthermore, the system transmits the gathered data to the user via email or SMS.

In the paper [13], a detailed overview was provided by the authors regarding their developed system. The system employed BMP-180, DHT-11, and FC-37 sensors to measure temperature, pressure, and humidity in the atmosphere, respectively. The ESP 8266 microcontroller played a pivotal role in this system.

In the paper [14], delved into an IoT system devised for quantifying atmospheric parameters like rainfall intensity, temperature, wind speed, and light intensity. This system leveraged the MQTT protocol to relay this information to the cloud for storage and display.

In the paper [15], an outlined system was presented that harnessed a variety of sensors to continuously monitor real-time weather parameters. The collected data was showcased on a web server using the HTTP protocol.

## III. PROPOSED METHODOLOGY

### *A. Block Diagrams*

The hardware of the proposed methodology is based on IoT, It consists of sensors like an Ultrasonic sensor, Water sensor, and also a servo motor all these components are interfaced with the Arduino UNO microcontroller board.

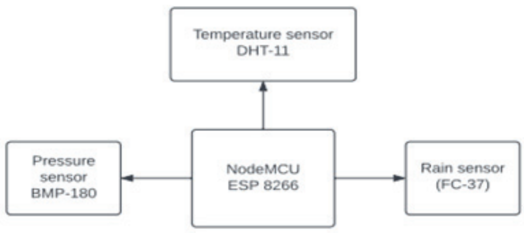


Fig. 1. System architecture for the proposed System

In addition, the system incorporates a weather parameter measurement mechanism that involves the utilization of sensors, namely, a Temperature, Pressure, and Rain sensor. All three of these sensors are interfaced with the ESP8266

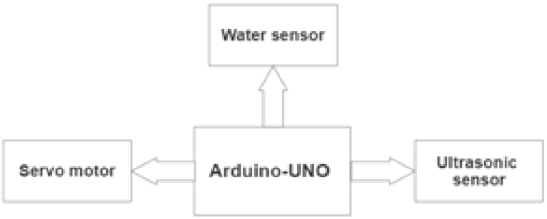


Fig. 2. System architecture for weather parameter measuring mechanism on the system.

## B. *Description of Hardware:*

TABLE I. PROVIDES A COMPREHENSIVE OVERVIEW OF THE COMPONENTS INCORPORATED IN THE ENVISIONED SYSTEM:

| Sr. No. | Component | Model No. |
|---|---|---|
| 1 | Arduino UNO | R3 |
| 2 | Ultrasonic Sensor | HC-SR04 |
| 3 | Servo motor | |
| 4 | Water sensor | |
| 5 | Node MCU | ESP8266 |
| 6 | Rain sensor | FC-37 |
| 7 | Temperature and Humidity sensor | DHT-11 |
| 8 | Barometric pressure sensor | BMP-180 |

### 1) *Node-MCU Esp8266*

Figure 3 illustrates the Node-MCU board, an affordable open-source IoT platform. It functions as the core component of the proposed system, interfacing with the Rain sensor FC-37, Temperature sensor DHT-11, and Barometric pressure sensor BMP-180. Node-MCU is a versatile development board specifically crafted to cater to the demands of smart applications, offering extensive capabilities and functionalities.

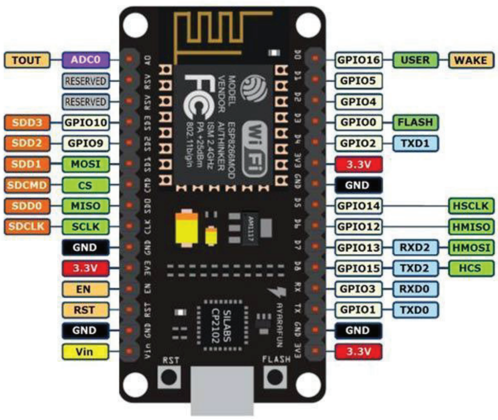


Fig. 3. Node-MCU ESP8266

### 2) *Arduino UNO:*

Fig 4. Showcaseshe Arduino UNO microcontroller is a versatile and cost-effective board with ATmega328P. It has multiple analog and digital pins for various projects, including interfacing with servo motors, ultrasonic sensors, and water sensors. Its input voltage range is 7V to 20V, making it a key component in the system.

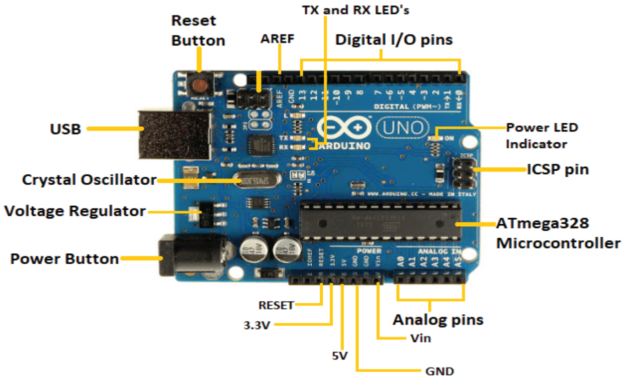


Fig. 4. Arduino UNO

### 3) *Ultrasonic Sensor:*

Fig 5 shows the Ultrasonic sensor, Ultrasonic sensors play a crucial role in the proposed system by generating and detecting ultrasonic waves. These waves are emitted and are subsequently amplified and processed to detect reflected echoes. The system excels at precisely determining the distance between the target and itself. The ultrasonic sensor is connected to an Arduino UNO board and used as the main component in Automatic parking mechanism


Fig. 5. Ultrasonic Sensor

### 4) *Servo motor:*

Fig 6 shows the Servo motor, It is a type of rotary actuator which is used in areas wherein highly precise and controlled angular actuation is required. It works based on a closed-loop mechanism. The servo motor consists of parts such as a DC motor, potentiometer, and Gear system.


Fig. 6. Servo motor

*5) Water Sensor:*

Fig 7 shows the Water sensor, which effectively identifies and measures the water level through the utilization of copper traces integrated onto its surface. The Water sensor comprises a total of 10 copper traces, each functioning collectively as a variable resistor. This resistance dynamically alters depending on the extent to which the sensor is submerged in water. It consists of three pins for the connection they are VCC, GND, and signal.

Fig. 7. Water Sensor

*6) FC-37*

Fig 8 displays the Water sensor employed for the identification of water presence. This sensor functions by establishing electrical connections on carbon boards with carbon leads imprinted on them, functioning as a variable resistor. It features four connection pins: Ao, Do, Gnd, and VCC, along with two pins for connection with the rain sensor

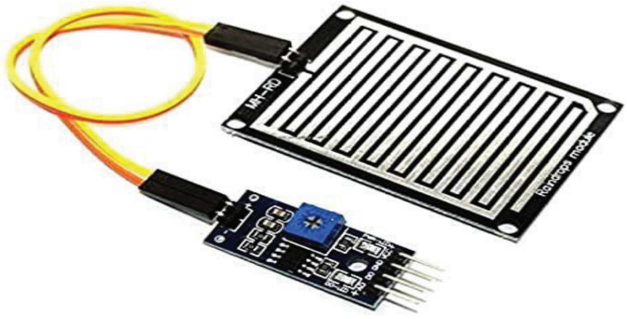


Fig. 8. Rain sensor

*7) DHT-11*

Fig 9 displays the DHT11 sensor, which serves as a temperature and humidity sensor. It is equipped with four pins: VCC, data, NC, and ground. The sensor operates within a voltage range of 3.5v to 5.5v, having a temperature range spanning from 0 degrees Celsius to 50 degrees Celsius. The DHT11 sensor provides humidity readings within the range of 20% to 90%.

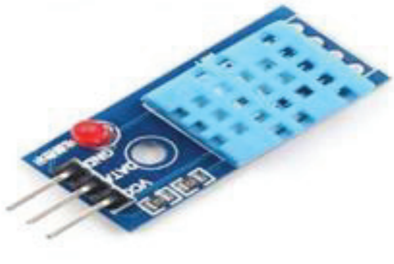

Fig. 9. DHT 11

*8) BMP-180*

Fig 10 displays the BMP180 sensor, an electronic barometric pressure sensor featuring GND, Serial data pin, Serial clock pin, and VCC as its four connection pins. Functioning within a voltage range of 1.3v to 3.6v, it employs a 3.4MHz I2C interface for communication and data exchange. This compact-sized sensor measures atmospheric pressure by assessing the weight exerted by the air and offers a pressure range of 300 to 1100hPa. Pressure conversions are swiftly completed in approximately 5 milliseconds.

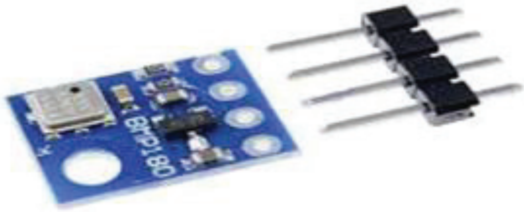


Fig. 10. BMP-180

## *C. Description of software used*

Lane Detection and object detection using OpenCV

OpenCV is a Python software library specializing in machine learning. OpenCV serves as a unified foundation for various computer vision applications, facilitating the widespread adoption of machine perception in commercial products. Leveraging OpenCV, developers can efficiently analyze images and videos to recognize objects, detect faces, and even decipher human handwriting, among other capabilities.

In the proposed system OpenCV is been used for lane detection using video and images so that the Car can be driven in a particular lane without getting distracted from its path and avoid accidents. The lane of a particular color is been detected and the car is meant to be driven in that particular detected lane. It includes 5 to 6 steps starting from capturing the video to detecting the lanes on it of a particular color. Which color lane has to be detected can be specified by mentioning it in the Lane detection code.

## *D. Combined working of the proposed system with all mechanisms*

The proposed system is combined with 4 mechanisms. Out of which 3 mechanisms are hardware and 1 mechanism is software. The mechanisms are as follows:

*1) Automatic Wiper system*

In the envisioned system, an automated wiper mechanism is implemented by utilizing the synergy between a Rain sensor, servo motor, and an Arduino UNO microcontroller board. These components are seamlessly integrated to enable efficient control and operation of the wiper system. The rain sensor senses the amount of water on the copper traces over it and accordingly activates the servo motor over a specified limit of water.

*2) Automatic parking system*

In the proposed system an automatic parking system is been included using an Ultrasonic sensor. It is linked to the Arduino UNO board., which is employed to perceive the proximity between the car and an obstacle or wall during parking maneuvers. Once the distance between the car and the obstacle reaches 10 centimeters, a warning light in the form of an illuminated LED is activated as an alert signal.

*3) Automatic weather parameter sensing system*

The smart car also includes a Node MCU ESP 8266 and other weather parameter sensing sensors such as DHT-11 which senses the Temperature and Humidity, BMP-180 which senses pressure in the car, and a Rain sensor which senses the percent of chances of rain. All these sensors are interfaced with the ESP 8266 Wi-Fi module. The data collected by the sensors is transmitted to the Wi-Fi module, which generates an IP address on the serial monitor of the Arduino IDE. By entering this IP address into a web browser, a visually appealing graphical user interface (GUI) displays all the acquired data. The system is installed on the car to fetch the atmospheric weather parameters and based on that fetched data many crucial systems can be made to run automatically and the automation level of the car can be increased.

*4) Lane detection using image and video*

Within the envisioned system, the code is executed, enabling the detection of lanes in three distinct formats: recorded videos, images, and real-time lane detection. The real-time lane detection feature allows for the instantaneous identification of lanes in dynamic scenarios. An application named IP-Webcam is been used which generates an IP address, this IP address when pasted into the code, the mobile cam can be used for real-time lane detection

The Lane detection code when uploaded to the system the lane gets detected with the chronology of some steps, which takes place in just a few minutes. The steps are as follows:

Step1: Converting the image to Grayscale

The video frames are initially in RGB format, which is then converted to grayscale. In grayscale format, the image consists of a single channel ranging from 0 for black to 255 for white. Converting the image to grayscale allows for faster processing compared to working with the three-channel RGB image, which is why this conversion is performed.

Step 2: Noise Reduction

To mitigate the impact of image noise, a Gaussian filter is applied. The Gaussian filter utilizes a kernel to average the pixels in the image, effectively reducing noise.

Step 3: Canny Edge Detection Technique

The image undergoes a process called Canny edge detection, which enables the identification of edges within the image. This technique computes gradients in all directions of the blurred image and traces edges with significant changes in intensity. Gradients falling within the defined upper and lower thresholds, as specified in the code, are selected. A gradient represents a change in pixel intensity across adjacent pixels.

Step 4: Region of Interest Definition

To focus solely on the region occupied by the road lane, the coordinates of the triangular region covered by the lanes are extracted using the "pyplot" library. A white triangular mask is created within this region, with a black background. The canny image is then bitwise ANDed with this mask, effectively masking the canny image and displaying only the region of interest defined by the polygonal contour of the mask.

Step 5: Hough Line Transformation

The Hough Line Transform is utilized to detect straight lines in the image. The output of this transform provides the endpoints of the detected lines. By implementing this method, lane lines are drawn in the desired color (e.g., red) on a plain black background. Finally, this image is combined with the original image, resulting in the display of the detected lane on the road.

In the proposed system, lane detection is performed using two approaches: image-based lane detection and video-based lane detection using a camera module mounted on the car.

Fig. 11. Python OpenCV code for lane detection using Image

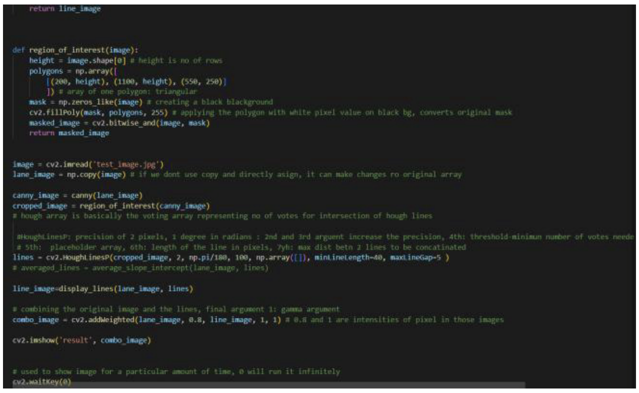

Fig. 12. Lane detection using Video

All these 4 mechanisms when properly connected with the microcontroller boards Node MCU and Arduino UNO as shown in the block diagram and circuit diagram below, A 5v VCC has to be supplied to the system. Once all the hardware connections are done correctly and the camera is ready for lane detection, the system is ready to run. Supply the 5v VCC power supply to the Arduino UNO and ESP 8266. Upload the code for all the mechanisms in their respective boards and also run the lane detection code in IDE.

All mechanisms will start working, the weather sensing system will generate an IP address on the serial monitor, and the servo will get activated once the water sensor associated with it detects the water level over a specified limit. The ultrasonic sensor will show the warning light if the car is just 10cm close to any object and the camera will detect the lane with the instruction received by the code to it.

*E. Circuit diagrams for proposed systems*

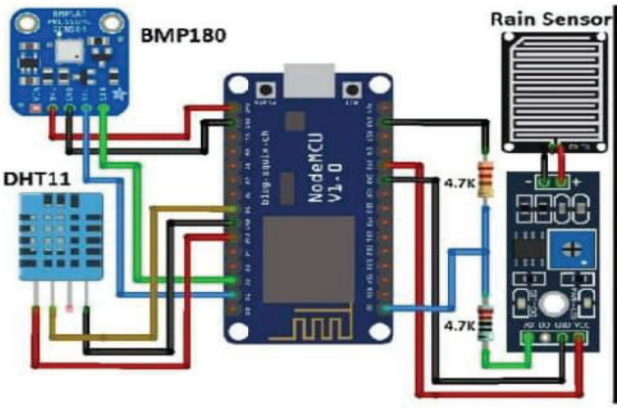


Fig. 13. Circuit diagram for weather parameter sensing mechanism of the proposed system

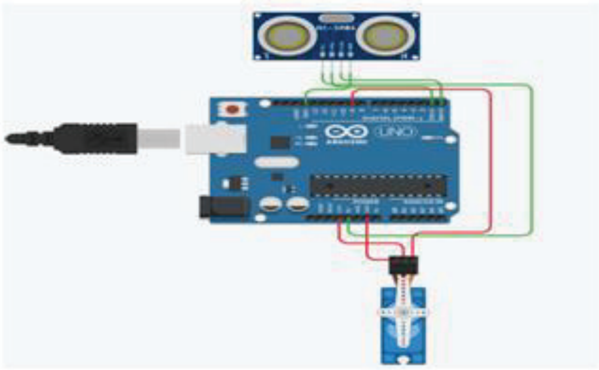

Fig. 14. Circuit diagram for automatic wipers and automatic parking system

## IV. Results And Discussions

The envisioned system worked successfully with all the mechanisms working with 95% accuracy and precision. All the hardware components were interfaced successfully with Arduino UNO and Node MCU microcontroller board. The C# program for each respective mechanism was written in Arduino IDE and all the programs were compiled and uploaded successfully without any errors. The actual real-time working of all the mechanisms is been presented below.

*A. Real-time lane detection using webcam and OpenCV*

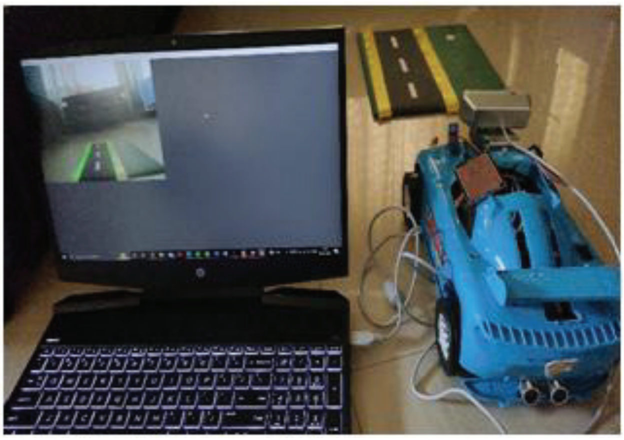

Fig. 15. Lane detection

Fig 15 shows the lane detection mechanism. The webcam mounted on the car is, marking and detecting the lane in front of it concerning yellow stripes on the road. The lane was detected very accurately making it a successful mechanism.

*B. Automatic weather parameter sensing system*


Fig. 16. Measured weather parameters

Fig 16 shows the output of the weather parameter sensing system. The sensors installed on the system sense the temperature, atmospheric, humidity, and probability of rain with 95% accuracy, and the output was shown on GUI.

*C. Parking alarm system*

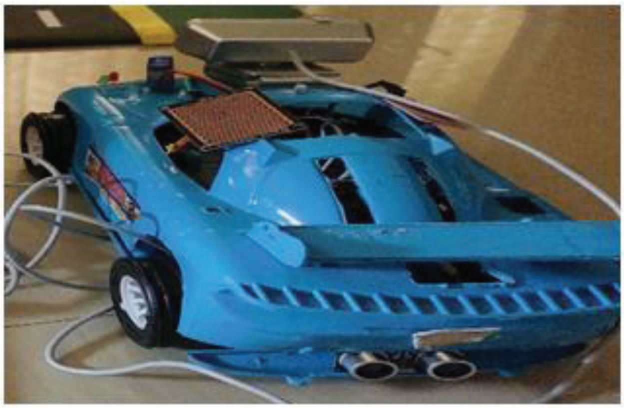

Fig. 17. Parking alarm system

Fig 17 shows the parking alarm system. The ultrasonic sensor mounted on the back of the car detects any obstacle/wall in a 10cm range of it and if the is any object within the specified range an LED bulb is been blown up as a warning for the driver. This mechanism can assist the driver while parking the car in compact parking areas.

*D. Automatic wiper system*

Fig 18 shows the automatic wiper system. The servo motor and rain sensor mounted on the system togetherly work as an automatic wiper system. Based on the amount of water sensed on the copper traces of the rain sensor, a signal is been sent to the servo motor if the water level exceeds a certain limit and the servo motor starts rotating, thus working as an automatic wiper system.

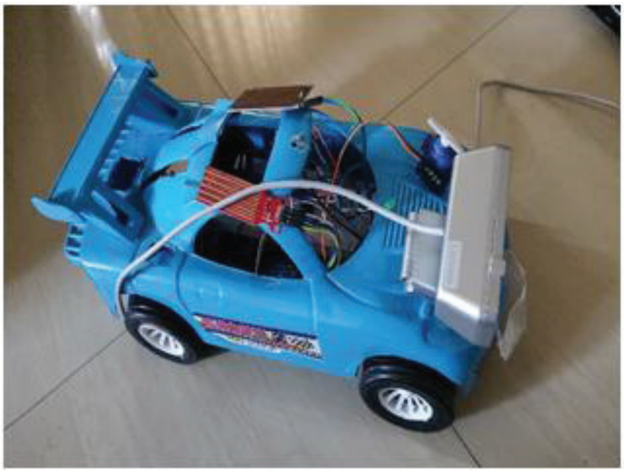

Fig. 18. Automatic wiper system

## V. Conclusions

Automation is rapidly growing in various sectors, offering advantages such as accuracy, precision, and speed. Our proposed system showcases how vehicles can be automated using basic sensors and software, resulting in a cost-effective solution. This system can be easily adapted for industry-specific applications with minor modifications. Future enhancements may include object detection using OpenCV and weather-based speed control, further increasing automation and self-reliance. The system effectively addresses driver challenges and provides accurate and precise coordination among its mechanisms.

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