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Image Processing & M.L Based Driverless Car with Image Detection System

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Abstract: Every year, it is estimated that 1.25 million people die in road accidents around the world. Humans' failure to heed road signs and obey the law is a significant cause of accidents. To avoid this issue, a signboard detection system has been implemented. This device would be useful in identifying unique domains such as classrooms, traffic signals, colleges, hospitals, offices, and so on, as well as potentially saving many lives. The creation of a low-cost prototype of a miniature self-driving car model using easy and readily available technologies is presented in this paper. To achieve vehicle automation, the Raspberry Pi controller and H-bridge drive two DC motors in this prototype. Intelligent systems have used technologies such as sonar sensors, image processing, computer vision, and machine learning. To solve the problem, we propose implementing a self-driving vehicle that employs a pattern matching technique.

Keywords: Raspberry Pi, Lane detection, Traffic light detection.

I. INTRODUCTION

According to a survey by the International Road Federation (IRF), India has the largest number of road fatalities, ranking first and accounting for 10% of global road accidents. Human error is found to be the cause of 78 percent of road accidents. With rapid technological advances, new designs for self-driving vehicles are being proposed in order to ensure accident-free transportation. Google, Uber, and Tesla are at the forefront of the global effort to design and produce self-driving vehicles. A self-driving car (also known as a driverless car) needs no human intervention and can feel its surroundings without it. A number of sensors are combined and used to detect the road, barriers, pedestrians, and other objects in the environment.

The Raspberry Pi was used to build this machine. The signboard recording and identification method rely heavily on digital image processing. The framework was created by Raspberry Pi in order to provide a simple way for young people to learn coding and computer programming. The device gives the driver real-time details from road signs that list the most critical and difficult tasks. Our system's ability to identify, interpret and infer road traffic signs would be of great assistance to drivers. Since it is difficult to predict what kinds of conditions the vehicle will face, the algorithm must be able to produce the desired result even under unfavourable conditions in order to achieve high accuracy. To ensure the safety of all drivers, all road signs are installed in particular areas.

The aim of road signs is to ensure that all drivers are kept safe. However, traffic signals can be difficult to see before it is too late due to changes in weather conditions or viewing angles. An automated road sign recognition system's goal is to recognize and identify one or more road signs from live colour images taken by a camera.

II. PROPOSED SYSTEM

According to the World Health Organization, about 1.25 million people die in road accidents every year, or 3287 deaths every day, and 20-50 million people are injured and disabled for the rest of their lives (WHO). Since the current systems are produced in other countries, it is difficult to introduce them in our country. Driving takes place on the opposite lane in certain foreign countries, while we drive on the left. In comparison to other developed countries, India's traffic flow is much more congested, so current systems which struggle to operate on these roads. The new method employs a pattern matching strategy, in which cameras are used to identify a unique pattern that will be printed on the roads. The camera will record this pattern and use a Raspberry Pi to process it before instructing the car to drive in the desired direction. The camera can also take ambient images in order to identify various obstacles nearby; if the obstacles get too close to

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the vehicle or are about to collide with it, the vehicle will come to a halt before the obstacle in front of it moves. To determine what type of road is present ahead, special patterns will be deployed alongside the road.

Below shown Fig. 1 is a block diagram representation of the **"Image Processing And M.L Based Driverless Car with Image Detection System".**

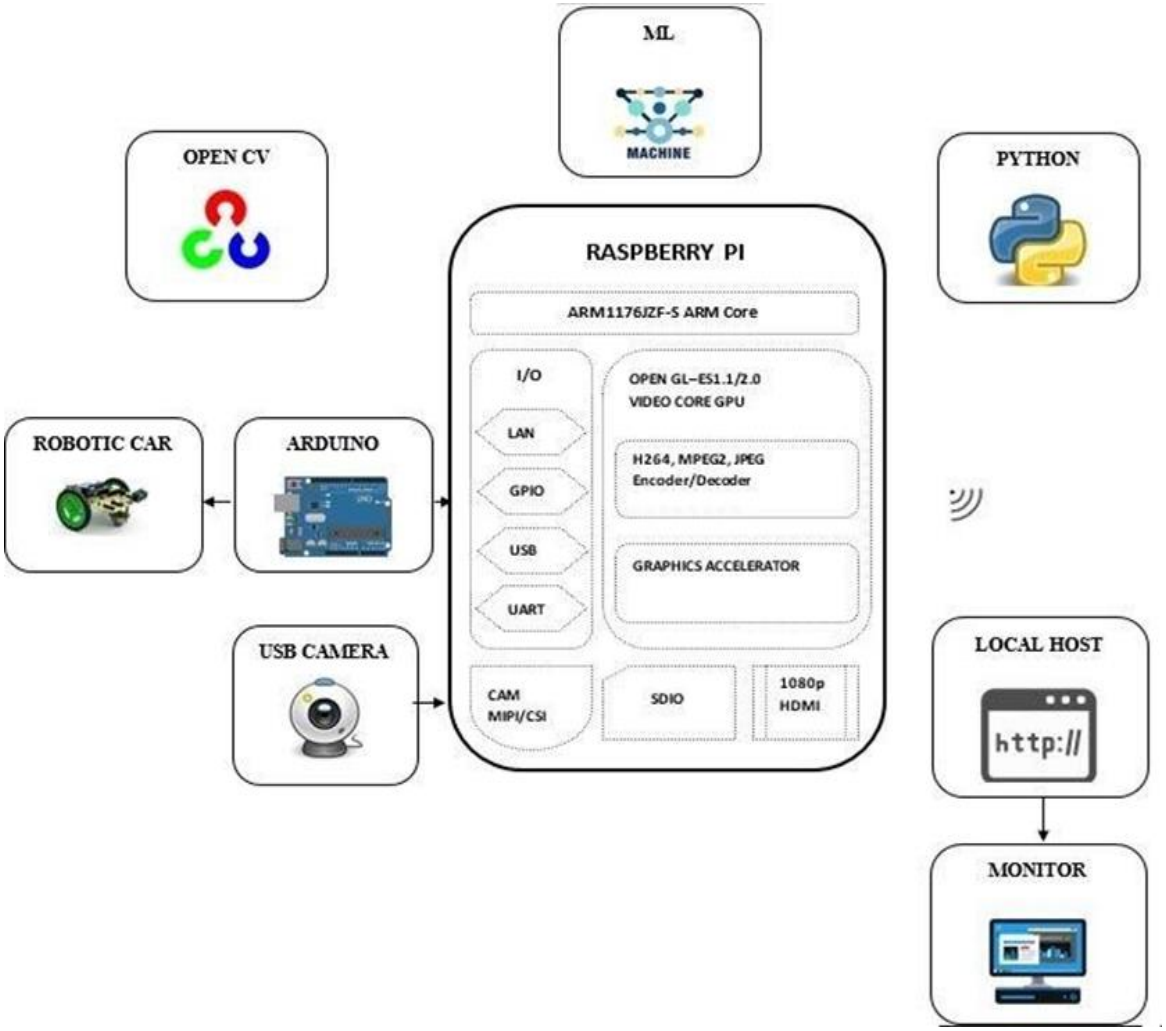

Fig. 1. Block Diagram

III. METHODOLOGY

A real-time signboard detection and recognition system have been created via a series of steps. We use the following methodologies to create an effective signboard detection and recognition system:

The H-bridge motor driver and a sensor, such as an ultrasonic sensor, are connected to the Raspberry Pi 3 controller via its General-Purpose Input Output (GPIO) pins. The Raspberry Pi board's USB port is used to mount the web camera. The analogue output of the accelerometer sensor is converted to digital and fed to the Raspberry Pi 3's GPIOs using the IC MCP3008 Analog to Digital Converter.

After receiving control signals from the Raspberry Pi controller, the H-Bridge driver circuit controls the movement of these motors in either a clockwise or anticlockwise direction. Ultrasonic sensors in the front and infrared sensors on the left and right sides of the car detect and measure obstacles in the area.

Lane following is controlled by an IR sensor module in the front. The x-axis value of the accelerometer sensor mounted on top of the car is set to detect the tilt of the driverless car, and it is linked to the controller via IC MCP3008 ADC. To track real-time artefacts and obey traffic laws, a USB webcam is used in conjunction with a Python library.

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The process of image processing, detection, and recognition is represented in Fig. 2.

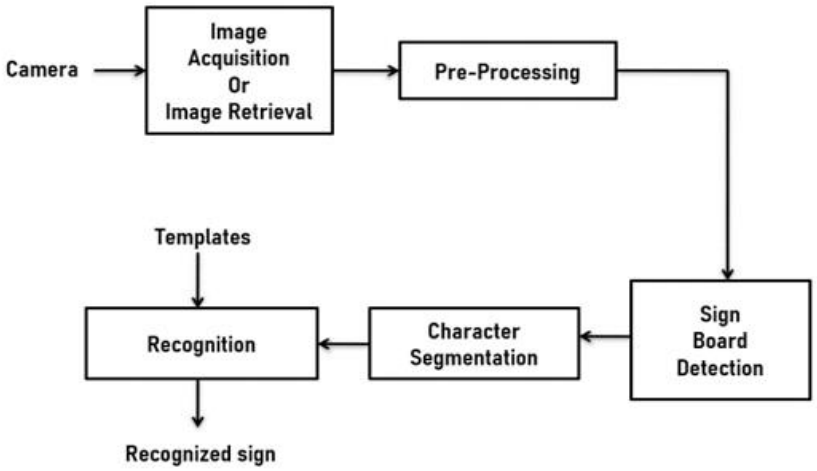

Fig. 2. Process of Image processing and Recognition

All of the programmes for implementing image processing algorithms are written in Python and loaded onto the Raspberry Pi 3.

An Android phone connected to the controller board via Wi-Fi serves as a desktop, allowing the phone to be used as an input device for commands and programme execution. Via Twilio, Raspberry Pi sends a message and a location connection to the phone number and email address specified in the file. The user's Android-based cell phone is set up to view the Raspberry Pi's desktop and monitor the car from anywhere using a mobile hotspot, and the programming is done in Python using the Integrated Development and Learning Environment (IDLE). By entering a code on the user's mobile phone, all self-driving car functions such as Lane Detection and Following System (LDFS), Traffic Light Detection System (TLDS), Real-Time Object Detection System (RTODS), and Accident Warning System can be selected.

To achieve the main goal of lane identification and tracking, a self-driving car must be able to identify, monitor, and distinguish various roads for proper road movement. The LDFS consists of three infrared sensors (IR1, IR2, and IR3) mounted on the self-driving car and connected to the Raspberry Pi controller to detect the car's position in relation to the yellow line in the middle of the lane.

A lane on the road is planned with a yellow line drawn in the centre for the car to follow in the proposed self-driving car. A black lane is detected when IR1 and IR3 are low, and a yellow line is detected when IR2 is high. The user's cell phone is designed to serve as a control system for starting and controlling the car's motion. When the user enters the car and keys in 1 on his phone, all of the car's sensors are triggered, and the motor starts. As IR2 senses a yellow colour line, the car begins to move forward. When the car is prone to shifting to the right, both IR1 and IR2 detect a yellow line, and the car shifts to the left before the only IR2 detects yellow. When the car begins to turn to the left, IR2 and IR3 detect a yellow line, and the vehicle shifts to the right until only IR2 detects yellow. As a result, the car self-corrects to be in the middle of the lane and continues to move forward as long as IR2 alone detects yellow. When the car begins to turn to the left, IR2 and IR3 detect a yellow line, and the vehicle shifts to the right until only IR2 detects yellow. As a result, the car self-corrects to be in the middle of the lane and continues to move forward as long as IR2 alone detects yellow.

Fundamentals of computer vision are used to detect and monitor the red, yellow, and green colours of the traffic light system. Object Detection System in Real-Time (RTODS) many applications, such as autonomous vehicles, defence, surveillance, and industrial applications, rely on object detection. The Single Shot Detector (SSD) is a good option because it can run on video and achieves a good trade-off between speed and accuracy.

IV. WORKING & ARCHITECTURE

The real-time object detection system's process flow is as follows: if the IR sensor on the left detects an object, the car should shift right, and vice versa. The front-mounted ultrasonic sensor detects and overcomes small objects when dynamically calculating its distance from the object.

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The OpenCV Deep Neural Network (DNN) and MobileNet-SSD algorithms are used to implement Real-Time Object Detection on the Raspberry Pi. The OpenCV library is used to implement the algorithm in Python. Training and test datasets with ground truth bounding boxes, such as Caffe-datasets and assigned class labels, are needed by the MobileNet-SSD algorithm.

The input frames obtained from the camera is in BGR format which is converted from BGR color space to corresponding Hue Saturation Value (HSV). In OpenCV, range of values for Hue (representing color) is 0 – 179, range of values for Saturation (representing intensity/purity of color) it is 0 – 255, range of numbers for value (representing brightness of color) is 0 – 255. The range of colors to be tracked is defined as per the requirement and then morphological transformations are carried out on the color to remove noise present in the binary image. Then, contouring of the colors is done with a rectangular bounded line called contour to differentiate between each color.

It returns a grayscale image, with each pixel indicating how closely the pixel's surroundings match the template. Contours are described as a line that connects all of the points along the image's boundary that have the same intensity. Contours are useful for shape analysis, determining the size of an object of interest, and detecting objects. At various scales, feature maps reflect the image's most prominent features. As a result, using several feature maps to detect an object increases the size of the object to be detected. Instead of using all negative predictions during preparation, a 3:1 ratio of negative to positive predictions is used to ensure that the network learns what constitutes an incorrect detection.

The accuracy of this module is dependent on the thresholding values changing. It indicates how similar a thresholding value is to a known or ordinary value. Compare a value to the agreed value to see if it is right. And these values may be something that has been created. It provides an accurate result for any image captured by the camera for signboard detection and recognition. The flow of the working process is shown in Fig. 3.

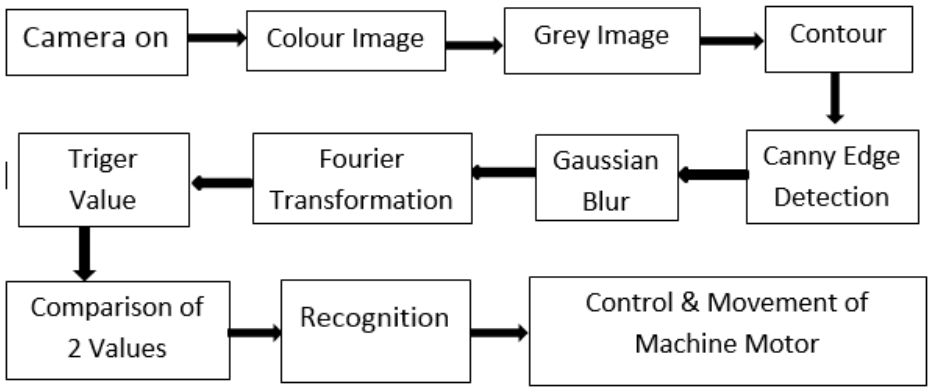

Fig. 3. Flow Chart

We are making a prototype that is easy to understand and implement as well. The following are the various parts of the architecture and its functions are mentioned below:

1. Contour – Contour is a concept that refers to the continuous joining points that shape a curve of similar strength or colour. It can be useful for object identification and recognition as well as shape analysis. Recognizing contour in OpenCV is similar to recognising a white object against a black background.
2. Canny Edge Detection- Edge detection is a technique for defining the boundaries of artefacts inside images that are used in image processing. It operates by detecting discontinuities in brightness. It is primarily used in fields such as computer vision, machine vision, and image processing for image segmentation and data extraction.
3. Gaussian Blur- This is the effect of blurring an image with a Gaussian function. It's a common effect in graphic software, and it's often used to minimise image noise and detail.
4. Fourier Transform- The Fourier Transform is an important image processing tool that is used to break down a picture into sine and cosine components. Image processing, image filtering, image restoration, and image pressure are only a few of the applications for the Fourier Transform.
5. Raspberry Pi -The Raspberry Pi is a simple, low-cost device that connects to a computer screen or television and uses a regular keyboard and mouse. It's a capable little device that, all things considered, empowers people to learn how to programme in languages like Scratch and Python.

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6. Ultrasonic Sensors- An ultrasonic sensor is an electronic device that uses ultrasonic sound waves to measure the distance between an object and transforms the reflected sound into an electrical signal. Ultrasonic waves propagate at a faster rate than audible sound waves (for example the sound that people can hear).
7. Relay Motors- Relay is switches that open and close circuits electromechanically or electronically. It controls one electrical circuit by opening and shutting contacts in another circuit. As transfer graphs show, when a hand-off contact is regularly open (NO), there is an open contact when the hand-off isn't invigorated.

V. RESULT AND DISCUSSION

1. Performance of Image Pre-processing

The original images are scaled down into pixels to save storage space and reduce computational complexity. The RGB segmentation approach is used to perform image pre-processing after the image acquisition phase in the proposed approach. A filter is added to each channel threshold area in the proposed method to select only those regions of the image where pixel values are within the target object's range. The median filter is used to smooth out the picture and fill in the smaller areas.

2. Performance of Traffic Sign Detection

The image is used to draw the final selected candidates' range of pixel values, region, and shape using extracted data (centre and area) from each of them. Only those traffic signs with red colours should be included in the proposed process. Several issues were found to be affecting the detection efficiency during the experiments. The proposed detection method reveals that the sun segments and illuminates the red colour of the traffic sign in an unwavering manner. This occurs as a result of the RGB model's colour segmentation property, which is used to compare RGB values.

3. Performance of Recognition

After colour segmentation and shape matching, the proposed system uses semi-supervised SVM to cluster the entire image. To reduce the effect of variable lighting, intensity correction and histogram equalisation are applied to standard traffic sign images. The recognition system takes 0.18 seconds to process. The system's average running time is 0.43 seconds.

4. The Outcomes of the system

On a 700 MHz Broadcom chip, the implemented algorithm is very accurate but quite slow; the overall average time for both detection and recognition is 1.5 frames per second (fps). The detection step, which is based on form and runs faster than recognition, increases the number of images that can be processed. The processor should be stalled for a short time to avoid errors caused by previous images. The presence of obstacles close to speed signs is the main problem with shape-based detection. Python-OpenCV is a wrapper for the original C/C++ code, making it easy and quick to use. However, there are native Python script written functions that are not available in OpenCV (our own functions in Python) reduces performance drastically.

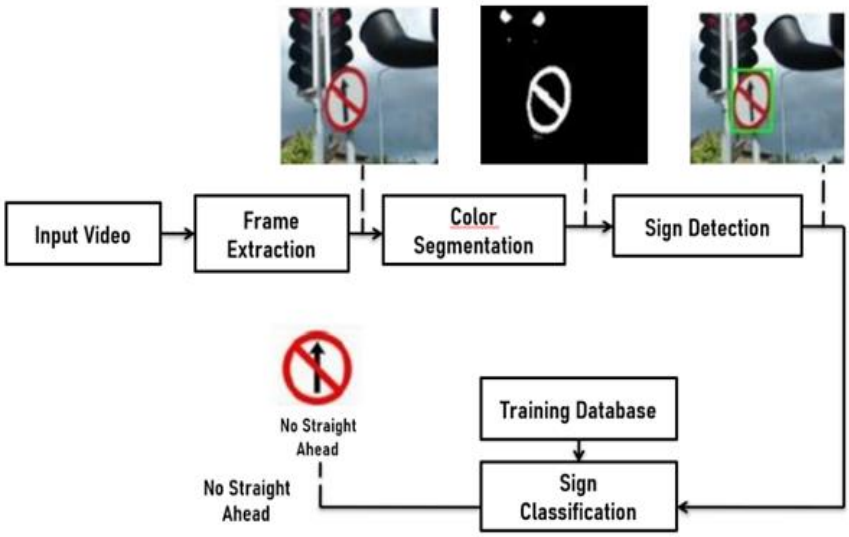

Fig. 4. A sample result

VI. CONCLUSION

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This paper's work is divided into two sections, similar to other applications in the field, called "detection" and "recognition." Since color-based segmentation is much less accurate than shape-based segmentation, shape-based algorithms were used for detection. A database of road sign patterns and controls is used to recognize and classify these potentially dangerous road signs. Complex techniques, despite their availability within the OpenCV libraries, were not chosen due to the Raspberry Pi's limited computation capacity (such as Eigen faces, SURF-SIFT template matching, and Fuzzy matching). Other classifiers such as k nearest neighbour and Euclidean distance were chosen for this project in order to keep Raspberry Pi running smoothly. Detection, monitoring, and recognition are all intertwined; recognition eliminates false positives, while detection narrows the options and improves the system's accuracy. Another critical aspect is keeping the results; as a result, it must be enhanced as more databases are built over time.

The basic concept is to identify and classify traffic signs using an input picture as a starting point. Our system is focused entirely on automation, which eliminates the need for manual labour. As a result of the automation process, human error is reduced, and precision, processing speed, and reliability are improved. A method for creating a self-responding mechanism is presented here.

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