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Automatic Vehicle Entry Control System

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Chandni Mangwani
Dept.of Electronics and Telecommunication
Vishwakarma Institute of Technology
Pune ,India
chandni.mangwani19@vit.edu

Isha Lad
Dept.of Electronics and Telecommunication
Vishwakarma Institute of Technology
Pune ,India
isha.lad19@vit.edu

Pratham Mandore
Dept.of Electronics and Telecommunication
Vishawakarma Institute of Technology
Pune, India
pratham.mandore19@vit.edu

Rohan Kulkarni
Dept. of Electronics and Telecommunication
Vishwakarma Institute of Technology
Pune, India
rohan.kulkarni19@vit.edu

Tanmay Lonkar
Dept.of Electronics and Telecommunication
Vishwakarma Institute of Technology
Pune,India
tanmay.lonkar20@vit.edu

Milind Kamble
Dept.of Electronics and Telecommunication
Vishwakarma Institute of Technology
Pune,India
milind.kamble@vit.edu

***Abstract* — This paper proposes a completely automatic vehicle entry control system which is based on vehicle license number plate recognition. The objective was to design and implement a gate control system which will automate the vehicle entry process while increasing convenience and security at the entrance of parking lots of societies, hospitals, offices etc. This system was implemented using a small pool of tools which include Arduino uno, servo motor, ultrasonic sensors and camera. The fundamental idea behind this was to automate the system that works without a need of human intervention. The system was implemented physically and was tested on various images to check its performance. The system was developed in such a way that it successfully detects and recognizes the vehicle license plate and determines whether to allow entry or not.**

Keywords- Automatic Gate Control System, Tesseract (OCR), Arduino UNO, Ultrasonic Sensor, Servo Motor, Python, OpenCV.

I. INTRODUCTION

In today's era, almost everything is going automatic. This paper suggests a system to increase the convenience and security at the entry locations of vehicles in various areas like societies, hospitals,
parking lots etc. by implementing an automatic vehicle entry system. A number plate is the unique identification of a vehicle. This project uses license plate numbers to allow vehicle's entry within the premises.
The working of the system can be explained as - whenever any vehicle arrives within the range of the ultrasonic sensor, the camera turns on and it starts to capture images of the number plate, which are further processed to extract license number from it. The database contains the details of the vehicles that are to be permitted in the premises. If
an extracted license number exists in the pre-prepared database, a vehicle is permitted to enter. This system consists of an Arduino UNO microcontroller, ultrasonic sensors to detect the presence of vehicles on the entrance, a servo motor to control the opening and closing of the gate and a camera to capture the images of number plates of the vehicles. Automatic license plate recognition (ALPR) technique is used to detect, extract and recognize a vehicle's license number from the captured images of the vehicle using image processing techniques which include OpenCV and Py-tesseract (Optical Character Recognition).
This technology can be used in numerous security and traffic applications, such as access control to car parks, analyzing traffic flow statistics, and an intelligent parking system named Smart Parking Service (SPANS), which can be used to manage public or private spaces.
The database which basically controls which vehicle should be allowed is built according to what purpose we are using the system. For example, if we put this to use in a residential apartment, the database can be prebuilt containing the vehicle information of residents in the apartment.
This paper briefs about different related projects already done in this domain, technologies and software used for creating this system with different hardware components and there working, results obtained and future scope of the project.

II. LITERATURE REVIEW

To work on this project, different project works that were already done in same domain were reviewed. [1] In this paper, technology of image processing has been used, which is used to automatically identify the vehicle using its number plate. This is implemented using OCR algorithm for reading characters from images. It is executed in three stages, extraction of number from license plate, segmentation of characters within the image and OCR technology. Number plate is detected, preprocessed and then passed for segmentation to segment individual characters which are

normalized and further performed with OCR algorithm and converted into encoded text. [2] This paper has proposed a completely automated monitoring and control of vehicle entry-exit using raspberry-pi system which captures vehicle image to verify details using extracted license no. with the database filled in online registration form, where the user gets a four-digit random code as the receipt of confirmation. The details are authenticated and processed by Raspberry Pi to allow vehicle entry. The verification is done on the basis of code. If the code is matched then the gate will be opened using a DC motor. When any unauthorized image of the number plate is detected, the system alerts this to authorities using the buzzer alarm systemand led.

[3] This research has developed and implemented a virtual automized entrance control system using proteus, in order to increase security at entrances of all the important places that require protection and avoid inconvenience. The system recognizes license numbers of cars using number plates at the entrance gate and decide whether to allow entry or not. The system consists of PIC microcontroller and a PC with video camera to capture vehicle number plate as video frames and further processes them to extract license number. This system was implemented using MATLAB, Proteus & Micro C. The objective was to develop an efficient vehicle identification-based entrance system that identifies the vehicle's license plate.[4] The paper presents a developed system that first captures vehicle's images from front, then detects the license plate and then reads the number. The license plate is extracted using the image processing techniques, py-tesseract, one of the optical character recognition (OCR) techniques, is used for the character recognition. The system is developed using OpenCV and is tested on various image to check its performance. [5] In this paper, the author has proposed an authentic technique of automatic entrance control system that will reduce inconvenience and improve security at entrances. This project can decide whether to let vehicles enter inside or not by recognizing license plates from vehicles at the entrance gate. The system was designed using Raspberry pi along with a video camera. The camera captures video frames of vehicles to capture license number plate and processes them. The system has been deployed using python language and OCR was used for character generation from text image.[6]This paper proposed system for recognition of vehicle License number (ANPR), from videos having vehicles captured using camera. This system performs detection of number plate region, segmentation and HAAR feature based classifier for recognition, class letter extractor and Convolution Neural Network for recognition with accuracy of recognition as 90.90%.[7] In this paper, the image processing concept is used to develop ANPR which consists of Optical Character Recognition (OCR) for reading license numbers from an image. Firstly, images are captured, processed for proper recognition and then read using OCR. This system generated 65-80% accurate results for Indian number plates.[8] This paper suggests a new algorithm that can be used for detection in vehicle number plates, using technology of - artificial neural network (ANN). Firstly, acquisition of vehicles images with good quality is done with a camera. This paper emphasizes on the accurate detection of the number plate location within the vehicle's image using contours tracing with Canny's edge detection algorithm. This paper uses various algorithms at every stage from detection to actual recognition to enhance the performance of the system. [9] This paper also suggests an Automatic System for Recognition of Vehicle Number Plate (ANPR which detects the vehicle's license no. using image processing technology. Vehicle's images are captured and the region with number plate is extracted using GrabCut color segmentation, OCR is used for character recognition. After the license number is obtained, it is used to collect the related data and information like, owner of vehicle, vehicle registration place, etc. [10] This paper presents automized vehicle parking system using identification where only authentic vehicles can access the parking area using RFID tag while check in /check out. This system ensures security by allowing only registered vehicles to access the parking zone/region. This system was designed using RFID technology combined with a NodeMCU V3 board.

[11] This paper suggests a parking system which is fully automized, which detects the available parking slots and generates specific slots for parking vehicles using the concept of visual detection for finding available slots for parking with visual sensors. The stated algorithm effectively detects the availability of parking slots in AVM images.[12] This paper proposed a system which automatically recognizes license plate using processing of captured images of vehicles and approach of template matching. Images of the vehicle were pre- processed using techniques of image processing and OCR. The techniques involved color conversion for pre-processing, thresholding using Otsu's algo for image segmentation, removal of noises, subtraction and cropping of image using bounding box feature. The OCR method was used to read the printed text on the pre-processed image of license plate and to generate an output data.[13] This paper resolves issues with existing parking systems by proposing three aspects: availability in parking lots using recognition, path planning tracking and control to reach correct parking slot. This paper suggests a system based on machine vision and pattern recognition techniques to develop a strategy for tracking and controlling path to improve parking automation.[14] The paper proposed a mechanized system for Recognition of license number plate (LNPR) which reads the number plate of vehicles crossing through lane. It uses cameras to capture images which in turn gets sent to a computer which extracts the registration number. The software uses different algorithms such as localization of vehicle, segmentation of number plate region within images and later optical character recognition of license number (OCR). The obtained data is checked with a database for further purposes [15] The paper proposed a system which uses technologies such as Localization of Number Plate (NPL) and Segmentation of Characters in License Plate (CS). It also proposed a better approach -OCR which uses Deep Learning techniques. After the NPL and CS steps it uses Convolution

Neural Network (CNN) using four convolution layers. The accuracy achieved was 95.84%.

[16] This work highly emphasizes solving parking related issues with high security, protection and reliability for electric vehicles. This paper introduces a smart-parking system which is implemented using the concept of blockchain. This system links drivers requesting parking lots and owners having free slots available for parking within the nearby region. Whenever any driver requests for parking, firstly it is authenticated and then the request is further sent to parking owner available in nearby region and driver will receive the location for parking if owner confirms it. [2] has implemented the system using Raspberry Pi which increases the effective cost and components of the system. [3] consists of a PIC microcontroller which makes the programming of the system more complex. [4] has made use of Raspberry Pi along with a video camera, which captures the images of the surrounding environment continuously, even when a vehicle is not present. [12] has implemented the system using NodeMCU which made use of its wi-fi connectivity for the RFID technology. It made the system secure, but more complex and wi-fi connectivity can contribute to the problem. Other projects were based on the technology of CNN and ANN which required more computational time and memory.

Our project mainly focused on the cost and complexity reduction of the system by making use of Arduino UNO and simple image processing algorithms. The system made use of an ultrasonic sensor, which turned on the camera only after detecting the presence of a vehicle. This further reduced the power consumption of the system. Also, the complete system is programmed in a single language-Python, which combined the image processing techniques and the interfacing of sensor and motor with Arduino UNO. This approach of combining the hardware resources with the image processing technology has not been implemented previously in any of the systems.

III. METHODOLOGY/EXPERIMENTAL

This system was implemented using a small pool of tools which include Arduino uno, servo motor, ultrasonic sensors and camera.

Block Diagram:

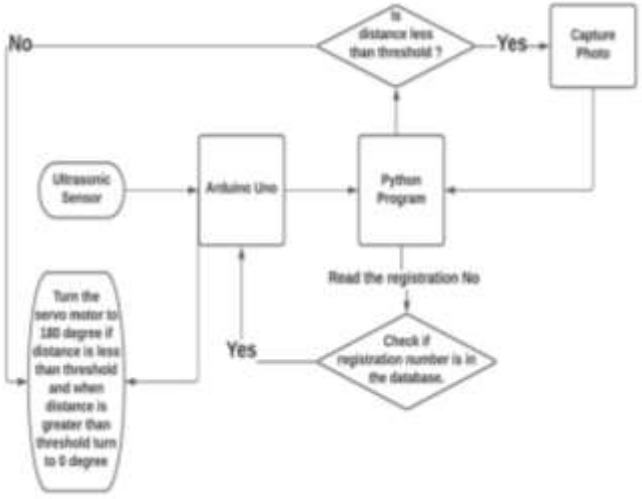

Fig.1: Block diagram

Fig.1 shows the block diagram of the gate control system. Entry system is triggered when a vehicle approaches the gate. This system is controlled simply using ultrasonic sensors. All the sensors and camera are integrated using python with its pymata library, which allows us to control Arduino UNO.

Ultrasonic sensor keeps checking the distance and if a vehicle arrives within a distance less than the threshold value, the camera gets turned on and captures the image of the vehicle. The license registration number of the vehicle is extracted using OpenCV, Py-tesseract (OCR) and other related libraries. The extracted registration number is checked in a pre-prepared database, and if the registration number is not present then the process is aborted. Now if the registration number is present in the database, then the servo motor is rotated to 180 degrees and it is kept there till the distance becomes greater than the threshold again. If the distance is greater than the threshold value, the servo motor is turned back to 0 degree.

Components:

1. Arduino UNO:

ATMEGA328P microcontroller is used in Arduino UNO controller board and it is developed by Arduino.cc.circuits. As it can be seen in the Fig.2, this board has 20 pins. Arduino IDE is a cross platform application developed by the same organization to code and upload the program on the board.

As our project focused on reducing the cost of the system, by using minimal resources, Arduino UNO was the best option . It also has minimum power consumption and an easily programmable interface. It is easier to connect analog sensors, motors and other electronic components to Arduino UNO without any need of external programmer or extra software, as it has a large collection of included libraries for interfacing a variety of hardware.

Fig.2: Arduino UNO

2. Ultrasonic Sensor (HC-SR04):

HC-SR04 has two cylinders at the front, one is a transmitter and the other is a receiver. We set the Trig pin high for at least 10µs in order to generate a sonic burst. The sensor then creates a burst of 8 cycles of sonic sound at 40KHz. This sonic burst is deflected by the object in its path and is captured by the receiver. The echo pin then calculates the time duration in microseconds and thus we can measure the distance.

3. Servo Motor:

Servo motor, as shown in the Fig.3, is a type of rotary actuator which has a precise control over its angular position. These motors have a closed-loop system, where the position feedback is used to control its angle.

Fig.3: Servo motor

Algorithm:

1. Image Processing:

Once a vehicle arrives within the range of the ultrasonic sensor, the webcam gets turned on and captures a few images of the vehicle with license number plate region. These images are pre-processed and license number is extracted from it using OpenCV, numpy for performing operations on image, py-tesseract for character recognition. Fig.4 shows the image captured by the camera.

Fig.4: Original Image

Firstly, image is converted to Grayscale image to perform segmentation operations on it and grayscale images are easier to work with than RGB images. Further, noise reduction is carried out using bilateral filtering which uses gaussian filtering thus prevents edges to affect from filtering procedure. Fig.5 shows an image after performing bilateral filtering on grayscale image.

Fig.5: Bilateral Filtered Image

Then, third step involves edge detection, which is used to detect the number plate region within image. Edges are extracted from processed image using Canny edge detection. Next step involves finding contours from edged image and sorting them which helps to remove and eliminate small and useless areas formed due to noise. From sorted contours, top 10 contours are selected to perform number plate detection, as number plate will cover the major region of image. Fig.6 shows the output image after edge detection.

Fig.6: Edged Image

2. Plate Detection:

Now, 10 sorted contours are iterated and contour with number plate is extracted out. To do that, we iterate over all contours and find one with 4 sides. This is done using cv2.approxPolyDP() function with approximation of 0.02 precision. After finding the required contour, coordinates of number plate are calculated using cv2.boundingRect(c). Height and width of the contour are calculated using coordinates and finally number plate region is cropped and extracted. Detected and cropped license plate can be seen in the Fig.7.

Fig.7: Detected License Plate

3. Text Recognition:

After license plate detection, characters on number plate are recognized using py-tesseract (OCR Tool in python). It will recognize the characters written in image and recognize them and finally extract those characters to text. Fig.8 shows the output text extracted by the system.

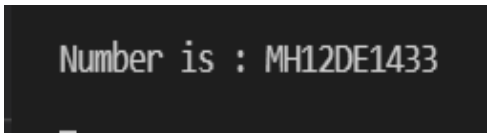

Fig.8: Output Text

Design:

1. Database:

Flat_No	Name	Vehicle_No
1	Rohan Kulkarni	MH15BG2180
2	Pratham Mandore	MH12AB4565
3	Chandni Mangwani	MH12 BF7825
4	Tanmay Lonkar	DL7C01939
5	Isha Lad	DL7CQ1939
6	Pratham Mandore2	H982 FKL
7	Isha Lad2	DL7CO1939

Table 1: Database

Table1 displays a database. This database contains the details of the vehicles that are to be permitted in the premises. The detected vehicle number is checked in this database.

2. Circuit Diagram:

The circuit has 2 main components connected with Arduino, an ultrasonic sensor and a servo motor. Ultrasonic sensor is used for vehicle detection, and its inputs are fed to Arduino. Servo motor is used to control the gate entry of the vehicles.

Coding:

Whole system was coded using python language. To code Arduino uno in python language, pymata library was used. It was coded in such a way that whenever ultrasonic sensor detects any object, detect_no_plate() function was called , which further turns on camera and capture images of car with no. plate to recognize its plate number and returns license number as a string .The number was then compared with the registered license numbers through database . If returned number exist in database servo motor was signal to rotate 180 deg to allow vehicle to enter, otherwise not.

Pseudo Code:

```
def gatecloseopen(data):
print(distance)
if distance < 30:
print("start camera")
text=detect_no_plate()
print(text)
if(database(text)):
board.servo_write(pin, 180)
print("GATE OPEN")
else:
print("Vehicle not registered")
else:
board.servo_write(pin,0)
print("GATE CLOSE")
```

Testing:

As shown in the Fig.9, the hardware consists of an Arduino UNO, ultrasonic sensors and a servo motor. Ultrasonic sensor detects the presence of the vehicle, which further turns on the camera. The system is tested using webcam of computer. The Arduino is attached to computer using an USB cable.

Images of vehicles are shown to the webcam of computer. The images were shown to the webcam through phone in our case. The testing can also be done by directly letting the webcam capture the vehicle image. Images of the vehicles were taken such that the system can detect and recognize their number plates. In the backend, the detected number was checked in the database and accordingly, the servo motor was controlled.

In real case the system gets triggered when the vehicle comes close to the ultrasonic sensor, but here we artificially block the ultrasonic sensor so that the webcam turns on and captures the image shown to it via a mobile phone.

The servo motor depicts a gate which opens and closes to control the entry of vehicles. Accordingly, when the servo motor rotates through 180 degree it depicts that the gate opens to allow the entry of vehicle and then when it comes ack to original position it shows the close position of gate.

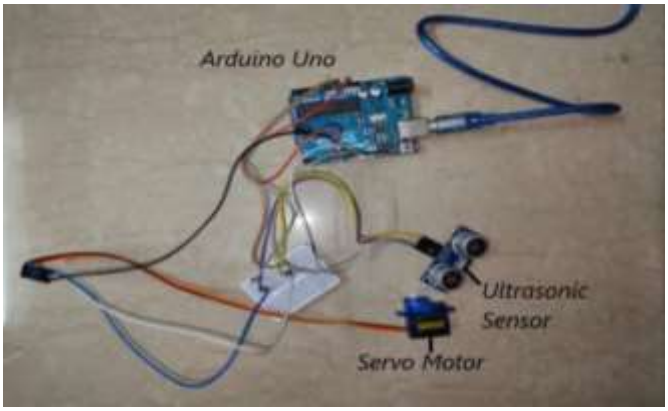

Fig.9: Hardware Implementation

IV. Results and Discussions

1. Referring to the results obtained in the testing, the system was subjected to tests to know the reliability of the system.
2. Whenever an object is found near the ultrasonic sensor, it sends a signal which, in turn, extracts the registration number from the number plate of the vehicle and compares it with the data stored in the database.
3. If this number is found in the database, then the servo motor is turned on to open the gate. If not, then the gate remains closed.
4. The accuracy of number plate extraction depends on various factors. As we don't use any machine learning or such factors, accuracy cannot be depicted in a numerical value. The accuracy is more when the number plate uses standard font, the system sometimes fails to read fancy fonts. Also, the system works with high efficiency when the number plate has a standard shape of rectangle because it crops the rectangle shape of the number plate.

V. Future Scope

Automatic parking slot system can be introduced within this system to automate whole vehicle management systems. Another feature can also be included, where we can keep a record of where the vehicles are parked and where it is vacant. This information, along with the parked vehicle numbers, will be displayed at the gates. This will further ensure the ease of finding a vacant place as well as the parked vehicle.

A system can be developed that takes extracts the details and information of unauthorized vehicles using their license numbers, and can be used to take strict actions against them.

VI. Conclusion

This paper suggests a technique for operating an automatic vehicle entry system on the basis of license plate number. The system was efficient enough to recognize the vehicle, read its license number plate, and accordingly make a decision to allow the entrance for the authorized vehicles.

All the tests are done on the physical hardware simulation of proposed system. The system was tested on 100 license plates having standard Indian Government authorized fonts, the system worked accurately for 87 cases. The system can be improved further for fancy fonts and non- rectangular number plates.

This system is efficient and robust enough to automatically operate without human intervention.

In conclusion, this system can be implemented and installed at places where security and protection are required, and also, it is easy to use and gives good accuracy.

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