Smart Parking System using Machine Learning

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ABSTRACT
This paper deals with the development of a model which is designed to detect the vehicle number plates which makes vehicle monitoring, parking management more efficient, this system also measures the size of the vehicle, thereby suggesting an efficient parking space for the vehicle which in turn provides increased safety of the vehicle. With the help of cameras fitted at the entrance object image is captured and measurement is taken as one of the cameras is situated at the top of the vehicle and by using openCV and numpy library, the dimensions of the object are obtained, so that a parking slot can be provided to the vehicle according to its measured size. Whenever the vehicle enters the parking space, an ArUco marker is placed at the entrance as a reference for measurement and with the help of ArUco marker the dimensions of the object can be calculated. The cameras fitted at the entrance gate also captures the images in real-time and then detects the number plate and updates the database. This system works on the technology of Automatic number plate recognition, which uses optical character recognitionto read number plates in real time. To get the parking space there are coloured LEDs (Red, Yellow, Green) present at every parking slot which tells us the vacancy status of that particular parking slot. Vacancy status is detected by ultrasonic sensors fitted the slots. Every slot has two ultrasonic sensors which give quite an efficient result. This system helps in providing the data of the vehicle number plate and also helps their users with the best parking space they can get so that they don't have to wait in lines for a space that has already been taken.

Keywords
Automatic number plate recognition; optical character recognition; ultrasonic sensor

1. INTRODUCTION
Parking space or parking lot is a vacant space provided for parking vehicles. With an increase in the number of vehicles, these days finding a parking space for our vehicle becomes a big task. Wherever we go be it hospitals, malls, schools, colleges, societies we look for an efficient space for parking our vehicle which becomes a tedious task to do. So, to help us find an efficient parking space we have this system. This system works by detecting the number plate and then measuring the size of the car in real-time and using the data for efficient parking. We have used ANPR and OCR to get the desired functioning of the system.

Automatic number plate recognition lets devices read vehicle license plates quickly and automatically, without taking help from humans. Optical character recognition (OCR) is used by ANPR to read vehicle number plates. Hence, ANPR makes capturing of videos and images easy for this system. Object measurement is also performed in this system. It is done so that the system can suggest a vacant parking space according to the size of the vehicle and no space goes wasted in the parking lot. We used the OpenCV contrib python library for measuring the object. We have also used the concept of ArUco marker, which is taken as a reference and helps us find the dimensions and angles of the object.

For the application of the parking space, we have placed two ultrasonic sensors in each slot in the parking space. Ultrasonic sensors are used to measure distance to an object, which will help us in parking our vehicle in the parking space. We have also used nodeMCU for developing this system. And to know whether the slot is vacant or not we have placed coloured LEDs.

Issues and challenges: -

1. At the entrance of any parking, detection of number plate is usually not seen. This model helps detecting the vehicle number plate and stores the data in the database through which we can detect the entry time and exit time of the vehicle, thereby providing vehicle safety.
2. In regular parking system, the parking space generally gets wasted due to improper management of the vehicles. The camera and arUco marker placed at the entrance will help us identify the size of the vehicle which in turn helps using the parking slot efficiently.
3. Whenever a vehicle enters the parking area there is a quite confusion regarding where to park it. With the help of LEDs present at the top of each parking slot the user can easily detect which slot is available to park the vehicle.

2. RELATED WORKS
The paper [1] deals with two major models that is software and hardware models. The software model consists of capturing an image by an electronic Pi camera or webcam which is then converted to a grayscale image. Then preprocessing is performed which removes the noises from the image, gray processing, and median filtering are done in this step. After this, plate region extraction is performed where extraction of the

license plate is done from the image. And finally, character segmentation step is performed.

This paper [2] describes the way of measuring an object using Numpy and openCV. We also need to write a piece of code for the webcam to turn on and off which basically captures the dimensions of the object. Requirements for measuring the object is that we need to change the background of the image to white. After that it takes an input image and creates its canny image and we also apply a few filters to amplify and grind down the features to make that image well ordered. After that, we find the hindrance of the white paper which is of the required shape, filters needed to be applied as that of the background which is white and in the shape of a rectangle. Flatten the contours and affix the length and area which is going to identify clearly and definitely the white paper. Application of a few mathematical concepts is needed in order to measure the object which is being placed on the white paper. Dragging a few lines around the object will let us know the estimated measurement.

This paper [3] describes real-time video analysis, and suggests using OpenCV libraries to implement an object measurement technique that includes four steps. The first step delas with identification of an object, which can be done with the help of canny edge detection algorithm. The second step involves performing a morphological operator to identify the objects' gaps. The third step will find and sort the contours and the fourth step will measure the size of the object. This system is implemented by using the Raspberry Camera, OpenCV software and Raspberry Pi 3 and. Approximate 98% of the object size is determined by using this technique.

This paper [4] describes that in each country, traffic control and car owner identification has become a serious negative. Typically, it is impossible to identify car owners, and UN agencies break traffic laws and drive excessively fast. Resulting in, making it impossible to catch and punish these types of people. To resolve this problem, we design an Automatic Number Plate Recognition system. ANPR systems are available in a variety of configurations presently. These systems are supported by a variety of methodologies,but it's still a difficult task because a number of factors such as speed of vehicle, non-uniform license plates, license plate language, and completely different visibility situations will impact overall recognition rate.

This paper [5] describes how ANPR can supply answers during which actions to running an efficient intelligent transportation network can be taken. Control management has become necessary as a result of the rapid increase in vehicle numbers. The fundamental goal of ANPR is to track traffic and defend against it. To recognize text on license plates, the method of image processing and object character recognition techniques, as well as edge detection technology are used. A model for detection of vehicle license plate, segmentation and recognition of the number plate make up the whole system, The Image procedure allowed the United States the determination to put a halt to violations ranging from automobile robberies to traffic offenses to enforcement administration. This review article looked at the various registration number plate recognition styles that have been used so far.

[6] The following research paper deals with a method that recognizes objects in real time video streams. With the help of OpenCV, an object measuring approach is proposed in the system for real-time video that incorporates erosion algorithms dilation and canny edge detection. There are four steps to the technique that has been suggested: (1) applying a canny edge detection technique to identify an item to be measured, (2) morphological operators such as erosion and dilation algorithms is used to avoid gaps between edges, (3) finding and sorting contours, and (4) dimensions of the object are taken.

[7] This paper proposes a method for assessing the size of the object even from distance with the help of computer vision and a LiDAR sensor in this study. The article details the procedures for obtaining the answer, as well as the training dataset and its restrictions. The proposed methodologies will be used in robotics engineering, self-driving drones, cars, and other areas. The LiDAR sensor, camera, and OpenCV Approach are used in this suggested algorithm to get the dimensions of the object even from a distance. A concise introduction to Realtime Object Detection, LiDAR Sensor and OpenCV techniques is also included in this work.

[8] Structure’s displacement responses can reveal vital information about their behavior. Because image-based measurements have improved significantly in the last few years, this study uses a comparison marker-based approach and proposes a displacement measuring technique. An high pixel camera is used to determine the displacement of a structure by detecting an ArUco marker with this approach. A comparison with a well-known reference approach was performed. The impact of acquisition and ambient characteristics on measurement findings, as well as the uncertainty caused by repeatability measurement, were investigated.

[9] The dimensioning and real-time object detection and is an essential part of the fourth industrial revolution from an industrial standpoint. These are the subjects that must be covered while dealing with computer vision issues. An elaborated approach is followed for detecting objects in real time and getting their measurement from an IoT video device, such as a camera, is shown in this paper. We proposed a real-time object measuring approach based on AI and IoT technologies such as OpenCV libraries and webcams.
Many libraries and algorithms are included in OpenCV, which are used in this project. There are four phases to the technique: (1) picture capture (2) object measuring (3) output saving (4) output display

[10] An effective vehicle number plate detection system is required in the future city. An unrestricted ANPR system is currently unavailable since each area has its own number plate type and design because due to the lack of data and the varied plate information, there hasn't been much work done on number plates. To address this problem, we gathered vehicle number plate data with diverse plate layouts and used it to construct a unique ANPR framework. The suggested system uses the YOLO model for object detection to locate the number plate region, then applies robust preprocessing approaches to the retrieved plate region before recognizing the plate label using OCR and Tesseract.

[11] In this day of rapidly evolving technology, individuals have a strong need for a safe way of life and travel. The number of automobiles on the road has grown during the last decade. With the tremendous development in the vehicular industry every day, tracking individual vehicles has become a very difficult undertaking. With the use of roadside surveillance cameras, this study proposes an automatic vehicle monitoring system for rapidly moving automobiles. Obtaining the images in real time backdrop is a time-consuming task. For object detection, a learning method called YOLO (You Only Look Once) which works on deep learning is used to address this issue. There are

four basic phases in the planned work. The automobile is detected from each frame in the first stage, which involves converting video material into pictures. The license plates of the observed autos are then detected in the following stage. The recognition of vehicle number plate characters is done from the detected number plates in the last stage. To make the process of training easier, the deep learning model is proposed which takes the help of Image AI package. Images of state number plates is used to find the performance of the model. An accuracy of 97 percent is achieved for car detection, an accuracy of 98 percent is achieved for number plate localization, and character recognition achieves a 90 percent accuracy.

[12] These days, finding the distance we want to measure is really difficult. Still, tape is a convenient solution, but this sort of instrument is susceptible to human mistake. Engineers had previously developed a range finder module, but they discovered that it has a number of flaws, including a distance restriction, inconsistent results with varied coloured barriers, and the necessity to constantly measure it before using it.

Human mistake is used to estimate distances on a regular basis. The main goal of this research paper is to accurately and correctly detect the distance of the minimum width. With 1cm precision, this gadget can measure distances ranging from 0.5m to 4m. This idea uses ultrasonic sensors to measure a file of distance. It operates by transmitting ultrasonic waves. The transferors will then rate the amount of time it takes for the audio to move to certain places before returning as a noticeable echo.

[13] A device named sensor transforms energy from one type into another type of energy. A tiny microcontroller board named Arduino makes a connection with computer using USB. The surroundings are being observed with the help of Arduino board by receiving data from a number range of sensors and which in turn changes them by manipulating LCDs, GS module, motors and speakers. The technology which is used by Ultrasonic Sensors is "non-contact" technology which determines the distance between materials in the air or target objects. They are straightforward to make the use of distance measurement without any damage being caused. Then sensor receives analogue signals, and the output is digitally structured which is being analyzed by the microcontroller. It is now being utilized to identify an obstruction as well as its exact distance.

[14] Engineers had previously developed a range finder module, but they discovered that it had a number of drawbacks, including distance limitations, varying results for various coloured obstructions, and the necessity for calibration every time it was used. When distance is being measured manually there are chances that human error may persists. The major goal of this research is to measure the distances of low range consistently and accurately. This gadget comprises a range of 0.5m to 4m which can determine distances with a precision of 1cm. Ultrasonic sensors are being used in this research paper to calculate the distance. At a frequency of 40 kHz, ultrasonic waves are being transmitted. The time it takes for a pulse of sound to travel to a certain surface, the transducers are being used to calculate and return as a reflected echo. This device calculates the distance with the help of speed of sound at 25 degrees Celsius, that is being programmed with an AT mega microcontroller. On an LCD panel the distance will be displayed. The main aim of this research paper is to calculate the distance with precision from any sought of barrier that we wish to measure.

[15] Implementation of a distance measurement system employing ultrasonic waves is detailed in the study. The project's goal is to achieve contactless distance measuring from a target. There are various methods for measuring distance without making physical touch. When compared to manually calculating the distance, this project improves reading skills. Essentially, there are three phases to this project. First phase of this project is to locate and create the necessary hardware which connected to the project. The second phase entails building and developing the hardware, as well as deals with the process of troubleshooting and testing. The third phase is to design and construct the software, which will be combined with the completed hardware component.

3. METHODOLOGY

3.1 Detecting the size of the car

3.1.1. Identify the object in space

Before measuring, locating object in space and coordinate's determination is required, which we can do using a simple object detection. A for loop is utilized for extracting the arrays containing all points delimiting the specified objects. Because of the lack in the geometrical shapes, reduction of object bound to plan rectangle is advised.

3.1.2 Measure pixels and centimeters with ArUco Marker

The coordinates of object are now with us, and we can see the measurements in pixels thanks to the rectangle but converting this measurement to centimeters would not provide us genuine data because we require a reference on the dimensions. ArUco Marker is used for this purpose.

ArUcomarker: - A squareshapedmarkerhaving a broadblackborderwithaninsidebinarymatrixwhichhelps in itsidentificationisidentified as an arucomarker. The black border of the image helps in spotting it easily, also binary coding helps in identification of it and use repair procedures and error detection. The size of the internal matrix is found out using the marker's size. For instance, a 5x5 marker is composed of 25 bits.

We don't need to calibrate the camera because we know it's a perfect square of 5cm X 5cm. Beyond that, OpenCV detects it and integrates it without the need for sophisticated processes. It's simply necessary for the marker to appear in the video alongside the objects.

We know that the Aruco marker I use is a square with 5 cm on each side, so we have a perimeter of 20 cm which is almost equals to 560 pixels. The perimeter is then calculated from the points identified, and the ratio is obtained by a simple division, which will also be utilized for object conversion.

Pixels_and_centimeters_ratio = aruco_perimeter/20

3.1.3 Conversion of pixels to centimeters

h and w are two parameters that are extracted by the for loop connected to the outlines of the objects.We get centimeters by putting the ratio calculation to the h and w parameters. After getting length and breadth, the area of the object is determined as shown in Fig 1.

width_of_object = w / Pixels_and_centimeters_ratio
height_of _object = h/Pixels_and_centimeters_ratio
area_of_object = w * h

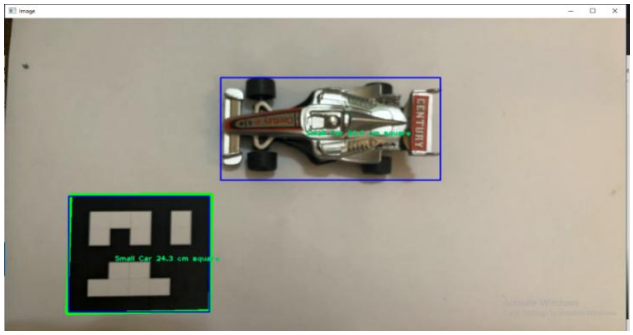

Fig 1: - Object measurement using ArUco marker

3.2 Number plate detection technique

3.2.1 License plate detection

Initially, sighting of the registration code from the automotive is done. The contour choice is used in OpenCV to sight objects having rectangular shape to search out the license plate. Improvisation of accuracy can be done if the precise colour, size and approximate location of the license plate is already determined. Ordinarily the detection algorithmic rule is trained to support the position of the camera and the kind of variety plate utilized in that exact country. This gets trickier if the image doesn't even have an automotive, during this case we are going to take an extra step to sight the automotive so the registration code can be identified.

3.2.1.1 Resize the image to the specified size then grayscale it.

Resizing tends to make it easier to avoid any issues with larger resolution pictures; check that the plate still remains within the frame once resizing is done. Gray scaling is common in the image process. This accelerates the alternative following method since now we do not have to handle the colour details once we process the picture.

3.2.1.2 Each image can have helpful and useless information, during this case solely the vehicle plate is the helpful information and the remaining area unit is just useless for the program. This useless information is named as noise. Unremarkably employing a bilateral filter (Blurring) can take away all the unwanted details from the picture.

Syntaxis destination_image = cv2.bilateralFilter(source_image, diameter of element, sigma Colour, sigmaSpace). It will be able to increase the alphabetic character colour and alphabetic character area from fifteen to higher values to blur out a lot of background information, however, use caution so that the other half doesn't get blurred.

3.2.1.3 Succeeding step is attention-grabbing wherever we tend to perform edge detection. There are many ways to do it, the foremost simple and common method is to use the canny edge methodology from OpenCV. The syntax is destination_image = cv2.Canny(source_image, thresholdValue one, thresholdValue 2). The minimum and the maximum threshold value is the threshold value one and the threshold value two respectively. Solely the sides that have an associated degree intensity gradient over the minimum threshold worth and less than the utmost threshold value are displayed.

3.2.1.4 At this stage it will try to find contours on the image. Once the contours are detected it will tend to categories them from huge too little and solely consider the primary the first ten results ignoring the others. In the given image the counter may be something that features a closed surface; however, of all the obtained results the number plate will be there since it is also a closed surface.

To filter the license plate image among the obtained results, it will loop through all the results and check that features a rectangle form contour with four sides and closed figure. Since a vehicle plate would positively be in a rectangular shape of four-sided figure. Once the correct contour is determined it will tend to put it aside in a variable which is referred to as screenCnt then draw a rectangular box around it to make sure the correct licence plate is being detected.

Step 5: Now that is known where the license plate is, the remaining info is just about worthless. Thus, will proceed further with the process of masking the whole image keeping aside the portion wherever the license plate is at that moment.

3.2.2 Character segmentation: Once the vehicle plate has been spotted, the cropped image of license plate must be saved as a new image. This may be accomplished by the help of OpenCV. The next stage in pate recognition is to crop and save the license plate as a replacement image after it has been phased out of the original image. There will be utilization of this photograph to figure out the character in it. Cropped image of Region of Interest has the most importance in this system. In addition to trimming the image, graying and edging it is also needed if necessary. This is frequently done in order to improve the character recognition in the following phase. However, it is discovered that it works well even with the first image.

3.2.3 Character recognition: The final stage in this is to thoroughly examine the quantity of plate information included in the segmental image. There will be usage of pytesseract package to examine the characters from photos as shown in Fig 2.

Fig 2: - Detected characters and number plate

3.3Parking space allotment

The car which enters the premises needs a parking space that is available and should also indicate to the other vehicles about the space which it has occupied through LEDs which will work using HC-SR04(Ultra-Sonic Sensors) via nodeMCU. The detector simply holds its "ECHO" pin HIGH for a while comparable to the time it takes to figure out the space by receiving the reflection (echo) from a wave it sends.

3.3.1 The burst sound waves are being send by the module, and voltage to the echo pin is also applied at the same time.

3.3.2 The reflection back from the sound wave is being received by the module and also voltage from the echo pin is removed. On the bottom of the space, a pulse is being generated within the inaudible detector to send the meaningful information to Mega Arduino or the other microcontroller. Formula: -

$$D=1/2\times T\times C$$

where the distance is denoted as D, T is the duration between the Reception and Emission, and C is used to indicate the sonic speed.

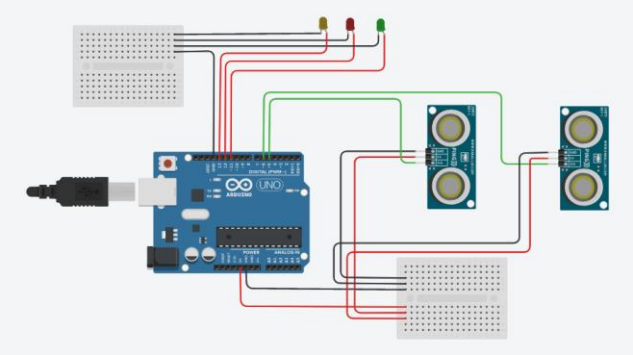

Fig 3: - Circuit diagram of a parking slot.

3.4 Flow chart

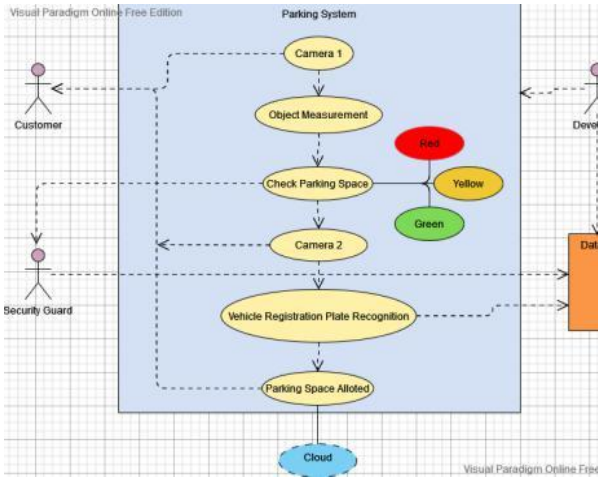

Fig 4: - Flowchart of the system

4. RESULTS AND DISCUSSION

The outcomes of putting the suggested work into practice are addressed here. The dataset is initially gathered. Label image is used to annotate the data. For both the test and train pictures, the actual image file and .xml files are kept in different folders in the similar directory. Frames are created using the input from the CCTV live feed. The CNN model has been taught to recognize autos in images. Users determine the number of epochs. Until all of the epochs have been finished, the system will be taught utilizing the GPU's power.

A json file is produced once the training is done. Models are also saved in their own folder. The model will then be validated using the validation samples. Following validation, each model's mean Average Precision score is determined. For determining the accuracy of deep learning models, a well-known method of Average Precision is present. Average Precision of values ranging from 0 to 1is being calculated. Calculating the area under the precision- recall curve is the broad meaning of average precision (AP). Predictions for vehicle detection can be made when the model has been validated.

$$\textbf{mean Area Precision (A.P)} = \int_0^1 p(r)dr$$

Using the vehicles dataset, the model can be designed and trained to detect the number plate in automobile photos. The files are saved in folder in JSON and H5 format. Finally, the model is well trained recognize license plates. A folder is created for the frames extracted from the incoming video source. The auto vehicle in the images will be acknowledged and will saved in some other folder.

Following that, the discovered number plates are subjected to character segmentation. OCR (Optical Character Recognition) is then used to recognize the segmented characters. The extracted character from a vehicle number plate is being saved into an excel sheet file along with the vehicle entry date and time. The accuracy of the system is indicated in the table below

Table 1. models and their accuracy

Models	Accuracy
Number Plate Detection	88%
Optical Character Recognition	90.7%

The result that we get from the detection of the license plate is shown as the given in Fig 5: -

Fig 5: - Detected number plate

The license plate is detected successfully, and the information related to it gets stored successfully in the excel sheet and the section of the car where number plate exists also get stored as .png file in the database. The name of the .png file is similar to the primary key of the excel sheet as shown in Fig 6 and Fig 7.

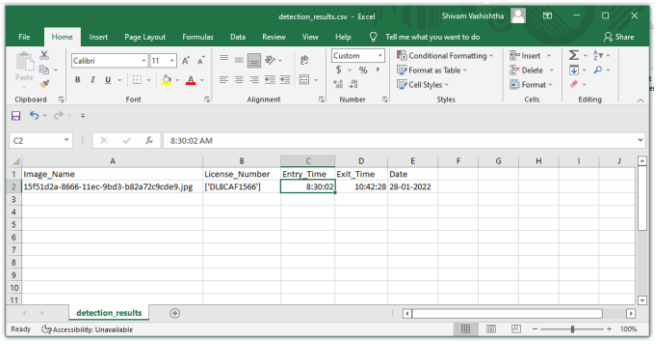

Fig 6: - Excel Sheet having the data

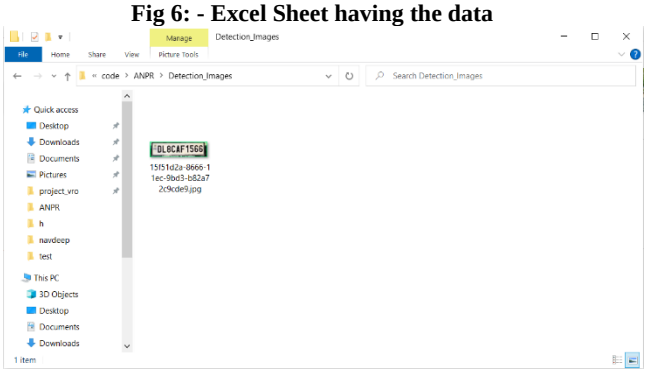

Fig 7: - Detected Images Folder

A parking slot consists of 3 LEDs red, yellow and green. Red LED will glow when the parking slot is occupied, yellow LED

will glow when the slot is occupied by a small vehicle and green LED will glow when the parking slot is empty.

5. CONCLUSION

The proposed system can be used in day-to-day life by the application of these technologies like TensorFlow, OpenCV, Python, Object-Measurement and IOT. Recognition of number plate using the above-mentioned technologies can be implemented in the parking of Wall-marts, Schools, Supermarkets, Colleges, Hospitals and many other places as well. This will provide the safety of the vehicle as the camera is being fitted at the entrance and exit which tracks the entry and exit time of the vehicle, the camera is also detecting the size of the object taking ArUco marker as reference. By storing the time along with vehicle number plate details in the database we ensure vehicle safety. With the help of Smart Parking System in the model which uses ultrasonic sensors and LEDs to detect the availability of parking slot the user can get the slot in no time with maximum efficiency.

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