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Autonomous Gateway Architecture for Security Using OpenCV

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Abstract: ***Today as we can see security for anything is considered to be a very important part of our livelihood and we need to seek more and more security every day in this fast growing world. As the security of public parking lots increases day by day and to ensure safety, many people are required in this job that increases the cost of security So we have looked into the process and came up with a plan to use computer vision for the security purpose which will reduce the manpower required for work instead with machine intelligence. We are going to use Computer Vision to mask the license plate and save it with the entry and exit time. This research paper will enhance the security provided by a CCTV camera in any public parking and will also keep the record of every car entering and exiting the parking area.***

Keywords: OpenCV, Machine Learning, EasyOCR, SQLite, Image Contour Processing

I. INTRODUCTION

The idea of building a "Smart City" is rapidly growing these days. Various software's or applications using CCTV are getting implemented. Therefore the role of CCTV is not only restricted to recording a video but also to gather information about generic vehicle data. The technology used is very advanced because it incorporates the use of inexpensive IP cameras and their excellence. Automatic License Plate Recognition (ANPR) is an advanced CCTV feature that enables video analysis software to automatically recognize and read vehicle license plates. We can use ANPR in functioning of many systems like Crime Detection System, Stolen Vehicle Detection and also used in controlling log access to building's parking arena. ANPR uses optical character recognition on images in order to detect the number plates on vehicles. It is quite difficult task to detect number plate from an image or video as compared to counting vehicles in a video footage. It is a challenging task as number plate writing style varies from state to state in India. Number plate style for two wheelers and four wheelers is also different in India. Number plate's background colour is also not same as in India it's yellow colour for tourist and white for private car. All these mentioned challenges needs to be taken into consideration before implementation of the ANPR system.

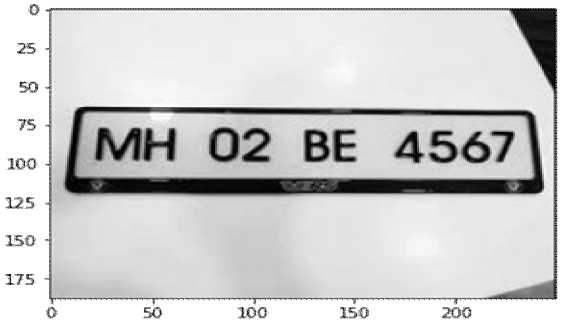

Figure 1 – Ideal Number Plate

The four predefined steps used to recognize the number plate are Image Capture: This step involves capturing the vehicle image by extracting the required frame from a stream of video from CCTV live footage .Image Pre-processing: After the interested image is captured in which the number plate is not blurred , then the further processing of the image is carried out. It consists of a series of steps such as resizing the image resolution, removing unwanted noise from the image, and finally the image is converted from RGB to Gray and then black and white color.Region of Interest (ROI): When pre-processing of image is completed then it is followed by extracting the number plate region from the image. Optical character recognition (OCR): In this step, text is extracted from the captured image which is done by the means of electronic conversion. Printed text images are converted into machine encoded text. OCR used to decode the number from the ROI image..

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II. METHODOLOGY

The main purpose of our project is to enhance the security feature provided by CCTV in the parking arena. In Number Plate Recognition, still images or photographic video is taken and then the process is followed by a series of recognition algorithms which are based on image processing and then eventually text is extracted from the given image. Number Plate Extraction is the process which is used to extract the number plate from the vehicle image and the system utilizes plate localization functions when a vehicle is detected in the image .

A. Research Approach

Our research paper revolves around anomaly in crime rates that are increasing everyday and our security system fails to identify many of the cars which are involved in the committed crime which sometimes also delay the case solving duration. So we found a way to rectify the errors in our existing security system. In this research we have made a project that will allow CCTV cameras to store the licence number of the captured vehicle image in the camera using OpenCV.

B. Method Approach

The basic steps which are involved in Automatic Number Plate Recognition are detecting and localizing a number plate in an input image then it is followed by Extraction of the characters from the license plate that would be stored inside the database.

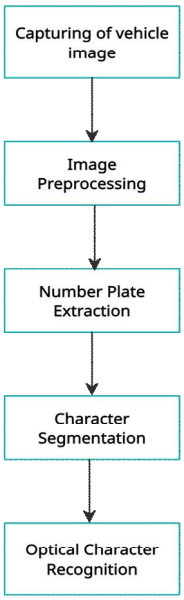

Figure 2 - Flow Diagram

C. Contour Processing

A Contour is a closed curve connecting all continuous points of a specific colour or intensity. They represent the shapes of objects found in an image. Contour detection is a technique widely used for shape analysis and object detection and recognition. We will follow the following steps in order to successfully detect contours in an image. Firstly the image is converted to a binary image, then contours are found using OpenCV function and lastly, these contours are drawn and the image is displayed.

Figure 3: Contour Processing

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D. Optical Character Recognition (OCR)

Optical Character Recognition (OCR) is applied to recognize the extracted characters. OCR was invented by Ray Kurzweil.
The first Optical Character Recognition device was developed in the late 1920s by the Austrian engineer Gustav Tauscher. OCR is conversion of images electronically into machine encoded text. It is a widely used method to recognize printed text so that it can be edited electronically , stored more efficiently and thus can be displayed online. We will use various python packages like OpenCV, Tesseract, and OCR. OpenCV is an open source library which is highly useful for image analysis. OpenCV supports processing of images and videos which helps in identifying objects, entities or even handwriting of people. Python-Tesseract is an OCR tool which is used to recognize and read the text present in an image or number plates. Image filtering is used to change images. These modifications essentially allow to lighten an image to get the desired information out of the image. This includes things such as extracting edges from the image, blurring an image or removing unwanted objects from the image.

E. Masking

The Masking is a technique used to make a specific object stand out from the image. In masking operation using OpenCV ,the value of each pixel of an image is recalculated based on a given mask matrix, which is known as the kernel. Masking is otherwise known as filtering.

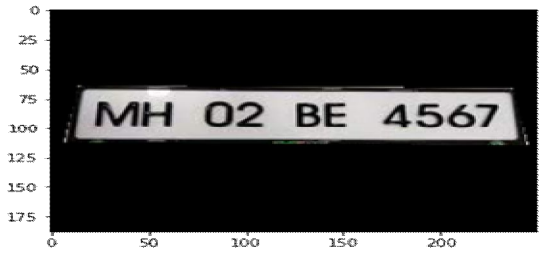

Figure 4: Masking Of Number Plate

F. Split and Merge Segmentation Technique

Split and Merge Segmentation technique is also used to divide an image into a uniform region. A digital image is divided into multiple segments in order to simplify the image into something that is easier to understand and analyse. The process of splitting the image region into smaller uniform regions is continued until no further splitting can be done and then these smaller regions are again assembled together to get the region of interest(ROI).

III.ALGORITHM

This section discusses the analogies we utilised in our application. Here, we've explained throughout procedure in detail about our application workflow and its reponse.

A. Canny edge Detection Algorithm

Canny edge detection algorithm is an algorithm involving multiple steps used to detect the edges for any input image. In this algorithm, firstly there is removal of noise from the input image using a Gaussian filter which has a specific mathematical formula which helps this to be more precise. Then it is followed by finding the strength and direction of edges using Sobel Filters and then later, Hysteresis Thresholding method is used to preserve the higher pixels in the image and the ones lower than the low threshold value are neglected. The image is taken into consideration and made a little blur to decrease the noise in the image as much as possible sent for image cropping for extracting only the number plate area by finding contours for the specific area and then applying contours to find the edges of the number plate and then applying a mask to get the part of image with only the number plate.

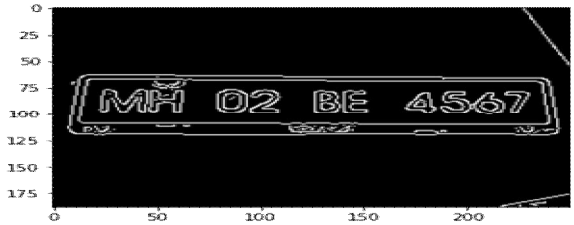

Figure 5 – Canny Edge Detection on Masked Image

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B. Character Segmentation

The extracted number plate is then taken into consideration and the characters on the licence plate are segmented first before going to the recognition process. The algorithm used for identification of the alphanumeric characters on a number plate is commonly termed as Character Segmentation. Character Segmentation is an operation that attempts to divide an image of a string into sub-images of individual symbols. It is one of the decision-making processes in an Optical Character Recognition (OCR) system.

Figure 6 – Character segmentation from Masked Image

C. Support Vector Machine Algorithm

SVM is commonly used for character recognition. The next character in the image is identified then there is extraction of distinguished attributes of the character image. Finally, the member of a given symbol set is found whose attributes best match those of the input, and output its identity. This sequence is repeated until no additional character images are found.

After segmentation of characters, there is translation of segmented characters into a text entry using the optical character recognition (OCR) techniques. The overall performance of ANPR system depends on the effectiveness of each individual stage or process thus this technique delays the process by increasing the iteration and utilizing computation power.

D. EasyOcr Library

The software here used for edge detection is easyOCR which can be used with several languages and English can be used with nearly all languages and this also allows a NumPy array other than a file to just be passed to it directly and also works with all commonly used languages world-wide.

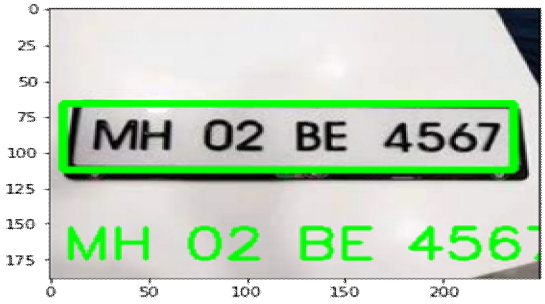

Figure 7- Character Recognition

E. SQLite

SQLite is a C-language library which implements a high reliability, small, self contained SQLite database that is today coming built-in in mobile phones and many computers and is one of the most used databases today. SQLite files are cross platform which allows us to use it as containers for content rich data transfer between the systems. When the number from the license plate is finally extracted then it is stored in the database with the time as well as date stamp and can be extracted whenever we want. SQLite never demands for different servers to run on. It supports most of the features found in SQL92 (SQL2) standards. Its features also allow safe access for multiple processes for running and multithreading thus we store the recognised character's from the number plate to the locally stored SQL database on the cloud and backup is devised on the server.

Results | Messages

	sno	car_number	time	date
1	1	MH 02 BE 4567	02:35:55	2021-11-20
2	2	MH02BG2L13	02:36:10	2021-11-20
3	3	MH 02 BR 4552	02:40:24	2021-11-20
4	4	MH02BA2172	02:44:18	2021-11-20
5	5	CG 12 7170	02:52:27	2021-11-20
6	6	CG 12 AR 8189	02:59:21	2021-11-20

Figure 8 – Sql Database for Captured Car Plates

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IV. RESULT

As we can see in the figure below, our system will accurately detect the number on the number plate and link it to the database. The canny edge detection helps to recognize the license plate edges and then by using easyOCR, ANPR will detect the number plate properly. CCTV will capture the portion of license plate to interlink with canny edge detector where the algorithm will detect the number plate and will transfer details to recognizing library and that would be returning the number on the license plate and hence the number will be stored in database in SQLite which will have the record of all the license plates that has been captured through the CCTV.

Figure 9 – Recognizing Number Plate

In most of the cases we will get an accurate result by using ANPR system .But there can be a possibility that the number plate is captured in the wrong way. Although, in most of the cases we will get an accurate result. When CCTV will capture the vehicle image, then canny edge detection algorithm will be implemented to detect all the edges of the number plate. Using polycontour and randomized function all the four pointers of the frame will be detected and number plate will be given as output. There is a drawback as there few cars whose number plate contain rectangular frames and those frames can also be detected and can cause problem to get the desired result .Thus it should be avoided so that we can get our final frames which is the number plate. In favor of odd there might be a slight possibility that easyOCR doesn't recognize the number plate accurately.

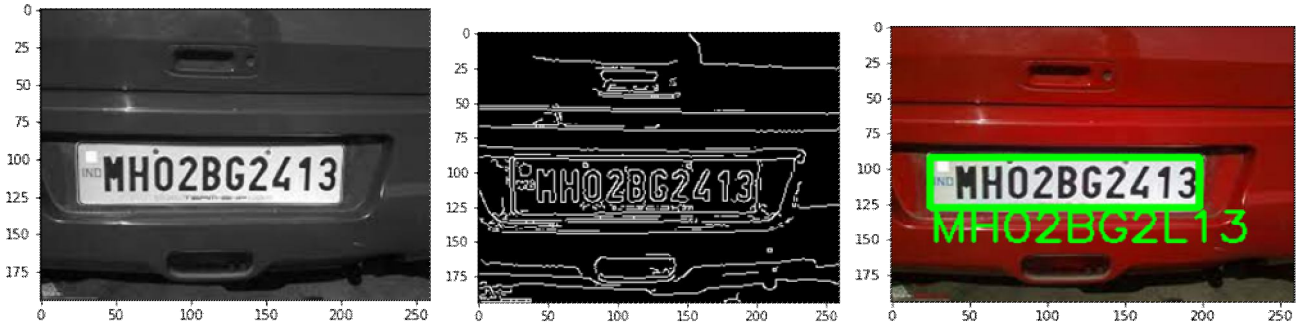

Figure 10- Limitation In Plate Recognition

Although, in turn the algorithm would improvise the security system and develop a sense of improvement in the ongoing process in the security automation sector.

V. CONCLUSION AND FUTURE SCOPE

This project's work scope includes interacting with a wide range of number plates that indulge in various container boundaries. People frequently do not perceive this to be an indispensable threat. As a result, they frequently fail to come up with a solution. We can upgrade this system in future, so that it can be used efficiently to detect number plates of the vehicles in foreign countries. We can also use this ANPR system in tracking vehicles by integrating new features into it. If a vehicle is passed from a place then route mapping can be performed using this system in order to know the next location of the vehicle. This can be very helpful and useful for maintaining security at city level. We know that image preprocessing plays a vital role in ANPR system and extraction of ROI from the image is a bit tedious task because the position of the number plate in the image is not constant for every vehicle image so therefore there can be the future work on this process to make it more simple and efficient.

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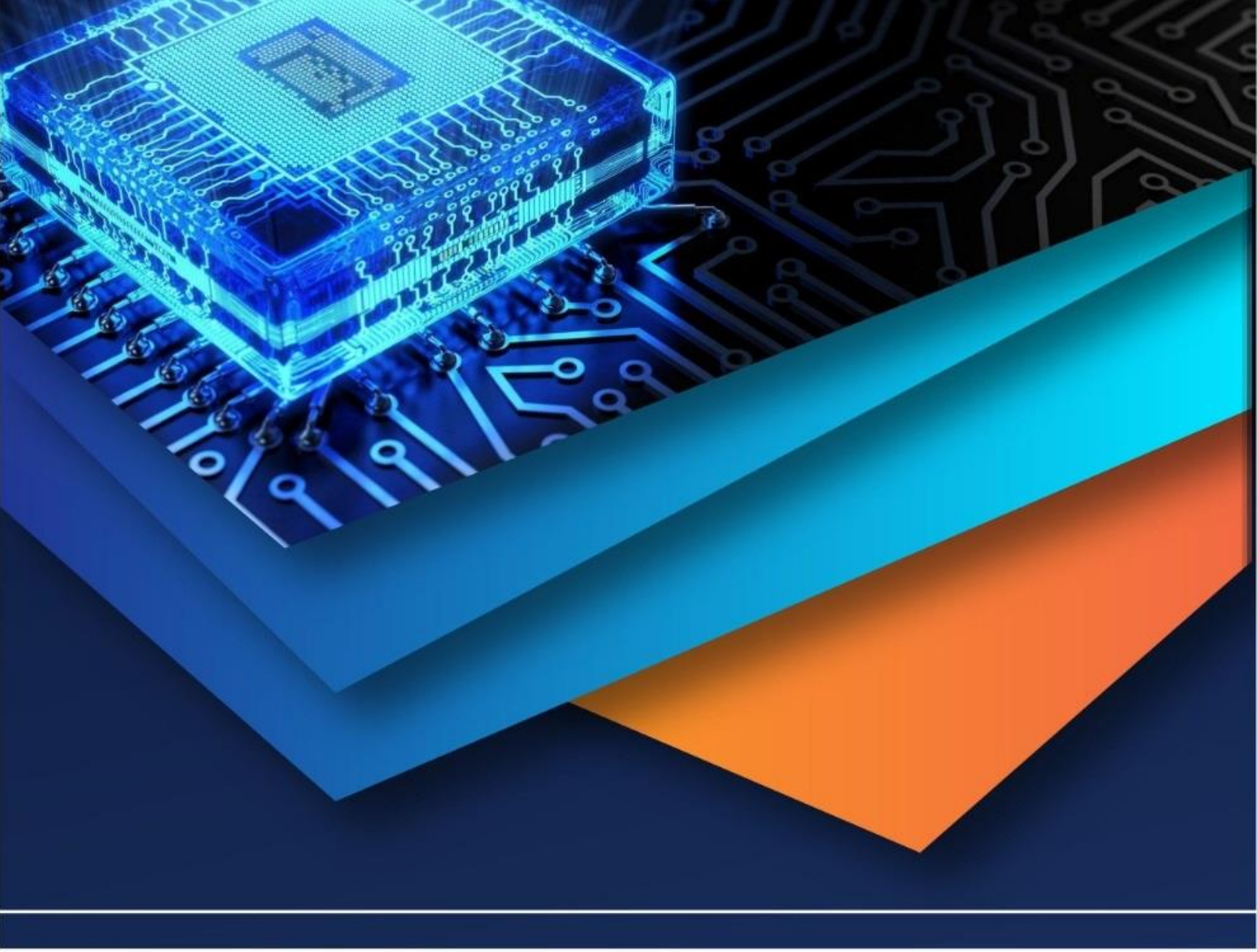

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