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INTRODUCTION

Background and Motivation

It has been more than three years at Habib and we have been noticing the function of HU's vehicle management system till now. The vehicle management system is a very crucial system of any organization in order to maintain its security. Getting into a building through gates is one of the obvious options for terrorists. Stablising security cameras and walk-through gates can provide a little bit of security assurance, but still there remains a big enough room for improvement. Controlling and managing the entrance and exit of vehicles is very necessary when talking about security. It just does not only ensure the avoidance of security threats but also helps in keeping count of number of vehicles going in and going out of a building. It also provides data about vehicles within the building and the time and date of their entrance. These statistics can be used at any point for security purposes.

THE CURRENT VEHICLE MANAGEMENT SYSTEM OF HABIB UNIVERSITY

Currently, Habib University uses a less technological vehicle management system. Vehicles are allowed to enter the gate if the driver has identity card or university's card and car has a sticker on windscreen. The license plate number is noted on a notebook by some security personnel, which later is updated in the existing database maintained in an excel file. There are two level of security gate which operate on the basis of the security check result of the security guard. The registration of vehicles is done through a registration form which has details of owner and vehicle. Once registration is done, the owner gets a sticker that serves as a ticket to enter the building. The sticker has to be renewed after a year of its issuance.

WHAT ARE THE LOOPHOLES?

The current system is working fine but it needs to be improved as there are some upgradation required regarding efficiency and security. We visited the security officials and they walked us

through the whole security system. The security guard standing at the gate goes and checks the IDs of the people in the vehicle and then gives hand's signal to another security guard handling barrier. The barrier goes up if the signal is positive. This small task takes up around 2 to 3 minutes for every vehicle. This sums up to a huge amount of time when many vehicles have to enter one after another causing the process slow down. When the vehicle enters on positive signals its license plate number is then noted from a small glass walled security chamber right in front of the security barrier. The security person noting down the license plate number only notes the plate number and relying on his own memory fills the other details. He, when asked to one of the security heads, was considered to be more reliable than anything. This is surely not a logical reason to rely on someone's memory as that person might get replaced or be off campus any time. This is, surely, a huge security loophole.

WHAT ARE WE IMPROVING?

We came up with an idea to automate this existing system and help the university use more secure system. We are targeting these drawbacks of Habib University's current vehicle management system by building an automated check-in and check-out system. The detection of license plate number through security camera and the data management of vehicles are the main parts of our project. From detection and of license plate to its data entry are all automated. We are using Digital Image processing strategy to help with detection and MySQL and PHP for data management and user experience. We are also providing an interface in the form of web to help the user easily manage the entire system in a matter of few clicks. Efforts have been put to make this system as simple and easy as possible so that existing people could easily incorporate it. This report discusses each and every part of our project in detail.

Following is the flow diagram of our system. Gate 1 entrance is under consideration.

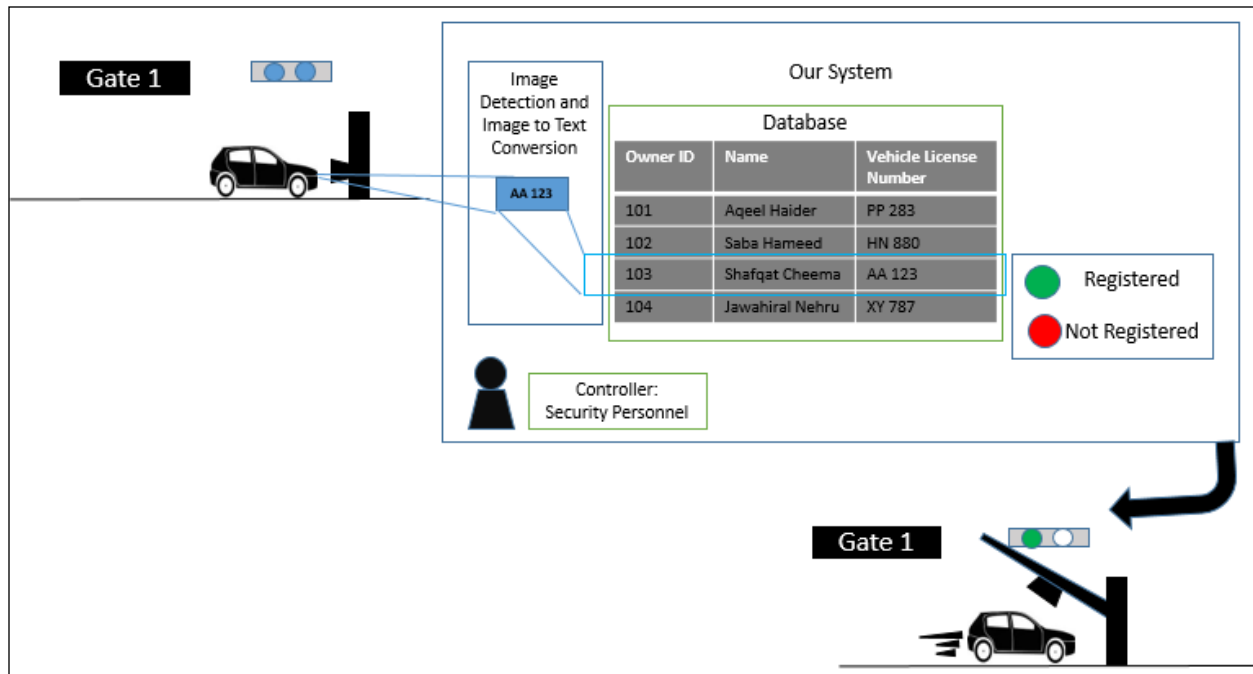


Figure 1 Flow Diagram of VMS (Vehicle Management System)

Details

The license plate recognition program is going to be used as the core engine for the detection and recognition of number plates of the vehicles. The program is mainly composed of two stages Detection and Recognition. On the top of it a web interface is made so that any person with basic knowledge of computer could operate the system.

Software Requirements:

The program is being developed using python 3.7. it can be used on any standard machine. The following libraries are used:

- OpenCV
- Numpy
- Pandas
- Pillow
- Pytesseract
- Matplotlib

On the other hand the web application part has been built using xampp tool that allows for development in php.

- HTML
- CSS
- Javascript
- Php
- MySQL

To make program run successfully above mentioned libraries need to be installed in the system.

Design & Implementation:

License Plate recognition

The core recognition engine takes an image as an input. It can be in format of jpg or png. The input image is first of all passed through ExtractValue function which converts the image to HSV and gets its values. (Shaik Azeez, Chaitanya, & P.Srinu, 2017) Here is the original image of the car.

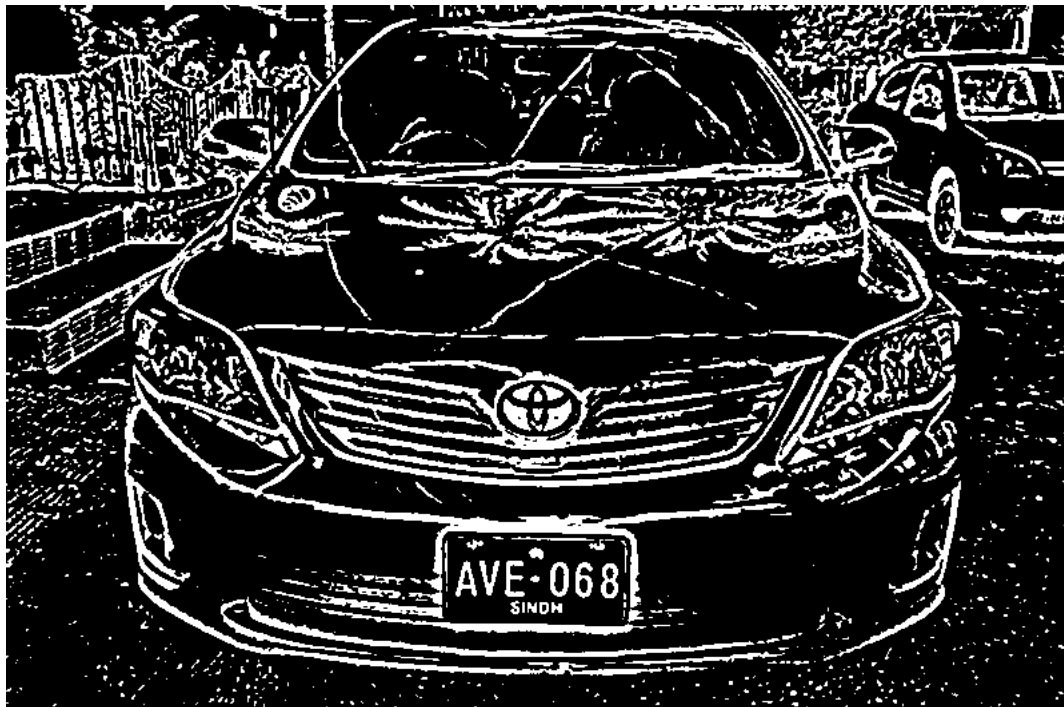


Here is the image after extractValue function.



Another function maximize contrast gets the greyscaled image and applies TopHat and BlackHat filters on it accompanied by morphological cleaning. These filters enhance dark objects in a bright background. Later results of these two functions are used in Preprocessing functions which applies Blur filter specifically Guassian Blur to remove unnecessary details from the image. Later Blurred image is used as input of Adaptive Thresholding filter. This filter gives different thresholds for different regions and gives better results for image with varying illuminations. Thresholding is usually used to separate the foreground of an image from its background. Any pixel with an intensity value lower than the selected threshold value is considered to be region black part and vice versa. (Goh & Juhairi , 2018).

Here is how the input image looks like after preprocessing:



One can see that, this is much more refined picture to work it. Number plate has been accentuated more and more details could be seen properly. Now this picture can be used for further processing.

After the above preprocessing we have defined constants to determine possible characters and a function has been made to check for possible characters from contours after finding the contours from the preprocessed image. The functions checks for possible characters from contours and keeps them in the list. From that list it draws those contours that could be characters. The result looks like this:



After further iterations...



And later after finding region where most possible characters could lie, it draws bounding box around the plate region.



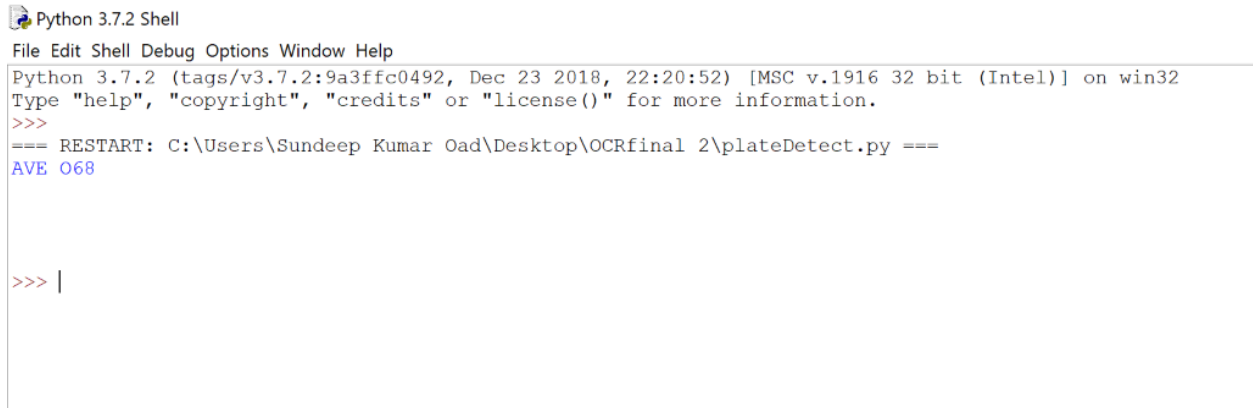
Moving on, the program extracts this region from the image which is the number plate of the car.



The plate is further bit more processed to make it more suitable for Optical character recognition. Final this image is sent to character recognition program to extract the text.



Here is the shot of extract text from the number plate's image.



```
Python 3.7.2 Shell
File Edit Shell Debug Options Window Help
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
=== RESTART: C:\Users\Sundeep Kumar Oad\Desktop\OCRfinal 2\plateDetect.py ===
AVE 068

>>> |
```

Moving on the recognized license plate number goes to the vehicle management system for further analysis. The database is one of the major parts of our system. It contains details of vehicles, drivers and vehicle owners. Habib University's existing system already contains these details. Although, we are using our own dummy data for now, but we are planning to use HU's database in future. The database we are using currently contains five tables: vehicles, persons, parkedvehicles, parking and admin. These tables contain respective data.

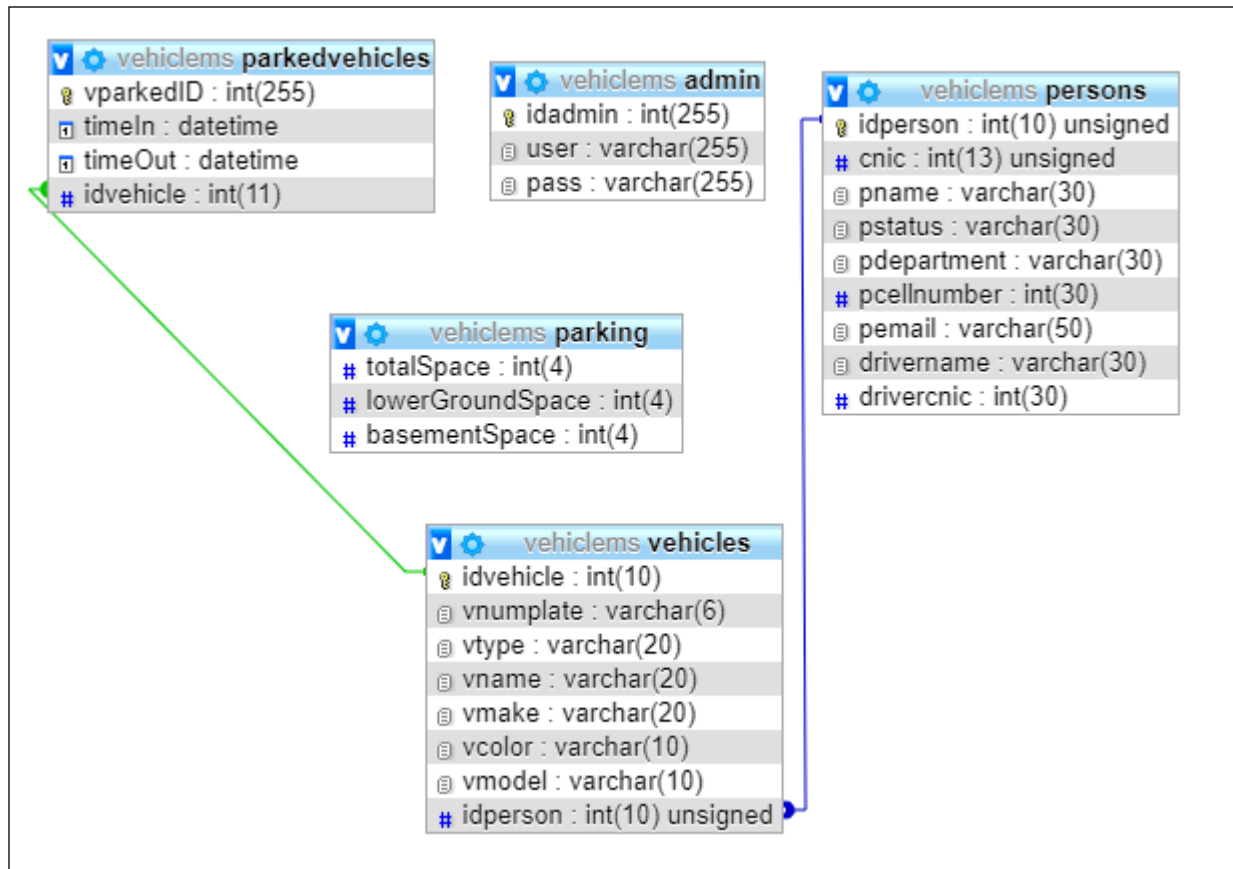


Fig: ERD containing necessary tables and their attributes

The database contains five tables with specific attributes.

1. ADMIN

Admin table contains *ID* and *Password* of the person who has the authority to manage the system. The *ID* and *Password* are provided by the developers and can be changed by contacting the developers. However, upon deployment source code would be shared with security so that they could issue ID and Password to anyone they trust. The *ADMIN* table is distinct and not connected with the other tables as (for now) we have created one admin. Once the Admin is logged in he/she can make changes or view the system until he/she logs out. The Registration of new vehicle(s) and their control (delete and update) can be done when admin is logged in.

2. PERSONS

This table is related to the owner of the registered vehicle. The attributes that form this table are: ID, name, status, department, cell phone number, cnic, email id and driver's information. These information of vehicle owner are necessary to keep track of who entered in the university. Majority of the owners belong to Habib University but there are some vehicle owners who are not related to Habib University directly.

3. VEHICLES

This table contains details of vehicle: The type of vehicle, its name, its maker and its model. These information are necessary to store in order to keep track of number of vehicles entering in the university and the registration status of vehicles.

4. PARKEDVEHICLES

This table stores the time of entrance and exit of any vehicle opposite to the respective IDs of vehicles. This information is very important to count the number of vehicle present in Habib University during certain time period. The information is also required to check if the parking slots are filled or not.

5. PARKING

This is also a disconnected table that holds information like total parking space and parking space in lower ground floor and basement separately.

What will be the User Interface?

We thought about the user interface beforehand and found some interesting ideas. The desktop application was our first idea but when we discussed it with our supervisors and among ourselves we found out that it would be only usable from a certain pc. We wanted our system to be used from anywhere by just logging into the correct user account. This requirement compelled us to go with web application. We have made a web application for better user experience.

- It provides interactive mode to user: The user gets to interact through buttons and different web pages. For example, the Homepage contains several buttons for several functionalities; *Register, view, analysis, logout and back* buttons.
- It is more aesthetically attractive: The outlook of the website is very user friendly and beautiful. User gets a vibe of a normal website and finds no difficulty in using the functions.
- It can be used from anywhere and anytime: There is a possibility that the security in-charge wants to know about the security status of Habib University from his home or somewhere else. If we had made this a desktop application, then the in-charge had to visit the university in order to check security status. But, in order to make it easy to check the security status from anywhere, we made a web-based application.

The web application contains several web pages for different functionalities.

- Login page
- Homepage
- Register New Vehicle
- View
- Analysis

Login page

This is the very first page that an admin encounters. It only asks the admin to log in in order to proceed further.

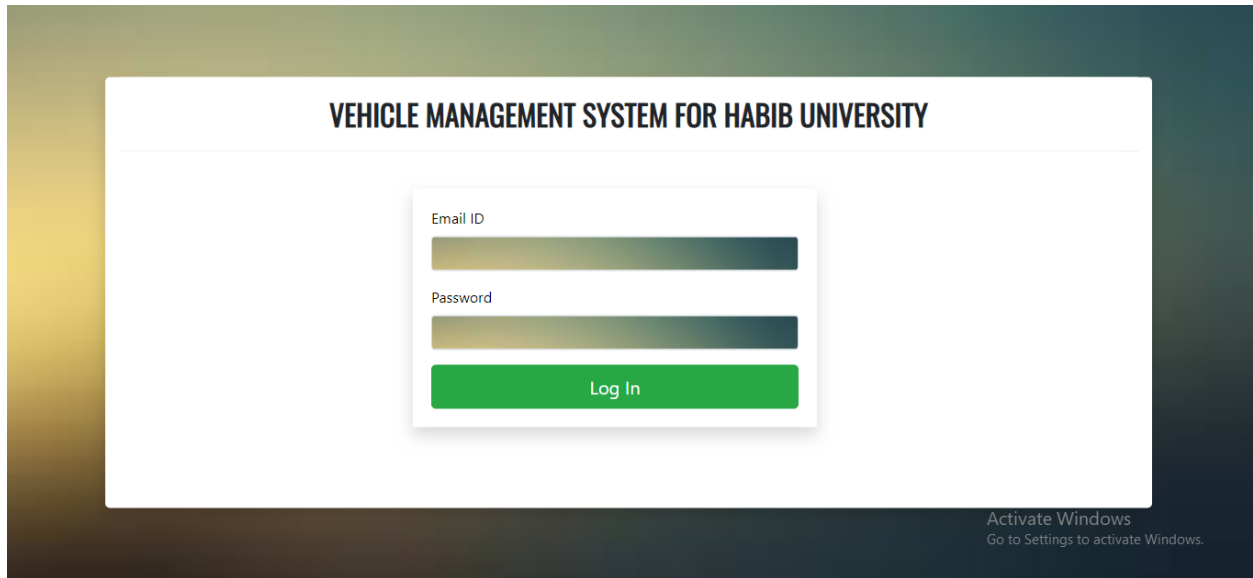


Fig: Login page

HOMEPAGE

Homepage is the parent page that links other pages to the user. This page contains a live video section on right and the information of vehicle and owner of the recently entered vehicle on the left. In center the information about parking and a welcome message is shown. This page also contains few buttons that link to other important pages like *view and analytics*.

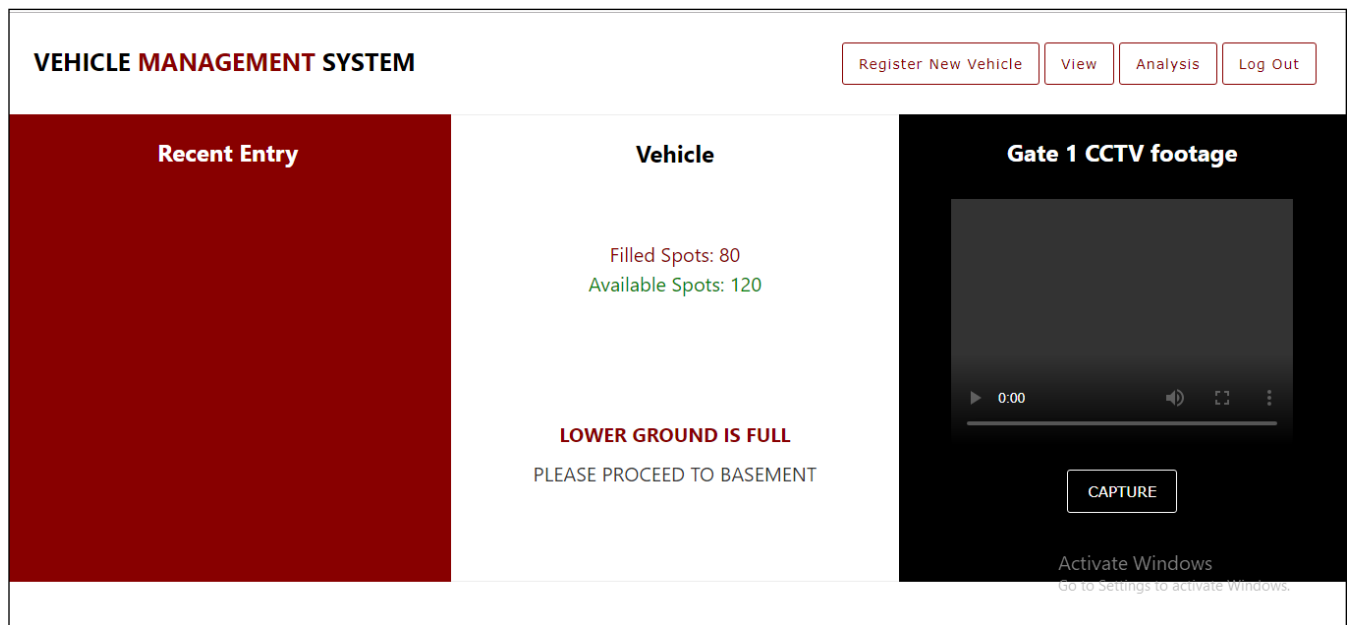


Fig: Homepage

The Homepage is technically the first page that a user encounters. This page gives information about the recent entry under *Recent Entry* heading. The video being played on the right side of the *homepage* has a capture button that captures the frame as an image and serves as python program's input (which runs in the background for license plate recognition). The video section is the live stream of *Gate 1*.

REGISTER NEW VEHICLE

This page contains a form that has to be filled out in order to register a new vehicle. The form asks for vehicle's information as well as the owner's and driver's information. These data are necessary to keep record of the registration and for further system use. The information goes to the database when submitted. The database considers the new entry as a new entity and treats it in the same way it treats other entities.

The screenshot shows a web form titled "VEHICLE MANAGEMENT SYSTEM" with a sub-header "Register New Vehicle". The form is organized into two columns of input fields. The left column contains: "Owner Name:", "Owner Status:", "Owner Email Address:", "Number Plate:", "Vehicle Name:", "Color:", and "Driver Name:". The right column contains: "Owner CNIC:", "Owner Department:", "Owner Cell Number:", "Vehicle Type:", "Vehicle Make:", "Model:", and "Driver CNIC:". Each label is followed by a text input field. At the bottom left, there is a red "Submit" button and a "Back to main" link. At the bottom right, there are links for "Activate W" and "Go to Setting".

Fig: Form asking information of vehicle that has to be entered

As discussed earlier the tables *persons* and *vehicles* contain one attribute as ID (*idperson* for *persons* and *idvehicle* for *vehicles*), but these IDs are not shown in the table above. The reason is that the IDs are auto-generated and the *registrar* has no authority to hard code or change it.

VIEW PAGE

The view page is to show the information of all the registered vehicles and their owners even if they are not currently in the parking area. The purpose of the view page is to show the information of every vehicle present in the database of Habib University. There are two buttons on the right of every information.

Delete: By pressing this button the detail of that row can be deleted from the database. It will permanently delete the information from university's database.

Update: If someone's detail is to be updated then the authority is allowed to do so by just pressing the *Update* button.

VEHICLE MANAGEMENT SYSTEM										
REGISTERED VEHICLES DETAILS										Back to main
Owner ID	Owner Name	Owner CNIC	Owner Status	Owner Department	Email Address	Owner Cell Number	Driver Name	Driver CNIC	Update	Delete
20	Ali Hassan	4294967295	Student	CS	edddf	2147483647	Areeba	0	Delete	Update
26	kapoor	34985098	Isajkdf	Ifajks	vnliw@lkj	39840		0	Delete	Update
28	Ali	9191919	Faculty	SDP	ali@faculty.com	12398249		0	Delete	Update
41	Pathan	123476543	Student	CS	pathan@kplk.com	192823377		0	Delete	Update
44	Pathan	123476543	Student	CS	pathan@kplk.com	192823377		0	Delete	Update
46	Blaaaa	4294967295	Teacher	SDP	bla@teach.com	39284098		0	Delete	Update
47	Blaaaa	4294967295	Teacher	SDP	bla@teach.com	39284098		0	Delete	Update
48	Alizar	4294967295	Student	CND	ali@zar.com	293840398		0	Delete	Update
49	Khan	57892879	Student	CS	khan@usman.com	2147483647		0	Delete	Update
50	Khan	57892879	Student	CS	khan@usman.com	2147483647		0	Delete	Update
51	Khan	57892879	Student	CS	khan@usman.com	2147483647		0	Delete	Update
52	Khan	57892879	Student	CS	khan@usman.com	2147483647		0	Delete	Update
53	Gulaab Jaman	4294967295	Mithai	Desert	gulu@mithai.com	29283744	Akhlaque Safdar	2147483647	Delete	Update

Fig: View page showing details of vehicles and their owners

ANALYSIS PAGE

The analysis of the data is shown on a separate *Analysis* page. This page contains the information about the count of vehicles present in the university building, not in the building and the total number of vehicles registered. Information of vehicles present in the university premises at certain time and day is also shown on this page.

CLASSIFICATION RESULTS

As mentioned above the program has been developed used Computer visions and Image processing tools, precisely python libraries such as OpenCV, Numpy, and Pandas have been used. These libraries provide very efficient and effective algorithms that make

image filtration and detection work quite handy. Various different tools have been deployed by other programmers around the world to work on Number plate recognition system. Some of the available projects have been using classifiers and machine learning to do the object detection and character recognition work. (Patel, Shah, & Patel, 2013) However, the program that we have developed is using OpenCV and its algorithms to find and process the image to make the detection of number plate detection easier. The procedure suggested above proved to be quite successful and have given us following accuracy when we tested the program after building it.

For the tests, around 80 images of cars were captured most of which were taken from entrance of a Habib University so that similar pictures could be taken that installed camera will be taken after deployment of this system. Most of the cars that appeared had number plates of Sindh province, however very minimal had Punjab and Islamabad's number plate. Moreover, for testing purpose we found images of cars outside Pakistan too so that we could get some idea how does the system work on Number plates that do not have number plate like Pakistan does.

Here are some of the results that we found after testing our program:

Table 1 Overall Results

Total	80	Percentage(%)
Fully Accurate	32	40
Partial	31	38.7
No accuracy	17	21.5

Table 2 Sindh's Number plates

Total	41	Percentage(%)
Fully Accurate	17	41.4
Partial	14	34.1
No accuracy	10	24.3

Table 3 Punjab's Number Plates

Total	7	Percentage(%)
Fully Accurate	0	0
Partial	7	100
No accuracy		0

Table 4 Islamabad's Number plate

Total	2	Percentage(%)
Fully Accurate	1	50
Partial	1	50
No accuracy	0	0

Table 5 Balochistan's Number Plate

Total	2	Percentage(%)
Fully Accurate	1	50
Partial	1	50
No accuracy	0	0

Table 6 Random Plates from Different Countries

Total	28	Percentage(%)
Fully Accurate	13	46.4
Partial	8	28.5
No accuracy	7	25

Analysis

After testing the program on a variety of cars' images captured at different times of the day, we found out the number plate recognition system works quite well. The systems tends to recognize number plates at low light too. This ensures that it will work at the night time as well provided the camera is of good quality. Moreover, the system provides fully accurate results on 40% of the images tested and partial accuracy on around 38% of the images. Here partial

detection means our number plate recognition program correctly extracts three to five characters out of six, the little inaccuracy comes because the OCR confuses 'P' with 'D' and 'O' with 'Q' etc. Moreover, seeing the tables above, number plate recognition system does not detect number plate at all. This occurs because of the fact the cars have number plates that are faded, or the number plates are bent, some are hidden, some number plate's sizes are very small to be properly detected.

Here is how our vehicle management system will work with the varying levels of accuracies. On 100% correct detection our system will grant access to the car, however in the case of partial accuracy we can modify our query (that checks whether specific number plate exists in the Database) to grant access if five characters out of six in the number plate match with the one saved in database. This means on partial accuracy our system will grant access to many of the cars.

Adding to it, to handle the cases where system is not able to detect the number plate of the car for the reasons like bent number plates, number plates with faded colors, number plates partially hidden, we have added a functionality of manually typing the number plate of car so that entry of people should not be hindered. The operator can use this option to manually type the number plate of the car in the search bar by seeing the number plate from the live video and press enter. The query in the backend of the search bar will check if particular record is registered in the system, if it does, the system adds the entry of the vehicle and it is given access inside the university.

Furthermore, another exception arises in the case of guests. To manage this, the web application allows to add a record for the guest too. It asks for the number plate only because details of department, name, color of vehicle and make might not be available in the case of guest. If guest arrives at the gate, system will work just like it does for other people and it will grant access if number plate matches with the one saved in database. Once the guest leaves university premises its record is deleted.

DISCUSSION

We tried to make *Habib University Vehicle Management System* on time. Because of the requirement of the course of time, we did not entertain a few functions that we were thinking of in the beginning. We adjusted our tasks according to the proposal and the time frame. We successfully completed what we proposed, but there are a few improvements that we will make before deploying it in the university.

- We are not using the real data for our project. Any data that you see in our report or demo are not real. We are using sample data in order to carry out our project. The real data can be used once we are done with other improvements and the university allows us to deploy our system. Using the real data in our project has nothing to add to the feature of project. The data are not for public use, so when using them there comes a great responsibility. Hence, for the sake of security of data, the actual data are not being used anywhere in our project.
- The second and most important improvement is the accuracy of license plate number recognition. The technique that we are using for our project gives 100% accuracy on around 40%-60% of the number plate images (for more details see the previous section). We aim to increase the accuracy by 75%-80% in future. For now, we are focusing more on the overall system rather than just the accuracy itself, that's why the accuracy for our project is what it is mentioned in the earlier section.
- The image detection strategy we are using is quite effective and is recognizing a good number of plates. This technique mostly depends on the quality of the image which, of course, depends on the camera that we are using. As we are not focusing on hardware techniques, that's why we have not considered on working on the quality issue for our project. In future we are planning to work on this improvement. We will come up with an optimal camera solution. This will help the system to successfully detect vehicles coming to university at night.
- The license plate detecting technique considers the plate number as a horizontal text. Some of Pakistani license plates are not just horizontal; vehicles from province Punjab

contain license plates with two-line license number. This project works very well in the plates where text is just one horizontal line, however it also works on Punjab's number plates but it further needs more improvement.

Besides these improvements, we will be applying more analytical feature to our user interface (website) in order to provide better user experience. Features like history of vehicles registered in certain range of time (probably 5 years or more) and guest vehicles entered in the university premises during certain range will be added to the web page. We have not considered adding these advance features keeping in mind the scope of our project. We will surely work on these improvements once we are allowed to take our project to next level.

Conclusion

The number plates recognition system is a kind of project that most of the organizations need because it adds more security to the system and it allows for the smooth running of system. The system can completely replace manually system which issues stickers to the registered vehicles and data is managed on hard copy registers. The Vehicle management system has been made with latest computer vision tools and further web tools are deployed to provide an interface that is simple and easy to operate so that any person with basic knowledge of computer can use it. There has been many challenges in the building of the project because number plates in Pakistan vary from province to province so making a generalized system is quite a tough task. However, this vehicle management system has tried to solve most the problems an organization faces in their access control system. Moreover, this project or system doesn't consume enough memory because it runs a python script in the backend and uses a simple website built using php, HTML, Javascript, CSS and MySQL. An standard computer system used in offices and universities could be used to run the program. The vehicle management system has been made looking at the need of University. In order to deploy this system to any other organization, we just need to make changes to the database because every

organization has a different structure and has a different database. Lastly, if some changes are made this system would be just perfect and it can be deployed to solve bigger problems such as Motorway tolling system, city's surveillance system to capture stolen cars and access systems of organizations.

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