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A new approach for a mobile device-based vehicle crime reporting and investigating system

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Abstract---Technology has become an important part of our day to day lives. Recent statistics indicate an upward trend in the number of users of Smartphones and the Internet, with the number of active mobile internet users in India alone reaching around 572.2 million. By aligning a solution with the present-day trend, users will not only be able to adopt it faster and easier than before, but also experience it in a familiar and straightforward framework. Through this application, we hope to make handheld devices a means for reporting and investigating vehicle crimes as much as possible without compromising the efficiency, accessibility, or privacy of its users. In addition to improving current record-keeping systems, the use of such digital resources also assists in developing better audit and monitoring systems. This system is also intended to alleviate people's anxieties about long, tedious processes of crime reporting and investigation, as well as provide the authorities with that sensitive data securely and expeditiously. In India, the crime rate rose from 172.3 in 2001 to 314.3 in 2020, with a charge sheet rate of 75.8,

implementation of such systems will help to elevate our citizens and lower these figures.

Keywords---Vehicle Crime, Artificial Intelligence, Optical Character Recognition.

1. Introduction

Reporting a Crime has always been a manual, taxing, and tedious task taking hours & effort which consequently unease people and thus makes them reluctant to make a report. Moreover, due to formalities involved in any investigation such as constant visits to the police station for verification, risks involving fear of being identified, or of social pressure, corruption, etc. consequently lead to some crimes not being reported. Besides if we were to also take into account the trajectory of an investigation which is generally manual thus leading to the pressure of maintaining and occasionally auditing the records and procedure of requesting access to information regarding the parties involved may affect the pace of the investigation.

With the recent advancement in technology and increasing use of hand-held devices, it enables us to reach anyone, anywhere, anytime over the Internet. There are numerous studies illustrating the elements that have an impact on the adoption of these devices [1] as well as the growing use of Internet technologies [2]. Technical professionals around the globe have already commenced integrating these technologies into their solutions with sectors dealing with crime now no longer be an exception [3]. If one were to take an approach of developing solutions utilizing such platforms it may help facilitate the process and make it easier and as much automated as possible with additional facilities such as advanced large-scale data visualization and data analysis techniques leading to considerably better insight [4]. Database systems also enable information to be stored for a longer period with easy accessing and manipulation facilities, while also being more reliable than physical data recording systems [4].

The Vehicle report and information systems in an attempt to make amendments to these existing procedures by providing a user-friendly experience without compromising security to make the reporting process effortless and seamless. The application works on android devices [5] which are estimated to have a market share of about 95.04% in India. In addition to that, the application is lightweight, with most functionalities utilizing the Internet in order to decrease the load on the user device. The framework between the 2 target segments provides easy information delivery and record-keeping along with automation in various sections aiming reduction in redundant data entries.

This application makes use of Google services in order to deal with complicated procedures such as fetching current location or navigation. With the integration of Computer vision and Optical character recognition, the application is able to extract the license plate of the reported vehicle and automatically fetch the vehicle records which are then attached to the final report enabling access to all relevant information for the authorities in charge of the case. Additional functionalities like

automated records for active and handled cases of all the police stations open room for data analytics to be implemented in the future [6].

2. Literature review

Crime in India 2020 statistics volume 1 [7] discusses many of the myriad complex factors in the manifestation of crime. Many social processes and structures, emerging opportunities, and the enlarging desires, which with the interplay of social, economic, demographic, local, and institutional factors from which the genesis of crime can be traced. The 'rise in crime' and 'increase in registration of crime by police' are 2 different things. But the rise or fall in crime numbers, however, does call for a professional investigation of underlying factors jointly with local communities to suitably address the issues involved.

Smartphones have made a major impact on business, education, health, human psychology, and social life in both positive as well as negative senses [8]. It has completely changed the way technology was seen before. Due to its omnipresent nature and social acceptance, we are able to realize use of smartphones in Institutes, hospitals, public places, malls, etc. Various Smartphone features such as converting text to speech, Navigation are examples, which can help people to easily communicate their needs, seek assistance from others, and remain connected to society [9]. Furthermore, features such as access to social websites, camera, video capture, and the ability to be connected to the internet enable individuals to capture and share videos at any time over the Internet.

In Kenya, the adoption of mobile technology in crime prevention has not considerably grown in distinction with the other portion of the world. As the records are usually kept and maintained within the police Occurrence book resulting in the creation of a significant hurdle when a need to analyze crime trends and rates of reported crimes arises. A study [10] was conducted to create a community-centric crime report application to report crime and receive or query information, more focused on giving citizens access to information and facilitating the reporting process.

Other than that, in some studies like the one in Indonesia [11], the Integration of location-based functionalities was observed in the developed applications where the location of the crime was obtained from the reports. Enabling the authorities to provide aid to the victim or reach the site as soon as possible. They made use of GPS and conjointly demonstrated the usage of a single environment with different levels of access to citizens and authorities. Tending to increase the response rate to report while lowering response time as much as possible.

Crime Report App discussed in [12] provides a framework to automate the existing manual system with help of electronic resources, and to provide storage of data/information to be stored for an extended duration with clean accessing & manipulation. Even though the application [12] doesn't involve the use of technologies such as AI like ours or Big data. It aims to aid the system in order to provide the power to report all kinds of criminal offenses and lead to error free, secure, reliable, and fast management system.

According to [13] and [14] the utilization of computer vision and OCR technology in sectors connected to investigation can significantly make substantial changes within the existing investigation system. CV-enhanced camera networks [14] can automate video analysis in real-time, while quickly dealing queries, and providing precise outline of archived video files. The [13] discusses a proposed solution over the use of OCR in the E-challan system to extract the vehicle plate of numerous fonts, especially in India. In many parts of India like Pune city and Mumbai, the police have completely automated traffic enforcement with the help of such automated systems. The relation at the back of this facility is to reduce the load of on-site police and help us go paperless.

As per the journal [15] Corporations are applying AI to avert and ascertain everything from routine employee theft to insider trading. Given the wealth of records available and the growing expectancies of clients and public government in relation to protecting and handling that information, many corporations have determined that AI is one of the approaches to coping with the increasing number of advanced criminals. AI-powered solution developed as crime-fighting tools could become essential for large enterprises, partially due to the absence of any such other technology to rapidly detect and interpret patterns across billions of pieces of data.

The paper makes use of the mobile application technology and its mechanism dynamics along with the use of prominent Computer vision as well as Optical character recognition concepts in order to make the process of reporting as seamless as possible. Moreover, in the process of doing so, it also tries to enhance the existing record-keeping system and provide room for better integration with other technologies.

The implications of Artificial intelligence and analytical techniques on crime other applications of big data such as deriving insights from road accident data, or time-series data will assist in analysis, extraction, and understanding of associated patterns and trends, ultimately aiding in crime prevention and management [6]. A study for effective visualization and trends forecasting of crime data made use of prophet, LSTM, and Keras neural network model and tried to show promising outcomes that will benefit police departments and law enforcement organizations to better understand crime issues and provide insights that will enable them to track activities, predict the likelihood of incidents, effectively deploy resources and optimize the decision-making process [16].

3. Methodology

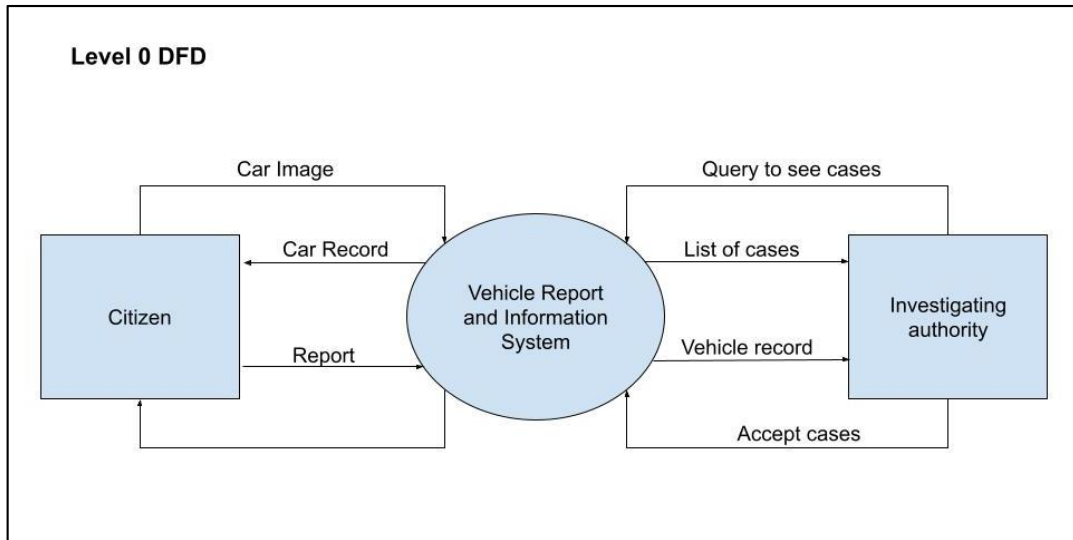


Figure 1. Data Flow Diagram

In accordance with the data flow illustrated by Fig 1, both the expected users will have different sets of data that will be required by and from them while using the application. As for making the report the necessary components include the image of vehicle in question, the information required for authentication of the informant, etc. On the other hand, a citizen should only be able to access basic vehicle information thus resulting in different output data in comparison to investigators.

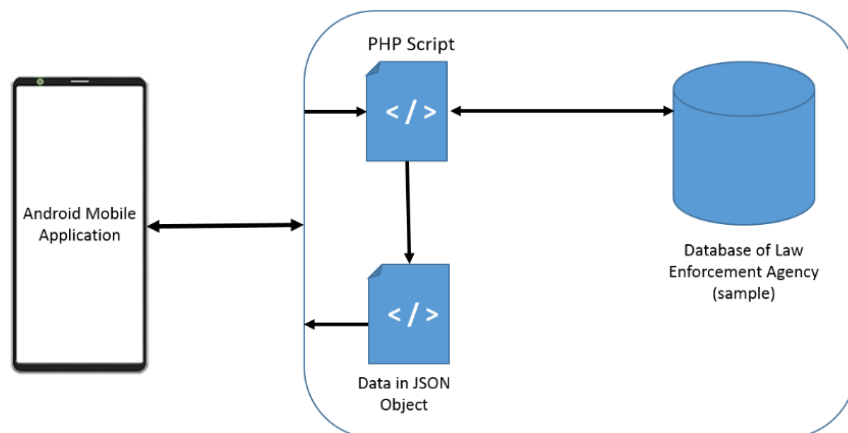


Figure 2. Working overview

The rough workflow can be seen in Fig 2, a Portable device with Internet connectivity will be used the means for communication with the server consisting of PHP and TensorFlow scripts. These scripts are responsible for executing all the necessary functionalities including communication with the database and provide feedback in the form of JSON objects to the user.

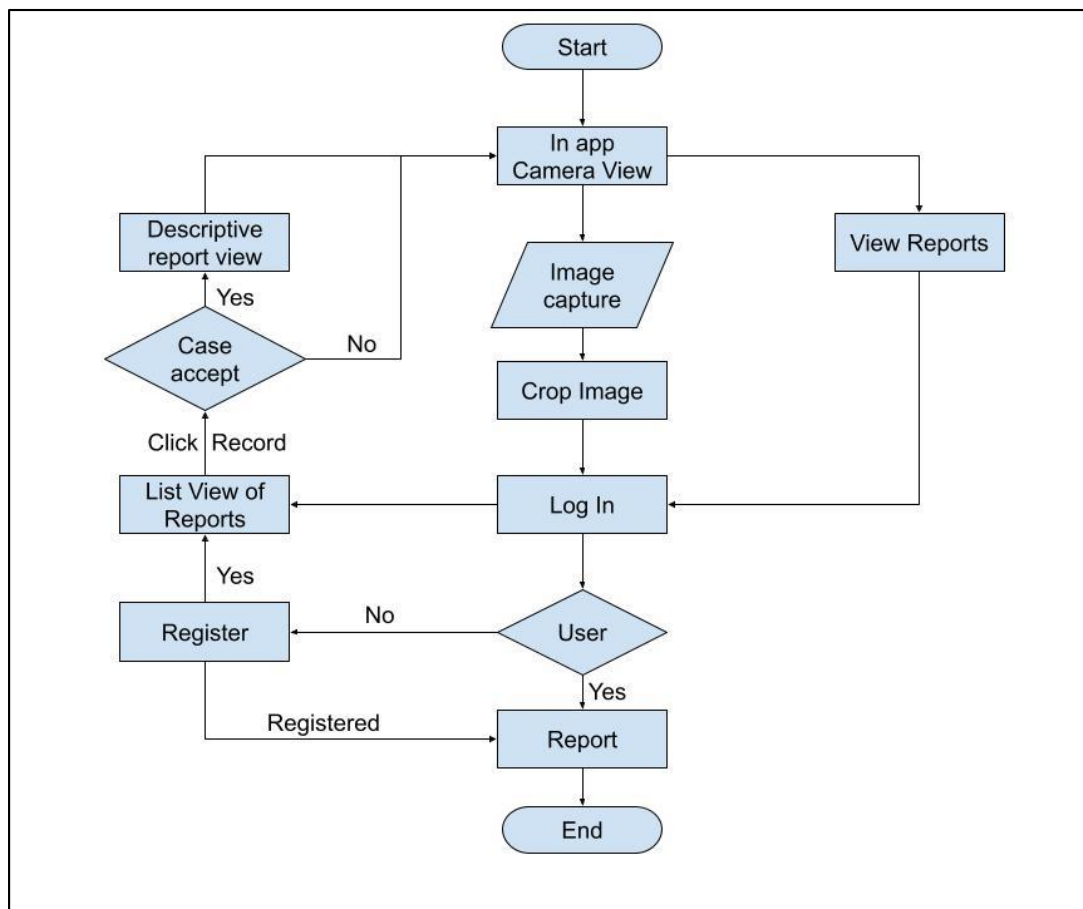


Figure 3. Flow Diagram

The detailed workflow diagram Fig 3 illustrates the working of the application on the portable device of the user.

A. Working

This application targets two segments, the public and the investigation committee, which is achieved by providing two distinct sets of functions with some resemblance to each other. This is done to prevent either segment from misusing the application. The working of this application can be fractionated into modules or interfaces.

1. Camera interface: - for the user to take the photo of the vehicle in question, and consequently prompts them to edit the image (only need to crop the image and rotate it according to instructions provided) and perform license plate extraction using the app.
2. Login/Register: - User needs to register/login into the application to make/view reports and enter information vital for verification.
3. Report interface: - provides an option to select the class of report needed and register the report in the nearest station using informant's current location. For the sake of authenticity of the report and further communication user

information such as location at the time of the report, Aadhar number, email id is required and absence of which prompts the user to enter those details without losing any progress.

4. Viewing reports: - the person in charge of the report can view the contents after accepting the case from within the application through a series of easy steps else only abstract information is available. Also, in case of assignment of the case to another person, their unique ID number will be displayed and will stop others from accepting or viewing the thorough details of the report. The application allows the in charge to put up the progress and conclusion of the report.

Furthermore, the database maintains the record such as:

- All the users for authentication purposes
- Information relating to reporting such as location, informant, etc.
- Vehicle information such as owner, dealer, and product description to provide the complete picture of the case and related parties to the officer,
- Case progress record such as the in-charge, progress status for audit purposes
- Moreover, the application also keeps track of active and handled cases of each police station.

B. Optical character recognition

The application contains an additional function for automating the process of reporting to some extent. This functionality makes use of computer vision and optical character recognition. The idea is to pass the image of the vehicle in question to the model of the application and obtain the license plate in text format. This is done to increase the accuracy of the report as human error can be dealt with using image processing and OCR. The crop activity provided in the application contains instructions for the user to make the input image as close as possible to the ideal input of the model. After text extraction, the application prompts the user to recheck the value in order to confirm the output of the model. This plate number is then sent to the database for reporting purposes.

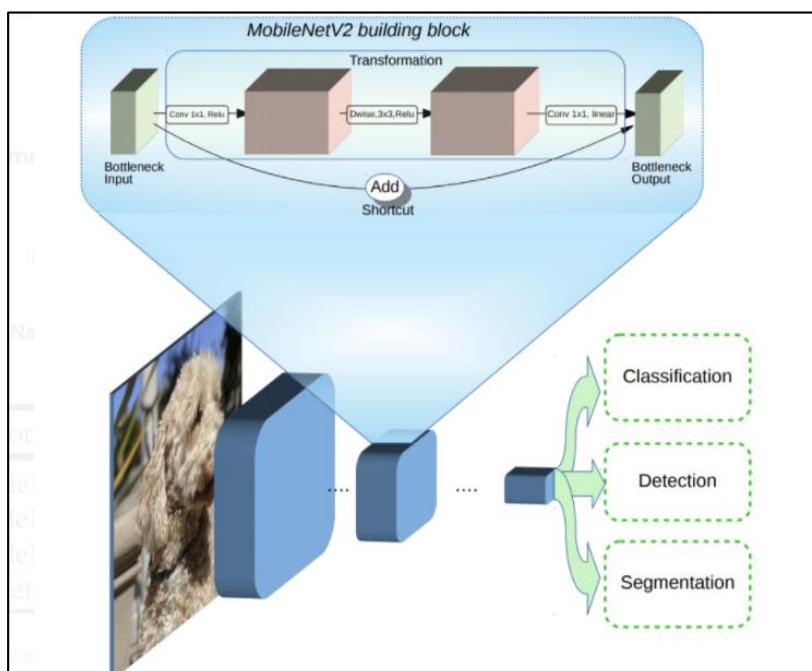


Fig 4 Architectural overview of MobileNetV2 used for license plate detection
(From <https://ai.googleblog.com/2018/04/mobilenetv2-next-generation-of-on.html>)

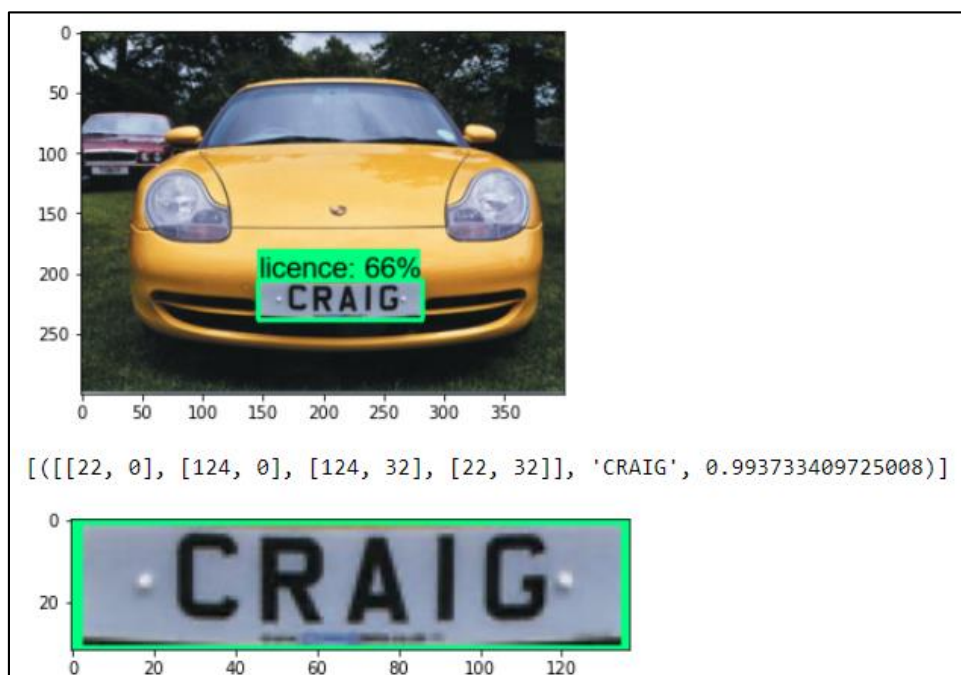


Fig 5 License plate detection, Segmentation, and OCR

An image is taken as an input from the source into an image processing function to scale the input as per the requirements of the MobileNetV2 model. This results in a processed image which is then passed through the model to detect the license plate and withinside the subsequent step we segment out the identified license plate which is further processed by an OCR library in order to extract the number.

4. Advantages

By employing a User-friendly interface with a wide range of automation, this application tends to provide seamless access to information independent of geographical constraints. The data collection module of the profile section makes the evaluation of the creditability of the report quite straightforward. Usage of a centralized working environment enables users to utilize the same system for accessing the needed functionalities. Availing the Computer Vision and OCR technology, here is an attempt to eliminate human error.

In contrast with the studies [10] [11] [12] This paper attempts to incorporate a wider range of functionalities dealing with the issues of the previous studies by:

- Providing a deeper degree of information access to the investigation authorities,
- Better documentation mechanism that keeps track of the standing of investigation alongside data concerning the investigator, informant in addition to the vehicle in question, this attempts to ease the analysis of the crime rates and trends.
- Reliable location-based functionalities by making use of google services to access GPS information along with navigation.
- Moreover, the capability to report using the camera can lead to a significant reduction withinside the number of false reports. As the images associated with the crime site are accessible to the investigator, enabling them to verify the image for the credibility of the report.

5. Result

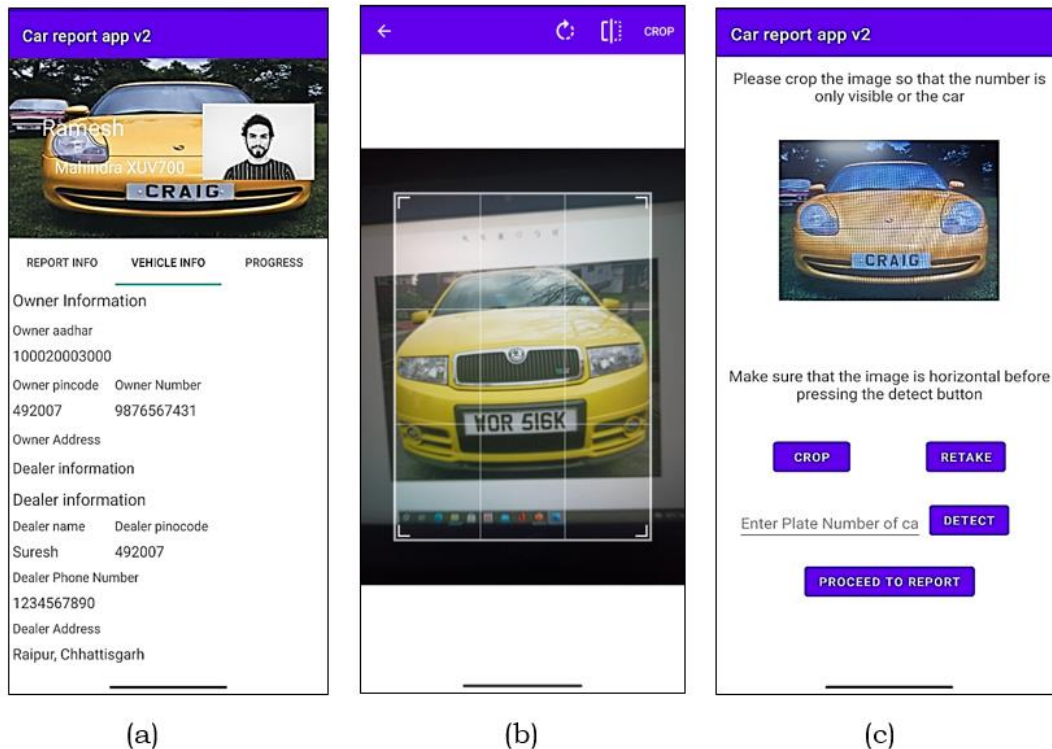


Fig 6 (a) Report View (b) Image crop activity (c) Edit image and OCR

Figure 6(a) and (c) illustrate the User interface within the application. In Figure 6(a) the Authorities can read all the required information concerning the case such as the Owner's and dealer's information, vehicle information and may conjointly update the status of the report.

The purpose of the activity illustrated in figure 6(b) is to provide manual editing services to the user, this is so that the user can ensure that the captured image contains only the vehicle in question rather than other background cars as presence of these can lead to undesired outcomes.

While Figure 6(c) illustrates the activity enabling the user to edit the image according to the instructions and perform OCR to extract the license plate of the vehicle. From here after a confirmation prompt to verify the detected plate number, the user will be navigated to the report activity for finalizing and submitting the report.

Figure 7 shows the database snapshot which expeditiously and effectively stores all relevant details of the application using the SQL relational database consisting of tables to store user information, case details, the status of the investigation, information regarding police station and investigators, as well as details related to vehicles.

Table	Action	Rows	Type	Collation	Size	Overhead
☐ handle_cases	★ Browse Structure Search Insert Empty Drop	3	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐ imageupload	★ Browse Structure Search Insert Empty Drop	0	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐ login_admin	★ Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐ login_user	★ Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐ police_info	★ Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐ reports_user	★ Browse Structure Search Insert Empty Drop	6	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐ station_info	★ Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_general_ci	16.0 KiB	-
☐ user_info	★ Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_general_ci	32.0 KiB	-
☐ vehicle_info	★ Browse Structure Search Insert Empty Drop	4	InnoDB	utf8mb4_general_ci	16.0 KiB	-
9 tables	Sum	23	InnoDB	utf8mb4_general_ci	160.0 KiB	0 B

Figure 7. Database tables

6. Conclusion

The application vehicle report and information system can be of great help to the current system of the criminal investigation concerning the vehicles and make it easier and more seamless for people to file reports while keeping the exposure of sensitive information as restricted as possible and only to the relevant parties, and without implicating much load on the host device using the application. Some in addition upgrades which may be brought on the way to enhance the reliability, efficiency as well as accessibility are indexed below:

- Integration of a more advanced AI model can enable better accuracy for license plate extraction even for extremely uncertain images like SRGAN model.
- Data analysis and visualization strategies can be enacted on data stored to advantage higher insights.
- Better encryption mechanisms can be introduced withinside the application.
- Verification via E-mail and SMS for authentication of the user, and access to Digi-locker for corroboration of documents.
- In-App navigation system can be implemented for better accessibility.

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