GENERATION OF CHALLAN ON VIOLATION OF TRAFFIC RULES USING MACHINE LEARNING

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Abstract

Nowadays, people violating traffic rules has become a major issue and the carefree and irresponsible attitude of people is damaging the moral fibre of the society. The traffic regulations in our country have improved leaps and bounds in the last few years but still the human interference aspect in our current system is a liability and leads to mediocre results which could have been much better. This in turns leads to late and sometimes inaccurate delivery of E-challans and papers based challans which in turn encourages such irresponsible drivers .Our proposed uses object detection, machine learning , object tracking and number plate detection techniques to automate the process of picking out traffic offenders (using object detection and object tracking) and generating the E-challans by directly fetching the vehicle information from the RTO after extracting the number plate data (number plate detection) and deliver the E-challan via Email and SMS on the same day the offence is registered .This will significantly increase the efficiency and accuracy of the system and eliminate the possibility of any human error as there is in the current system

1.0 Problem Statement

In contemporary society, the rampant violation of traffic rules poses a significant threat, fostering a culture of irresponsibility and undermining societal values. Despite notable advancements in traffic regulations, the current system's dependence on human intervention results in suboptimal outcomes, characterized by delayed and sometimes inaccurate issuance of e-challans and paper-based challans. This inefficiency inadvertently emboldens reckless drivers, exacerbating the issue.

Our proposed solution aims to address these challenges by leveraging advanced technologies such as object detection, machine learning, object tracking, and number plate detection. By automating the identification of traffic offenders through sophisticated object detection and tracking techniques, and generating e-challans via real-time number plate detection, we aim to enhance the precision and promptness of traffic violation enforcement. The system will directly retrieve vehicle information from the RTO and deliver e-challans via email and SMS on the day of the offence, thereby eliminating human error and significantly improving the efficiency and accuracy of the current traffic management system.

2.0 Customer Needs Assessment

2.01 First Step:

The first step involves identifying all potential stakeholders who would interact with or be affected by the automated traffic enforcement system. This includes:

- **Traffic Authorities and Law Enforcement Agencies**: Need for a more efficient, accurate system that reduces manual effort.
- **Drivers and Vehicle Owners**: Concerned about fair and timely issuance of challans.
- **Municipal Authorities**: Interested in overall traffic management and safety.
- **Insurance Companies**: Potential to use data for risk assessment.
- **Public Safety Advocates**: Focus on reducing traffic violations and accidents.

2.02 Second Step:

Once the customers are identified, the next step is to develop structured guides to facilitate interviews and observations. This includes:

- **Interview Guides**: Question sets tailored to each stakeholder group.
    - For traffic authorities: "What challenges do you face with the current challan system?"
    - For drivers: "What are your experiences with receiving challans, and what improvements do you suggest?"
    - For municipal authorities: "How do traffic violations impact urban management and safety?"
- **Observation Guides**: Checklists to observe current processes.
    - Monitoring the issuance of challans.
    - Observing interactions between traffic officers and violators.
    - Analysing time taken for challan processing and delivery.

2.03 Collecting Data:

In this phase, data is collected through interviews, surveys, and direct observations. The iterative nature of this step ensures that initial findings are validated and refined through multiple rounds.

- **Initial Interviews**: Gather broad insights from each stakeholder group.
- **Surveys**: Distribute to a wider audience for quantifiable data.
- **Follow-up Interviews**: Clarify and deepen understanding based on initial data.

Table 1: Analyzing Data and Converting to Customer Requirements

Stakeholder	Customer Requirement
Traffic Authorities	A system that reduces manual effort and errors.
Drivers	Fair, transparent, and timely challan issuance.
Municipal Authorities	Improved traffic management and reduced violations.
Insurance Companies	Access to driving behavior data for risk assessment.
Public Safety Advocates	Enhanced road safety and accountability.

Table 2: Prioritizing Customer Requirements

Requirements	Priority
Automated detection and tracking of violations	High
Real-time e-challan issuance	High
Integration with RTO for vehicle information	Medium
Timely notifications via email and SMS	High
Data security and privacy measures	High
Detailed reporting and analytics	Medium

3.0 Target Specifications and Characterization

3.1 Timely Challan Issuance

Specification: The system must issue challans within 24 hours of detecting a violation.
Performance Metric: Time from violation detection to challan issuance.
Target Value: Less than 24 hours.
Tolerance: ±2 hours.
Testing Method: Measure the time taken for a sample of 100 violations from detection to issuance of challans.
Data Collection: Logs of system processing times.

3.2 Accuracy in Challan Details

Specification: The system must achieve a minimum accuracy rate of 95% in recording violation details.
Performance Metric: Accuracy rate of recorded violation details.
Target Value: 95%.
Tolerance: ±3%.
Testing Method: Cross-check a sample of 100 issued challans against ground truth data.
Data Collection: Comparison of system data with manual records.

3.3 Real-time Monitoring

Specification: The system must monitor and process data in real-time, with a maximum delay of 5 seconds.
Performance Metric: Processing delay.
Target Value: Less than 5 seconds.
Tolerance: ±1 second.
Testing Method: Measure the delay from data capture to processing for a sample of 100 events.
Data Collection: Logs of data capture and processing times.

3.4 Automated Data Entry

Specification: The system must correctly recognize and enter license plate details with an accuracy of 98%.
Performance Metric: Accuracy rate of license plate recognition.
Target Value: 98%.
Tolerance: ±2%.
Testing Method: Test the system on a sample of 1000 images and compare results with ground truth.
Data Collection: Logs of recognized license plates and manual verification.

- Integration with Existing Systems: The system must seamlessly integrate with existing RTO databases and traffic management systems.

- User-Friendly Interface: The system must provide an intuitive and user-friendly interface for both traffic authorities and citizens.

4.0 Business Model

4.1 Subscription-Based Model

Target Customers: Municipal traffic authorities, law enforcement agencies, and government bodies.

Offer subscription plans based on the number of vehicles monitored or the number of violations detected. This model ensures a steady revenue stream and allows customers to choose a plan that fits their needs.

4.2 Software as a Service (SaaS) Model:

- **Monthly Subscription Fees:** Government agencies pay a recurring monthly fee for access to the platform, including:
    - AI-powered image recognition software for violation detection.
    - Secure cloud-based data storage for violation details and challan records.
    - User management and reporting dashboards.
    - System maintenance and updates.

Transaction Fee:

- A small per-challan fee can be implemented alongside the SaaS model to incentivize efficient use of the system.

4.3 Cost Structure:

- **Development and Maintenance:** Costs associated with developing, maintaining, and upgrading the ML algorithms and software platform.
- **Sales and Marketing:** Costs to reach potential government clients and demonstrate the system's benefits.
- **Data Management:** Costs for secure cloud storage and data management infrastructure.
- **Customer Support:** Providing technical assistance and training to government users.

4.4 Marketing and Sales Strategy

1. Pilot Programs

- Launch pilot programs in selected cities to demonstrate the effectiveness of Smart Challan.
- Use pilot results to attract more customers and build case studies.

2. Partnerships

- Partner with government bodies, insurance companies, and fleet management firms to expand reach.
- Collaborate with smart city initiatives to integrate Smart Challan into broader urban management systems.

3. Awareness Campaigns

- Conduct awareness campaigns highlighting the benefits of automated traffic enforcement and safer driving practices.
- Utilize case studies, white papers, and webinars to educate potential customers.

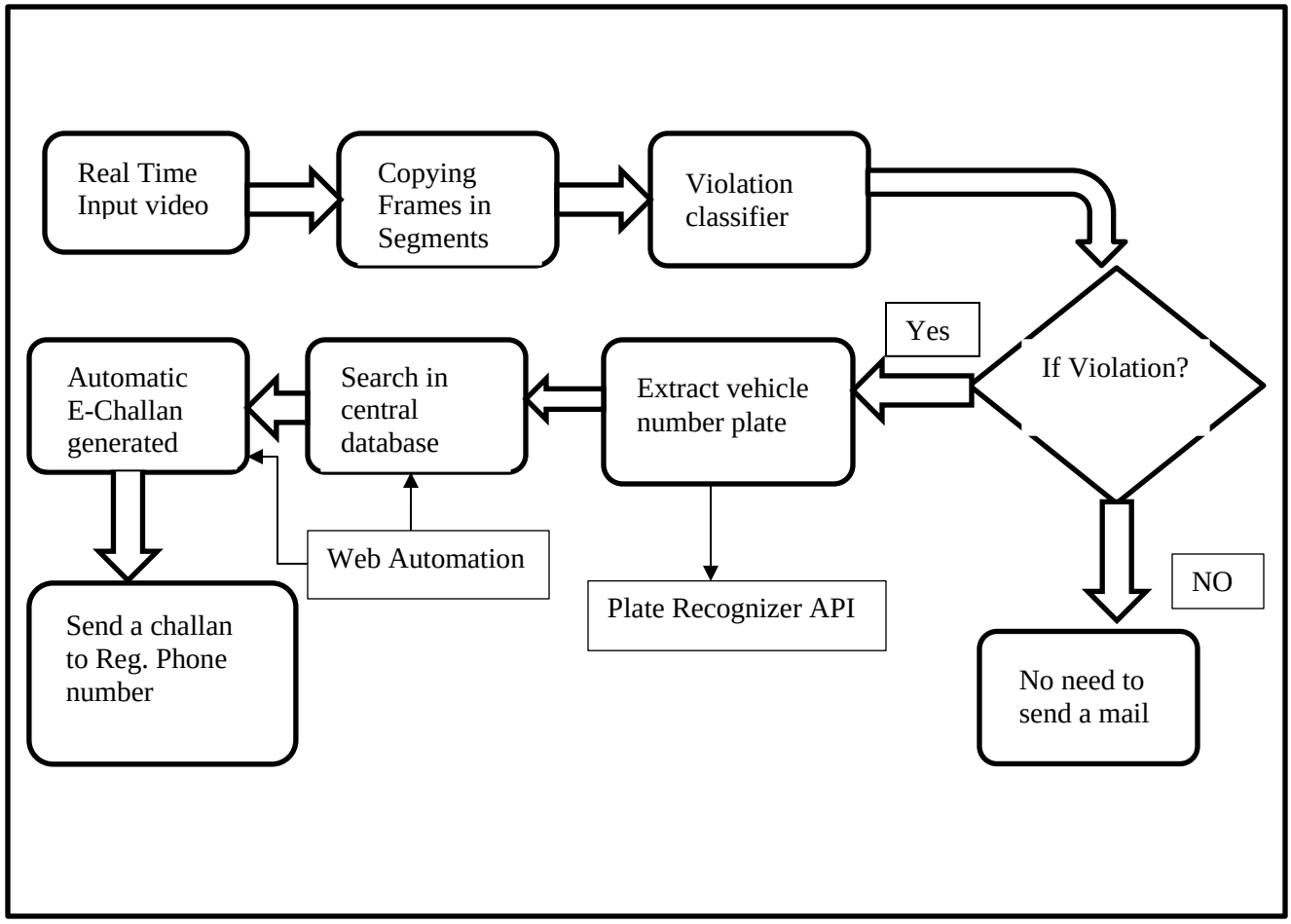
4. Direct Sales

- Employ a dedicated sales team to approach municipal traffic authorities, law enforcement agencies, and other target customers.
- Provide demonstrations and tailored proposals to showcase the value of SmartChallan.

5. Digital Marketing

- Use online platforms, social media, and targeted ads to reach a broader audience.
- Maintain an informative and user-friendly website to attract and engage potential customers.

5.0 Final Project Prototype



6.0 Project Details

6.1 How does it work?

We will begin with the basic flow of the system and then we will discuss individual modules in detail.

Basic Flow To begin with, the proposed system works on both live video feed, recorded footage and static images. Whenever any of the street cameras catch any vehicle breaking any of the laws, the officers monitoring the feed in the monitoring centre draw a bounding box around around that vehicle and then that image is fed to our proprietary API which performs object detection, license plate detection, character segmentation, character recognition and finally returns the extracted license plate number in the GUI of our system along with a magnified image of the license plate. If in any case the system returns a license plate with any errors/mistakes in character recognition, then the officers can correct that with the help of the magnified image. Once we have the license plate number, the system fetches the information about that vehicle by mapping it with the RTO Database (Our local database

in the prototype). And with that information we generate an electronic challan which is sent to the offender on the same day via email. Thus, you can clearly see how we are proposing to the fastrack a process which is very tedious at the moment.

Individual Module:

1) License Plate Detection (YOLOv3)

You Only Look Once or more popularly known as YOLO is one of the fastest real-time object detection algorithm (45 frames per seconds) as compared to R-CNN family (R-CNN, Fast R-CNN, Faster R-CNN, etc.) The R-CNN family of algorithms uses regions to localise the objects in images which means the model is applied to multiple regions and high scoring regions of the image are considered as object detected. But YOLO follows a completely different approach. Instead of selecting some regions, it applies a neural network to the entire image to predict bounding boxes and their probabilities. In our system, we feed the screenshot of the vehicle to our API which runs the object detection model in the background and then the model detects the license plate and draws a bounding box around those plates and returns the coordinates of the bounding box. YOLOv3 offered us a good balance between speed and accuracy without the use of any GPU.YOLO v3 performs at par with other state of art detectors like RetinaNet, while being considerably faster, at COCO mAP 50 benchmark. It is also better than SSD and it's variants.

2) Character Segmentation (YOLOv3)

Once the license plate is localized, then the system further performs character segmentation on the license plate. Character segmentation is an operation that seeks to decompose an image of a sequence of characters into subimages of individual symbols. It is one of the decision processes in a system for optical character recognition (OCR). Its decision, that a pattern isolated from the image is that of a character (or some other identifiable unit), can be right or wrong. It is wrong sufficiently often to make a major contribution to the error rate of the system. Character Segmentation finally returns an image in which there is a bounding box around individual character. We have again used YOLOv3 for the segmentation process because it offered better accuracy over the other models that we tested.

3) Character Recognition (ResNet50 + ResNet50V2 +DenseNet169)

Finally Character Recognition also known as Optical Character Recognition recognizes the characters on the segmented license plate. In our system the recognized characters are returned as a json object which are then displayed in the GUI of our system along with other details. We have here used an ensembled model that combines three individual models to improve the overall accuracy and performance of the system. Once the system gets the characters of the license plate, it can be then used to generate the electronic challan by cross referencing the license plate with the RTO Database (our database in the prototype) and getting the information about the owner of the vehicles.

7.0 Conclusion

Smart Challan represents a significant step forward in modernizing traffic enforcement. By leveraging the power of AI and machine learning, the system not only improves the efficiency and accuracy of traffic management but also contributes to a safer and more disciplined driving environment. The successful implementation of Smart Challan can serve as a model for other cities and countries aiming to enhance their traffic enforcement capabilities and reduce the societal impact of traffic violations.