

Report on

**Facial Recognition System at Toll Posts
of NHAI**

**Prepared by: Sub Group on Technology and
Infrastructure**

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Facial Recognition System at Toll Posts of NHAI

Background

BPR&D was mandated by the Border Management Division, MHA, to study and prepare a report on installation of Face Recognition System on toll booths of the National Highways Authority of India (NHAI) which would be helpful in nabbing the suspects.

(Ref Point no. xi vide CIS Division (MHA) ID No. 22003/19/2018-CIS-II of Dec 30, 2019) - Appendix 'A'

Need and Scope

2. Shri Ashok Kumar, Director, MHA, clarified that the purpose of the discussions was to look into the proposal for installing a Face Recognition Capability on the toll booths of NHAI, to detect suspects, and help the Law Enforcement Agencies in the country.

2.1 With clarity over the concept and scope as underlined above, it was realized that international experience with such systems is not encouraging. The high failure rate associated with the current technologies in respect of Facial Recognition is the major concern to be resolved, all over the world. Vendors in the market are selling technology and equipment with limited capabilities. The technology is still emerging in the domain of Facial Recognition and is not yet fool proof.

3. It was informed that the existing facilities at the toll booths of the NHAI do not cater to Facial Recognition needs. The scope should thus cover the feasibility of the proposed capability.

Understanding the Technological Challenge

4. The conferences organized by the BPR&D on January 22, 2020, and February 10, 2020, helped in knowing the emerging concept of National Integrated Facial Network System, sharing central data base for various stakeholders, including state and central LEAs, BPR&D, NCRB, Finger Print Bureau, National Highway Authority of India, Central and State Public Works Departments, State and District Roads & Transportation Departments, RTOs, Insurance Companies, etc.

5. It helped in flagging the current technologies in Automatic Vehicle Number Plate Reading (ANPR) & Recording Systems integrated with the Facial Recognition systems, for effective law enforcement and improved compliance.

6. It was pointed out that Facial Recognition technology is used generally in two different ways for law enforcement: firstly, for identifying, where a person's face is matched to the digital image in a document, secondly, for discovering a suspect from a gallery of images in a database. In the first case it is 'one-to-one' analysis, whereas second method is 'one-to-many' analysis, where a still image or a surveillance video can be a reference for matching and analysis. The accuracy of analysis is crucial considering the privacy issues. Since a match provided by the system is the best option for the LEAs, it needs a confirmation of the identity of the suspect. Thus, 100 percent accuracy is the need. Technology, although improving continuously, has not reached that stage yet.

6.1 It was resolved to get an update on the existing practices, if any, on the functioning of toll booths and derive meaningful lessons. **Project Tollscape** – an online platform for traffic regulation is discussed in succeeding paras.

7. Shri Rohit Natahan, SP, Shivgangai, Tamil Nadu, made a presentation on **Tollscape**, an online platform developed by the Shivgangai district Police for the purpose of collecting information related to vehicular movement at the NHAI toll booths for the purpose of prevention and detection of crime.

8. **Tollscape** is a functional project, feeding on live data via File Transfer Protocol (FTP) from seven NHAI toll booths in Sivganagai. Tollscape is fed by the databases of RTOs, NHAI and the Police. The data so generated is compared and notified via the Tollscape dashboard, through SMS, Whatsapp or E-Beat mobile applications. Tollscape is capable of searching vehicles passing the NHAI toll posts based on various criteria including - Time specific searches, Toll Specific Searches, Direction Specific Searches, Vehicle Type Based Searches (Car, LMV, Bus, Truck

etc) and also specific vehicle searches with a pop-up alarm. The advantages accrued from Tollscope in policing functions include tracking of suspect vehicles, stolen or lost vehicles, escaping criminals, tracking of smuggling routes, law and order issues, traffic management, and crowd control applications. It additionally helps in better incidence response also. In the second phase, the Tollscope would have an auto challan capability which would ensure traffic law enforcement as well as revenue earning. The future growth of Tollscope would depend upon resolution of challenges like capacity issues needing bigger platforms and challenges on technical as well as financial front.

9. It was, however, observed that Tollscope is not a Facial Recognition platform. It just helps in traffic regulation. It suffers from other limitations, too. Tollscope, however, validates that 'strengthening the investigation' can also be an important objective of the project envisaged.

10. To get a first hand update, a session on available technologies was organized in which three vendors familiarized the participants with the interplay of optics, data analytics, machine learning and communication platforms. The capabilities of the technologies demonstrated although in use, were less than satisfactory. They suffered on account of reliability, accuracy and speed in unconstrained conditions.

Initial Observations and feed back

11. From the discussions and demonstrations it emerged:

11.1 That technology available in the market is impressive in *controlled conditions* like offices, airports, etc., but yet to mature, before it can be relied upon for national level projects in ever-changing dynamic conditions with multiple variables.

11.2 That the choice of technology tools should undergo testing criteria and their capability must be proven.

11.3 Experiments of Gurugram and Delhi Police point out reservations on the effectiveness of the Face Recognition System at toll posts. The systems

experimented with, worked well in controlled situations like the Airport and Metro Stations, but the experience of Gurgram Police at Gurugram-Delhi toll booths was not encouraging. There were serious limitations observed with the technology available.

11.4 Delhi Traffic Police experience revealed that real time results require very robust servers. Tests conducted at the New Delhi Railway Station generated false alarms and the pop ups by the system were not manageable.

11.5 Issues of image analysis, data analysis, propagation delay, data banks, hosting and security of systems need due resolution. Security of the database is a big concern, before any vendor can be selected.

Formation of the Working Group

12. Working groups were formed on Technology and Infrastructure with the following members:

Group on Technology

Convener- Shri Prashun Gupta, Dy. Director(C-II), NCRB

- a. Prof Mayank Vatsa, IIT, Jodhpur
- b. Prof Richa Singh, IIT, Jodhpur
- c. Rahool Alwal, IPS, SSP, Puduchhery
- d. Shri Rohith Nathan, IPS, SP, Shivgangai, Tamil Nadu

Group on Infrastructure

Convener – Shri Rohith Nathan, IPS, SP, Shivgangai, Tamil Nadu

- a. Sh. Akhilesh Kumar Srivastava, CGM (T) NHAI
- b. Rahool Alwal, IPS, SSP, Puduchhery
- c. Ms. Priyanka Tomar, Solution Architect, BPR&D

13. A background on the qualifications and experience of the experts involved in the preparation of the report is given here under.

Dr Prasun Gupta, Deputy Director, in the NCRB has been involved in shaping the *RFP and the standards for Face Recognition System*. He has intimate knowledge of the systems requirements in the domain.

Dr Richa is a Professor at the IIT, Jodhpur, Associate EIC, Pattern Recognition Vice President - Publications, IEEE Biometrics Council and an Adjunct Faculty, WVU, USA and IIT, Delhi, India. Face Recognition is her area of interest. She is also the **General Co-Chair of FG 2021** (highly regarded conference in Face and Gesture Recognition) of which she is the co-organizer, in India, for 2021.

Dr Mayank Vatsa, PhD, is Professor and **Swarnajayanti Fellow**, Department of Computer Science and Engineering, IIT Jodhpur, India, and Adjunct Faculty, WVU, USA. Face Recognition is his area of interest.

Both Dr. Richa and Dr. Mayank were involved in designing standards for face recognition for **UIDAI** and **e-gov applications**.

Shri Akhilesh Srivastava, CGM (T), NHAI, assisted as domain expert.

Shri Rohit, SP, Shivagangai, Tamil Nadu, has developed and operationalized a Toll Both Traffic Management System in Tamil Nadu on the NHAI toll booths. The project is operational.

Shri Rahul Alwal, SP, an IIT Mumbai alumnus in Computer Science, was associated to relate his policing background for the systems need assessment.

Ms Priyanka is a Cyber Solution Architect, at the Modernization Division at the BPR&D Hqrs.

Deliberations

14. The Conference and Sub Group meetings considered the existing infrastructure with the NHAI on 559 toll booths across the country, the capabilities of the vendors in the market, experience of the Delhi Traffic Police and the Gurugram Police on the toll booths at Delhi-Gurugram and Delhi-Noida highways and the feedback from similar experiments conducted at the New Delhi Railway Station.

15. The discussions resulted in finalization of the intervention areas, viz., Identification of suitable and available technology and vendors for the Facial Recognition Systems and Infrastructure need assessment for instituting systems at NHAI Toll posts. The Sub Groups on Technology and infrastructure were clubbed considering the synergy need.

16. The proceedings of the two Conferences and the Sub Group deliberations are attached as appendix to the report.

Findings

17. The findings from the deliberations conducted by the group are summarized below.

18. The issue of face recognition, capable of identification of suspects on toll booths, is a complex challenge, as it involves choosing a reliable technology satisfying various standards. Since the standards, have not yet been defined in India for law-enforcement or unconstrained applications, the challenge to set benchmarks is not easy. For the purpose of testing 1000 probe images (test cases), there is need for 1 million images in the database for reference and matching. Reliability of statistical evaluation improves with a bigger 'test sample' during the development phase. The lower 'test cases' are not favored, especially when there are too many testing parameters. Face identification becomes challenging when the parameters of plastic surgery, aged conditions of faces, face visuals with low resolution and cases of disguises and occlusions crop up.

19. No single face recognition system is capable of taking care of all of the challenges listed by the experts and authorities elsewhere. In the **challenge of face recognition for Disguised Faces in the Wild Competition** - with over 16000 images in 2018 and 2019 competitions, no one team could show consistent performance across all protocols. This suggests the need to define the working protocol in terms of face recognition under different conditions, size, etc., for the applications to evolve.

20. It is important to realize that for the success of such real-world projects, it is very important that specifications are carefully designed. We

need to define operating conditions of the sensors and environment, distance and angle between camera and objects, ambient lighting conditions, NIR vs Visible Spectrum, occlusion, rain and weather, etc.

21. The standards which the UIDAI uses would not be suitable for NHAI application because of the large stand-off distance. Without proper standards for Indian conditions, it will again be a mismatch between expectations and reality. Foreign vendors develop software using the data mostly pertaining to their demographics, e.g., race, skin color, etc., and its direct usage in the Indian context may not be advisable.

22. The experience supports the need to define the standards upfront which would govern the operating process of bio-metric systems for the given applications. These standards would also give clear guidelines to the vendors about the expectation attached with the system. Vendors who participated in the demonstrations during meetings at the BPR&D validate the shortcomings in the technology offered.

23. The NHAI infrastructure is robust for placement of cameras, if decided to be utilized. The current capabilities of the NHAI aim at traffic management and are short of Face Recognition requirements even though the AVNPR cameras placed at the toll booths have sensor activated AI capability. The integration possibilities for communication network and current infrastructure with the proposed installation of Face Recognition network needs assessment.

24. NHAI recently issued RFP for **Automatic Traffic Management System (ATMS)** for only one national highway (NH) as a pilot case, which is 230 kms long. But to achieve the actual results, ATMS needs to be put on the entire NH, which will be exorbitantly costly. Therefore, some other Big Data or AI based solution may also be considered. Placement of RF Systems in conjunction may require reassessment of systems integration.

25. Utilization of NHAI toll booths for any study purpose is feasible with proper approvals.

26. Although Face Recognition technologies have seen upgradations in

recent times, Face Recognition is still considered a research challenge for researchers worldwide. Such projects also provide opportunities to explore challenging problems like **false positives and false negatives**. Communication of a match for actionable pop up to the LEA is another functional area that remains a challenge. A testing criterion, that allows only quality visuals in data base, improves the outcome of identification. Similarly, proper lighting and engineering modification of the passages used by people to move in crowded places improves the quality of visuals captured. Such regulations, aided by technology, further improve the results manifold. This would reduce the rate of false positives and false negatives.

27. The capabilities of Indian technology companies may be explored to have a fair assessment of options to be taken as substantial work has been generated in the country in recent times. The group favors in-house development of technology in a mission mode.

28. Evidence based feedback may be relied upon to develop the technology in the best case scenario. A pilot project is, thus, the favored option. It would facilitate the decisions on technology standards and benchmarking needs. The pilot project may also cover non technological but crucial challenges like, lack of standardization of vehicles and limits on occupancy. It is, however, felt that mere technology may not be the final answer.

Suggestions

29. Adopting a model or approach from the western-world may not work in the Indian conditions.

30. It is suggested to, jointly, with the NHAI, conduct a pilot project on, at least, two locations to understand the operating and environmental conditions. Pilot data is expected to reveal unknown challenges involved in the problem. This will help setting the standards as well as give vendors a good idea about the problem statement, if market is to be explored.

31. The Pilot being conducted by the NHAI may suggest grounds for development of existing capabilities with the NHAI, as many sub-components of ATMS like Video Incident Detection System, Video

Surveillance System, Automatic Traffic Counter-cum-Classifier System, Variable Message Signs System, Mobile Communication System, Integrated ATMS Software and System Architecture with ATMS Control Center have the components that provide integration possibilities with Facial Recognition Systems.

32. The reports of ATMS, functioning on the Eastern Peripheral Expressway available with the NHAI may give relevance to further work.

33. Academics, Engineers and Industry together can be the 'start-up combination' to build up the in-house capability. In-house R&D is crucial to the step-by-step improvements as technological challenges are dynamic in nature, and need dedicated attention and solutions to any system of this nature.

34. A home grown technology will have support of institutional research. One time purchase of technology is not the favored solution.

35. Secure servers and effective web protocols, remote access including roles and responsibilities against data theft must be looked at.

36. Investigation of crime and regulation of traffic may benefit from such huge investment. Vehicle particulars like markings, signage, and stickers are important aspects of regulation and need to be taken care of when planning a pilot.
