Using Artificial Intelligence for Traffic Policing: Developing a Framework for the Future

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POLICY BRIEF

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Executive Summary

With the continuous expansion of the population of Pakistan, there has also been another unintended consequence and that is the rapid expansion of vehicular traffic. However, due to decades old traffic management practices and the lack of innovation, Pakistan seems to be severely lacking in traffic management. Artificial Intelligence is one such tool that can help streamline traffic management in Pakistan. Tools such as Artificial Neural Networks and integration with deep learning techniques can create a profound impact on the future of traffic management. The basic infrastructure required for the implementation of an effective AI-based traffic management system is already in effect, it is their potential that needs to be harnessed. Considering above, following are the broad strokes of the policy recommendations provided by this research.

- Integrate AI-based traffic management systems in the provincial capitals as a pilot project
- Overhaul the existing traffic signals and converting them to solar energy in order to ensure continuous operability
- Creation of provincial traffic command and control centers with liaison from various police/intelligence agencies and technical departments to ensure timely action on data collected through AI-based traffic management systems.

More specific recommendations to this can be found at the end of the document.

Issue to be Analyzed

The rise of vehicular traffic in Pakistan is creating hurdles for smooth traffic flow. The solution to this issue by the provincial and federal governments seems to be the expansion of road infrastructure. While this may be true in cases where there is genuine lack of infrastructure, in most of the cases, traffic flow can be managed through efficient policing. Artificial Intelligence (AI) is technology that can be used to improve traffic management in Pakistan as it is done in other developing countries as well.

Analysis

Traffic management in Pakistan has been one of the key issues. According to the Pakistan Bureau of Statistics, the number of traffic vehicles in Pakistan has risen dramatically over the years. In 2018, the number of registered vehicles in Pakistan was 26,570,320.[1] This number was 15,940,561 in 2014, representing an increase of 66 per cent.[2] This number becomes even more significant when the numbers for registered motorcycles are analyzed which represents an increase of nearly 80 per cent for the same time period.[3]

With such a large vehicular influx and the lack of a police infrastructure, traffic management is becoming a serious problem for Pakistan. These problems are further compounded by unique situations such as traffic motorcades, sit-ins and protests. These factors further exacerbate the issue of traffic management for Pakistan. One of the solutions that can be implemented in this regard is the inclusion of technology, in particular AI.

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[1] Pakistan Bureau of Statistics, *Pakistan Statistical Yearbook 2018*, (Islamabad: Government of Pakistan, 2018).
[2] Pakistan Bureau of Statistics, "Yearbook 2018."
[3] Pakistan Bureau of Statistics, "Yearbook 2018."

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Through the use of AI-based vehicle recognition systems, a rigorous monitoring system can be established that can improve traffic management significantly. There has been tremendous progress in the use of Computer Vision and Machine Learning-based technologies due to the progress of Artificial Neural Networks (ANN). These models are capable of processing videos/images from CCTV cameras. There are very advanced and accurate object detection methods that are capable of identifying pedestrians, cars and other types of vehicles. This can help estimate traffic densities based on these techniques and help to control the traffic accordingly.[4]

Reinforcement learning in particular, is very ideal for real world scenarios like traffic management. In this case, the system interacts with an environment and learns through trial and error using feedback from its own action and experiences. This method can improve over time as more data is fed to the system and is capable of taking real time decisions. Over a period of time, AI is capable of learning the underlying patterns in the traffic based data. Hence, it can learn events like rush hours or car accidents, as these contribute to traffic congestion and take actions accordingly to improve traffic flow.[5]

Another important aspect of it is the detection of anomaly in traffic flow. With the advent of some powerful models like Convolutional Neural Networks[6] and Recurrent Neural Networks[7], Traffic accidents and other rule violations can also be automatically detected.[8]

In order to implement such an AI-based system, a basic hardware requirement would be a good CCTV camera infrastructure. Through the Safe City project, this requirement has already been fulfilled. [(9)(10)]

In terms of developing an AI-based vehicle recognition system in Pakistan, there have already been several projects undertaken by various universities, one of the notable among these is the Artificial Intelligence-based Video Analytics for traffic Management (AiVAM), developed at the iVISION lab, Institute of Space Technology (IST), Islamabad.[11] The AiVAM system is specifically designed for the Islamabad Safe City Project, in collaboration with NADRA and the Islamabad Police.[12] However, the project is hampered due to bureaucratic red tape.[13] Projects such AiVAM are designed to register traffic densities, traffic demography and is able to identify vehicle based on its make and model. E.g. the user can query a particular make and model of a car and the AI model can detect all the vehicles of this make/model from the video archive of Safe City. This can help identify malicious vehicle, whose registration number is unknown.

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[4] Mirialys Machin et al., "On the use of artificial intelligence techniques in intelligent transportation systems," *2018 IEEE Wireless Communications and Networking Conference Workshops (WCNCW)*, 2018, 334.

[5] Nizwa Javed, Email interview, Islamabad, December 7, 2020.

[6] Convolutional Neural Networks are a class of deep neural networks that are most commonly used to analyze visual imagery and data.

[7] Recurrent Neural Networks are a class of artificial neural networks that can process variable sequence of outputs, making them suitable for speech and handwriting recognition.

[8] Mirialys Machin et al., "On the use of artificial intelligence techniques in intelligent transportation systems," *2018 IEEE Wireless Communications and Networking Conference Workshops (WCNCW)*, 2018, 334.

[9] Nizwa Javed, Email interview, Islamabad, December 7, 2020.

[10] Farrukh A. Bhatti, Zoom Interview, Islamabad, December 9, 2020.

[11] "Projects," IVision, accessed December 14, 2020, https://ivisioneeist.wixsite.com/ivision/projects.

[12] Farrukh A. Bhatti, Zoom Interview, Islamabad, December 9, 2020.

[13] Farrukh A. Bhatti, Zoom Interview, Islamabad, December 9, 2020.

Such systems can help Law Enforcement Agencies (LEA) to quickly locate the whereabouts of any wanted vehicle. This is an especially essential characteristic to automatically flag the entry/exit of any wanted vehicle within the premises of the Safe City.[14] Instead of having a human monitor all of the video data, the video analytic software will automatically identify and flag the presence of the vehicle to the concerned authority. This is an important characteristic because it removes the human limitations and introduces AI to perform the repetitive tasks, allowing human operators to focus on acting on the intelligence provided by the algorithm.[15]

The creation of such an AI-based architecture relies on the computation of video data gathered from CCTV cameras.[16] This data is run through complex ANNs that are able to extract information and then convert it into actionable intelligence.[17] The key component in this process is the CCTV camera architecture.[18] With the implementation of the Safe City projects in other cities of Pakistan, this architecture is soon to be installed. Through the CPEC project, the major urban centers of Pakistan are planning to install a robust and thorough surveillance system.[19] These systems will rely on the installation of a viable CCTV camera architecture. Islamabad is one example of this. In collaboration with Huawei, Islamabad has seen the installation of an extensive CCTV camera network and the same is expected in other major cities as well.[20] Therefore, Pakistan is focusing on the inclusion of a CCTV architecture in the near future (5-10 years).[21]

What is needed at this time is the development, testing and implementation of a AI-based traffic management system. After development what is left is the testing and implementation which may be expedited to test the results of the system. As a pilot project, Islamabad Safe City project may be considered, due to the vast traffic management of two cities (Islamabad and Rawalpindi), along with the frequent instances of motorcades and other obstructions. This will serve as a test case for the implementation of such a system in other cities of Pakistan and to figure out the weaknesses and strengths and to tweak the system.

While it may seem that currently these projects are financially infeasible, it needs to be reiterated that the hardware requirements for these systems is already being fulfilled under the Safe City projects' purview, with limited features included such as number plate recognition. In terms of computation, ANNs are progressing with rapid pace and their ability to process data in real-time is increasing exponentially. Furthermore, a lot more features can be added to such projects while leveraging local AI developers in Pakistan, which can save enormous costs. It is a viable and profitable investment that will pay its dividends very quickly.[22]

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[14] Farrukh A. Bhatti, Zoom Interview, Islamabad, December 9, 2020.

[15] Khurram Khurshid, Email Interview, Islamabad, December 13, 2020.

[16] Nizwa Javed, Email interview, Islamabad, December 7, 2020.

[17] Mahima Jaiswal, Neetu Gupta, and Ajay Rana, "Real-time Traffic Management in Emergency using Artificial Intelligence," *2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)*, 2020, 700.

[18] Farrukh A. Bhatti, Zoom Interview, Islamabad, December 9, 2020.

[19] Khurram Husain, "Exclusive: CPEC master plan revealed," *Dawn*, June 21, 2017.

[20] Husain, " CPEC master plan,"

[21] Husain, " CPEC master plan,"

[22] Farrukh A. Bhatti, Zoom Interview, Islamabad, December 9, 2020.

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Following recommendations are proposed:

Recommendations:

- Islamabad Police should expedite the AiVAM project and incorporate the project into mainstream testing.
- The Provincial Governments should set up of provincial command and control centers where data from AI-based monitoring system can be tabulated and converted into actionable intelligence.
- The command and control centers should include liaison representatives from NACTA, FIA, IB, ISI, NADRA, Customs, PTA and PTCL. The system should allow for a quick-time response of possible threats and would also allow for technical support.
- Analysis of data from AI-based traffic management software to be used for future road infrastructure expansion.
- Overhauling of existing traffic signal systems to ensure operability and to move them to solar systems to ensure continuous operability.
- Setting up of a central database system for the data collected via the AI-based traffic management system and to coordinate with NADRA and Excise and Taxation departments to maintain an extensive data of vehicles.
- Relevant ministries i.e. Ministry of Interior and Ministry of Communications should collaborate in resourcing and planning of research projects through universities (NUST, IST, UET etc.).

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