GORIA

Case Study

Smart City Solution

Traffic Violation Management

Kaohsiung Transportation Bureau

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Overview

Traffic violations are a common problem for most dense urban environments. Yet what are the root causes of them — failure of urban design to integrate traffic flow? lack of law enforcement? poor dissemination of road rules?

These issues were top of mind for lawmakers at the Kaohsiung City Government in Taiwan when trying to address persistent road violations at most of their city's intersections. Gorilla partnered with the Kaohsiung Transportation Bureau to implement a project deploying AI solutions in order to collect data, raise safety awareness and help law enforcement protect their citizens.

The results from this project produce some interesting takeaways regarding:

- How cities can utilize hi-tech solutions to manage traffic issues
- The reconfiguring of urban design for public safety in large-scale cities
- Managing large scale data collection for infrastructure projects

The 'Improper Turns' Issue

Kaohsiung City handles over 900,000 cars and 2.1 million motorcycles on its streets every day[1]. Motorists navigating the city often encounter traffic jams and one of the increasing problems for officers and pedestrians alike is motorcyclists making illegal left-hand turns.

Currently, the city (like most of Taiwan and other Southeast Asian cities[2]) employs a 2-stage process for motorcycles turning left. Yet with driver impatience and long traffic wait times, drivers frequently cut across the pedestrian crosswalks in order to make other turns:

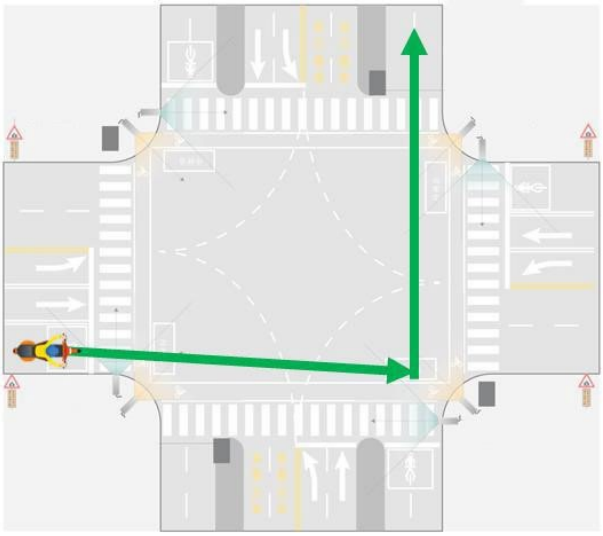

Figure 1: Legal Left Turn

(Motorists first cross to the Left-Turn Box, wait for the light to change, then proceed straight)

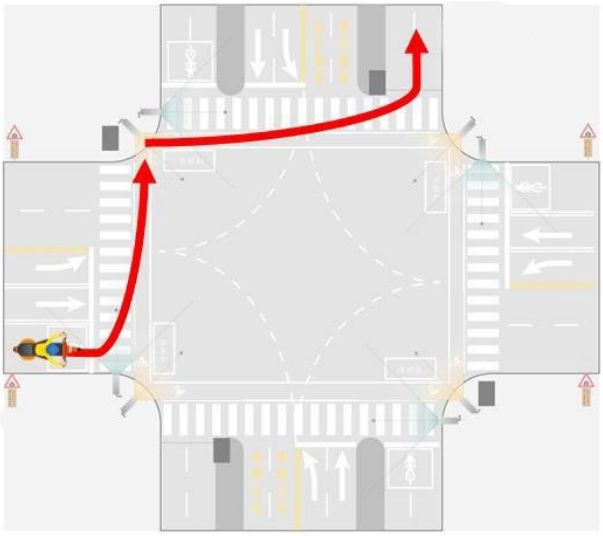

Figure 2: Illegal Left Turn #1

(Motorists cut across the 1st crosswalk, cross with the light across the 2nd crosswalk, then quick-turn left)

[1] The Statistical Yearbook of Kaohsiung City 2010, Department of Budget, Accounting & Statistics.

[2] "A Study of Motorcycle Lane Design in Some Asian Countries" To Quyen Le, Zuni Asih Nurhidayati. Procedia Engineering. Volume 142, 2016, 292-298.

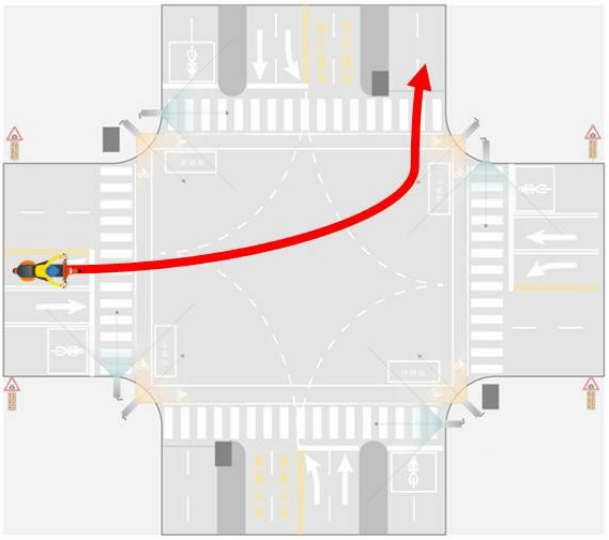

Figure 3: Illegal Left Turn #2

(Motorcycles cannot turn from the left turn lane)

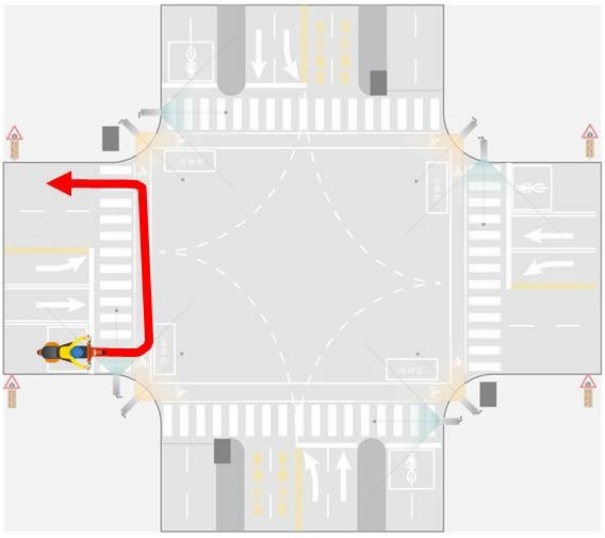

Figure 4: Illegal U-Turn

(Motorcycles cut across the 1st crosswalk to U-turn)

Pedestrians trying to walk across the intersection are increasingly met by these illegal-crossing motorists. The city's 2700 police staff cannot handle these infractions around the clock. Furthermore, the city government needs to have comprehensive data in order to make any legislation regarding traffic planning and safety.

Kaohsiung City Goals

Do the drivers who engage in these illegal crossings know they are breaking the law? It's safe to say that most do. Yet the city government wants the starting focus of this project to be an educational campaign reminding motorists the proper rules of the road.

Yet the key goals Kaohsiung Officials wanted to address were as follows:

- **Gauge the accuracy and effectiveness when recording infractions.** Could ticketing violations be more precisely administered via the use of AI technologies?

- **Detect other violation types occurring at the same intersections.** Illegal turns aren't the only infractions happening at the intersections

- **Reduce police deployment at the intersections for such infractions.** The Bureau was in need of some solutions to support the police's operational efficiency.

- **Gather data as to the extent of the problem.** Big data was needed to collect statistics of drivers' behaviors, their violations and how that correlates with times and locations.

AVERAGE DETECTED VIOLATIONS BY POLICE

= 3 / DAY

Technical Challenges

The pilot project brought about some technical issues. How to identify a motorbike from a pedestrian or another object? It's difficult to recognize a vehicle in motion. Furthermore, how to register a vehicle's behavior? The system needs to recognize different kinds of behaviors and types of traffic violations in order to successfully determine that the vehicle is performing an illegal turn.

Also, can the system recognize the infraction and then send a warning message immediately? Traffic movements naturally have erratic patterns and this adds a lot of difficulty in accurate detection.

Phase I: Test and Optimize the Accuracy Rate

Gorilla set to work on designing a system using edge AI that could monitor two sites that would meet the city's needs. It came up with a **Traffic Violation Enforcement AI (TVEA)** solution using dynamic AI and video analytics:

Install cameras at Pilot Project intersections

Kaohsiung City workers highlighted two key intersections which were best suited for the customized TVEA system. Gorilla set up RTSP cameras at the sites as well as 4G routers to loop back the data to the Transportation Bureau's data center. The on-site 4G technology allows for realtime transmission of data that users at command central could analyze as well as collect.

Figure 5 - Pilot Project Map

Use video analytics to detect vehicle types, their locations and license numbers

Gorilla's IVAR system (which uses Intel®'s OpenVINO™ toolkit) was installed to analyze the video streams and set up target regions. When infractions occur, the system can perform vehicle detection to identify which are motorcyclists in the prohibited region.

The other installed cameras perform license plate recognition on violators moving through the crosswalk. This video analytic can collect data on frequent abusers for use in future city projects or investigations.

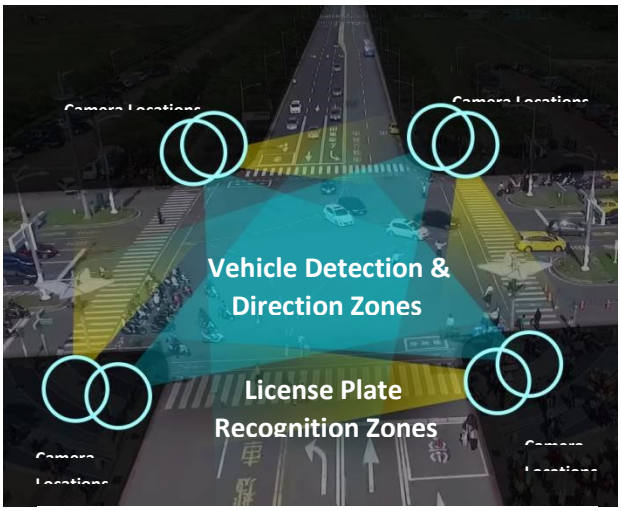

Figure 6 – Intersection Camera

AVERAGE DETECTED VIOLATIONS BY POLICE

= 307 / DAY

Phase II: Increase Awareness

Once the detection module was set up from Phase I, the second process could begin by deploying a warning sign.

Display a warning message back to the offending driver

Before the driver makes their illegal turn, a warning sign displays back their license plate number with a polite message indicating their violation. This educational approach is to 'shame or tame' the motorist's behavior and hopefully lessen the incidence of future infractions.

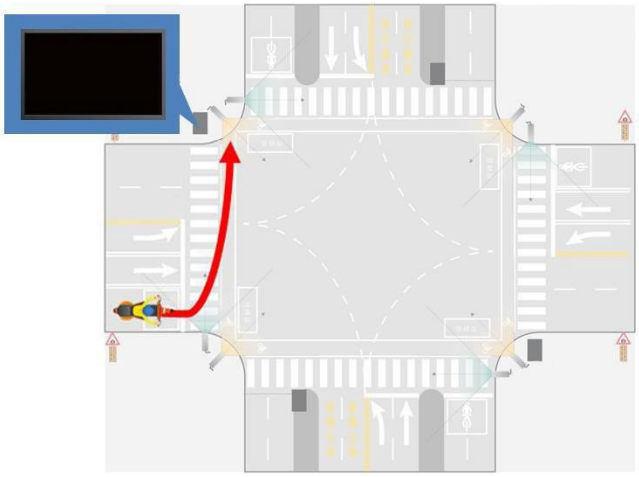

Figure 7 – Warning Sign Setup

This also allows the Transportation Bureau to capture the statistical data for the purpose of incorporating it into the development and deployment of future phases of their project.

Edge Deployment

The technical setup is used to maximize Edge Inference and to record Traffic Violation Big Data. The data is recorded as two streams from analytic RTSP cameras which are connected to a 4G router and IVAR system. The inference data can be sent back securely to a central management system using InField Deep Learning and records the following:

- Data regarding warnings
- Data regarding violations
- Data of different violation types

Figure 8 – Edge AI Real-Time Architecture & Data Flow

The data is collected 24-hours a day and can be stored for future investigations as needed. This allows staff to remotely access both pilot project locations at once and review the footage seamlessly.

The router and IVAR system are housed in an easily-movable chassis making installation and protection from the elements safe and simple. When infractions occur, the router transmits the data in real-time to the warning sign over a secured WIFI connection.

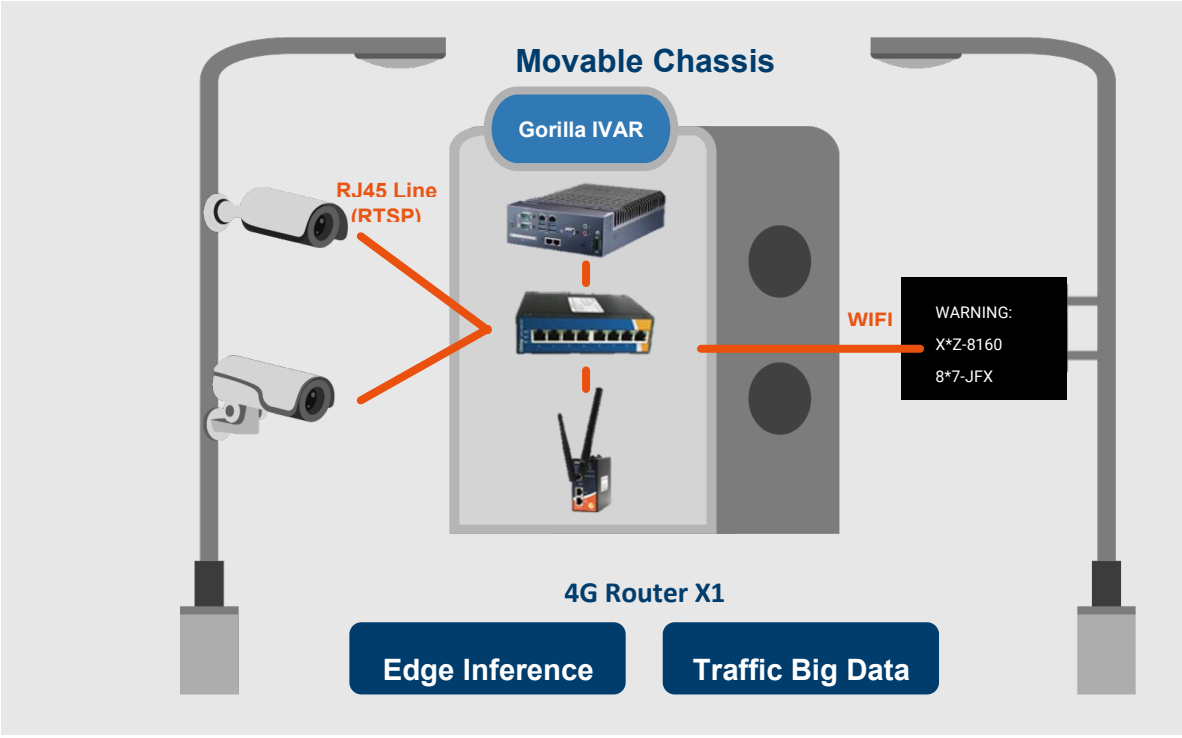

Figure 9 – Site Equipment Setup

The overall solution was cost-effective to install, meeting the Kaohsiung Transportation Bureau's requirements for scalability for future TVEA systems to be deployed. Moreover, the city's request for data collection can be met via auto-sampling, improving the solution's algorithm while gathering statistics for future collaborations.

Decreased Violations

The pilot project brought much awareness to citizens about proper driving etiquette and pedestrian safety. Drivers were more aware that their violations were being monitored and displayed. Police and media reporters stopped motorists to ask their opinion on the test system. While no tickets were issued for infractions during the recording period, infractions decreased 50% and city planners are using the data to analyze the overall effectiveness of Kaohsiung's intersections.

300 violations/day ➔ **150** violations/day

Furthermore, extensive media coverage allowed for additional educational reinforcement and was able to start a dialogue with citizens and legislators.

Figure 10 – Local & National Media Coverage of Pilot Project

Hi-Tech Efficiency

The initial results of the pilot project are promising and the data suggests some far-reaching options for integrating tech solutions into urban planning and public safety. Previously, one of the intersections recorded a monthly tally of 99 infractions. With this solution in place for a week, the TVEA system logged an average of 307 daily infractions.

These data can be used for future phases when the project is scaled up to other intersections and to clearly see if a drop-off ratio occurs for illegal turns.

Staff Recorded Infractions (MONTHLY)[3]

Intersection	Vehicle Infractions Statistics
Zhonghua–ShiDai	512
ZhongHua–ZhengQin	99
Bo'Ai–ReHe	903
DengQing–YiHua	246
Bo'Ai–Sushi	110

Table 1 – Monthly Infractions Recorded by Officers by Intersection

Infractions Recorded by Pilot Project (DAILY)

Date	Vehicle Infractions Statistics
2019/7/30	335
2019/7/31	306
2019/8/01	295
2019/8/02	284
2019/8/03	312
2019/8/04	314

Table 2 – Daily Infractions Recorded by Pilot Project

In-Depth Analysis Capabilities

The results of the Pilot Project illustrates not only the frequency by which illegal turns occur, but also the ability for technology to aid law enforcement in catching and notifying violators in the act at the time when the infraction occurs. The data collected from this project can be used to inform urban planners as they design transportation systems to address safety and traffic flow.

Gorilla's TVEA system shows the possibility to develop into a long-term deployment plan for use by Kaohsiung City Hall to develop multiple solutions

Figure 11 – Data Collection & Video Search Software

Phases III: Expand to Other Areas &

Record More Violation Types

The third phase of the project is to continuously deploy the optimized TVEA to 5,132 intersections city-wide. In tandem, the data gathered from each location can be used to survey other traffic violations, thus developing new TVEA systems for other infractions. Analyzing the data sets can establish deployment priorities as well as design changes for the Transportation Bureau.

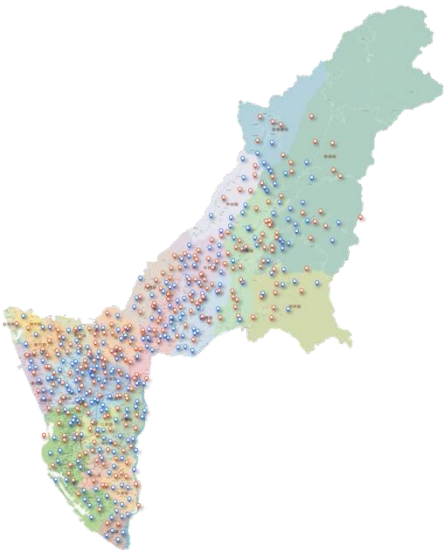

Figure 12 –TVEA System – Expand to Other

For a large city to run on big data analytics means a robust data-centric focus that can monitor violations, reduce accidents and maximize the police workforce. Once city-wide TVEA systems are in place, this gives Gorilla and partners a proven template for introducing AI technologies to cities across the nation and beyond.

Figure 13 – Expand to Detect Other Violations

Main Takeaways

The pilot project in Kaohsiung is a first step in creating safe urban spaces that utilize edge AI solutions. While only a preliminary glimpse on the future of creating smart cities, there are some interesting findings that can be made:

EDGE AI

Traffic Big Data and In-Field Deep Learning
Such solutions can gather city-wide statistics as well as improve algorithms via auto-sampling

Enforcement Support
AI systems can aid police in both violations and investigations

PLANNING & DEPLOYMENT

Fewer Police Deployment
Technology deployment can be used to address resource management

Cost Efficiency
The scalability of these types of projects can replace higher full-time monitoring costs

Design Implementation
These tools can support urban designers with traffic planning and safety concerns

SAFETY & EDUCATION

Safety Implications

Smart solutions have the potential to be an effective tool in reducing accidents and increasing pedestrian safety

Educational Ability

These systems need not be used as merely tools for enforcement or monitoring and can be utilized for public campaigns and promoting awareness. Not ticketing people.

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