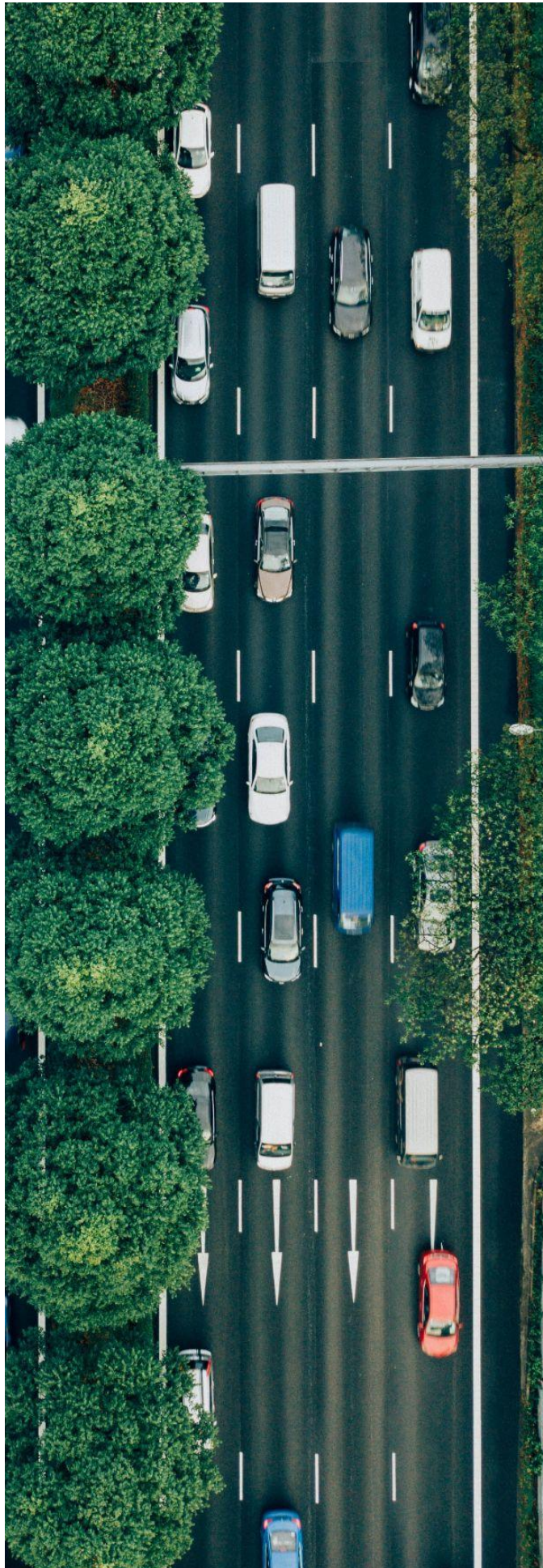


THE INDUSTRY LEADING VEHICLE RECOGNITION SYSTEM



WHITE PAPER



1. INTRODUCTION

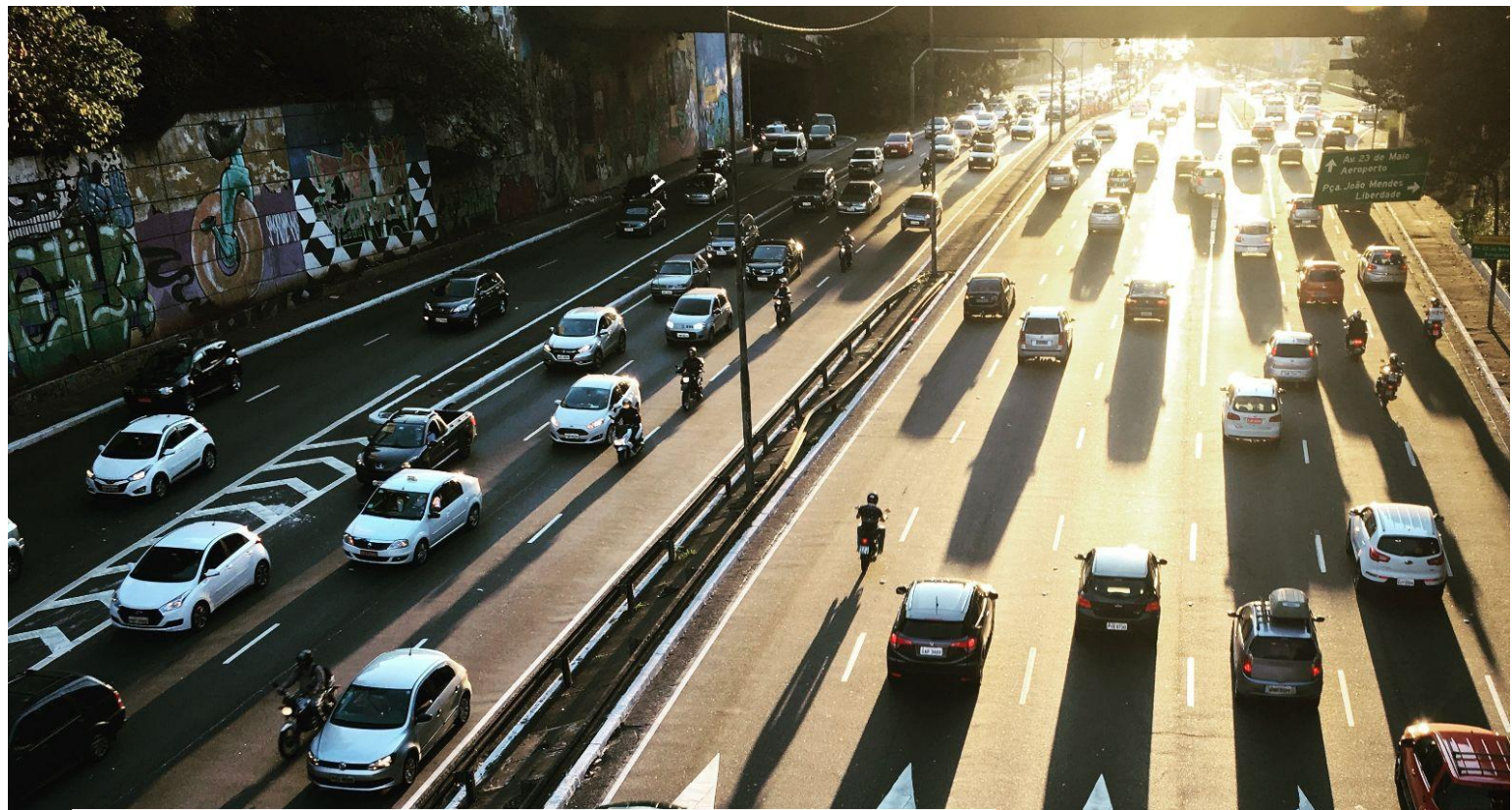
1.1 Challenges

Intelligent vehicle management is becoming increasingly important for various businesses as they have been facing a lot of challenges mainly related to their operational inefficiencies. Among the many challenges includes:

- Not being able to smoothly secure vehicle access control
- Lack of security in car park operations and inefficiency in car park payment resulting in customer frustration
- Crowded vehicles at toll gates from the slow manual classification of vehicle by human labour

Today, AI is helping to solve these and other persistent problems to enhance the vehicle management and make its way to the mainstream. However, even though it would not be possible to eliminate all of the challenges,

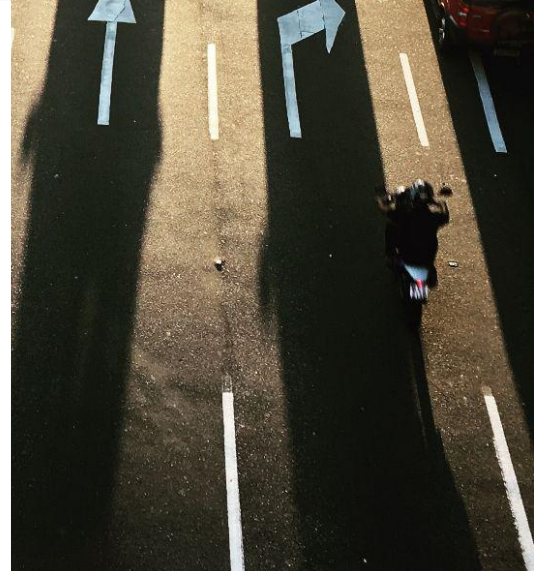
the solutions powered with AI can face the challenges with greater efficiency.



1.2 Benefits of Vehicle Classification

AI technologies helps businesses run their vehicle management safer, faster and economical. With a high accuracy of vehicle classification, businesses are now able to:

- Reduce the cost associated with human labour
- Increase revenue generation and efficiency
- Reduce losses due to fraud
- Track movement of vehicles on their premises



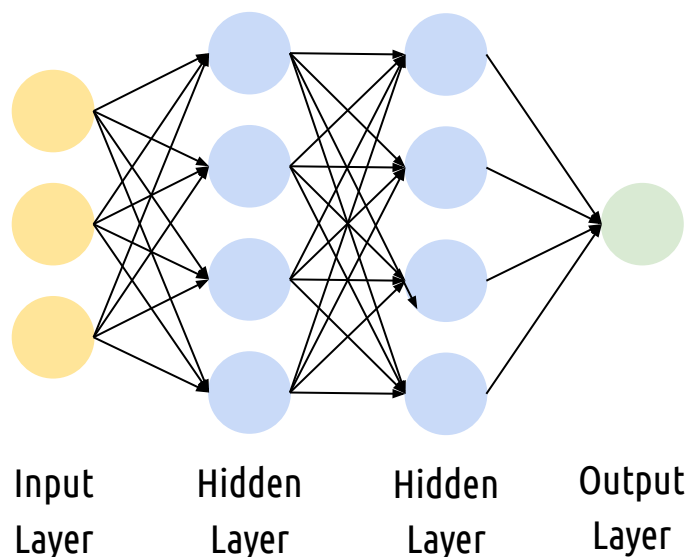
2. THE TECHNOLOGY

Tapway VehicleTrack is capable of detecting vehicles and classifying them based on their shape, it also locates license plates and recognizes the characters. We utilize state-of-the-art deep learning models to perform all of these tasks within sub-second, while not compromising on the accuracy of our system.



2.1 What is deep learning and why use deep learning?

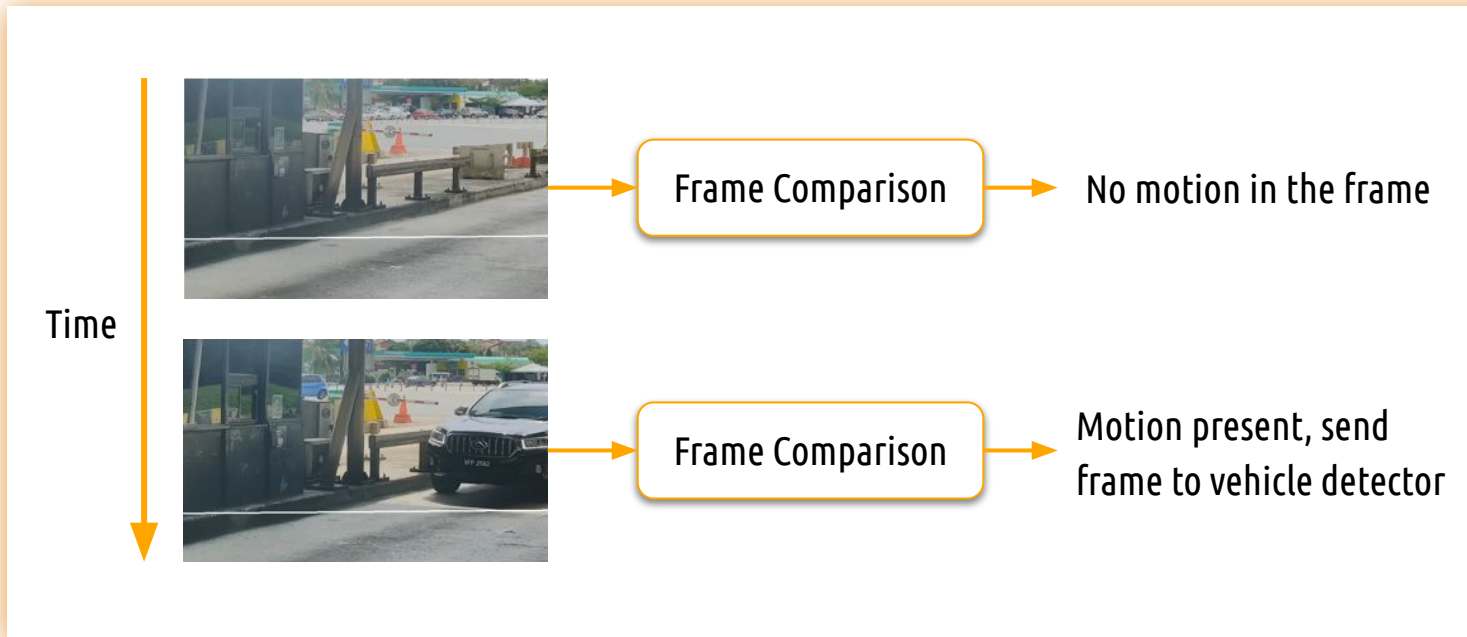
Deep learning is a subfield of AI that can quickly and accurately learn structure from images, videos and text. Using deep learning allows us to create high accuracy vision models that can identify vehicles using key landmarks on a vehicle. They can also be optimized to achieve sub-second prediction speeds.



Compared to traditional computer vision algorithms for vehicle detection, deep learning methods achieve much higher accuracies.

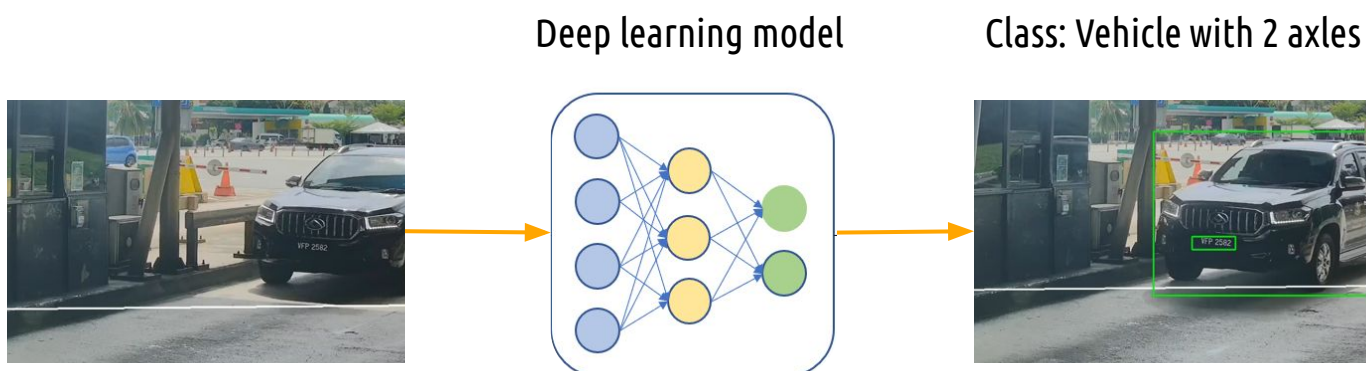
2.2 Motion detection trigger

During the day, we do not expect the lane being monitored to always have vehicles, We utilize computer vision based algorithms for detecting the presence of a vehicle within a Region Of Interest (ROI), once motion is detected we trigger our deep learning model to classify the vehicle.



2.3 Vehicle detection and classification

Once motion has been detected within a region of interest, we trigger a deep learning model to detect and classify the vehicle, we also locate the position of the license plate on the vehicle. The bounding boxes allow us to extract only the vehicles from an entire frame.

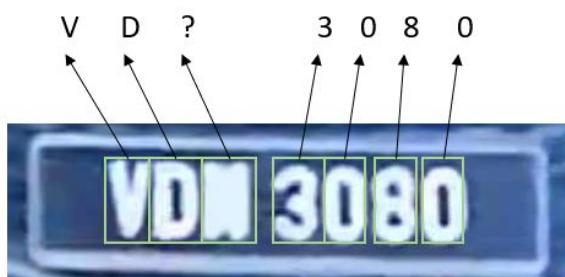


2.4 Automatic License Plate Recognition (ANPR)

Along with vehicle detection and classification, we detect the license plate and pass it on to a different model called the ANPR model. **This model enables us to recognize the characters and reconstruct the license plate string from the image.**

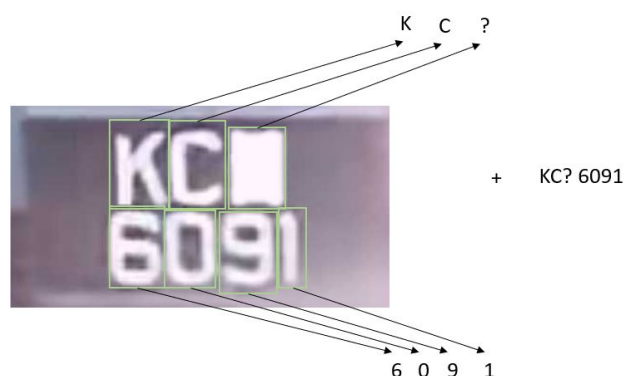
2.4.1 Single layer License plate

Our ANPR model detects and classifies each character individually, based on the position of the character relative to the rest of the characters, we can arrange the characters from left to right.



2.4.2 Bilayer License plate

Our ANPR model can Bilayer license plates by sorting the classified characters on each level and then joining the upper and lower strings of characters to form the final license plate number



3. TAPWAY VEHICLETRACK

Tapway VehicleTrack recognizes vehicles through a platform powered by deep learning technology. The solution is capable of recognizing vehicles beyond just their license plate information, vehicle, brands and colors.

3.1 Tapway VehicleTrack's Features

The Tapway VehicleTrack solution plays a critical role in today's world in meeting the needs of drivers while ensuring their safety. Tapway has been investing their resources in bringing an advanced vehicle tracking system powered by AI featuring:



Secure Vehicle Access Control

Enable highly secure multi-factor vehicle recognition to automate access into and out of your premise.



Enable Free-Flow Toll Collection

With highly accurate vehicle classification and recognition, toll payment may be automated without manual classification input from humans.



Parking Lot Management

Automatically recognize available parking lots, and guide vehicles along the best route, while providing carpark utilization report to management.



Traffic Violation Management

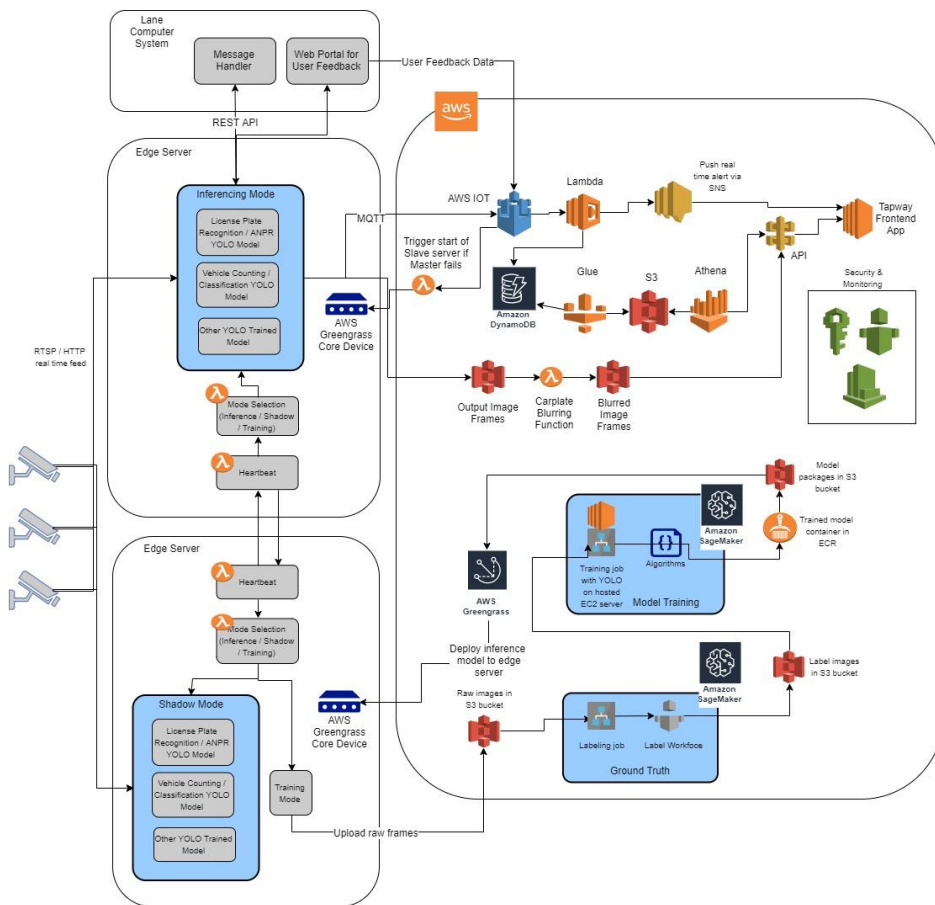
Handle various types of traffic violation, including speeding and red-light violation, while providing law enforcement with vehicle registration.



Delight the Customers

Provide personalized offers to customers based on their visit patterns captured from each time they enter and exit your premise.

3.2 Tapway Full System Architecture



Based on the diagram, a hybrid model is adopted where AI inference (i.e. object detection and classification) is performed at the Edge server, while data is pushed to the cloud, and all data processing and visualization, server monitoring, provisioning and deployment reside at the cloud.

3.2.1. Software Architecture

The key software components involved in the system are:

1. Edge server with a **Greengrass** container and runtime containing local lambdas and AI model
2. **AWS IOT** which manages all Greengrass group configurations and deployments
3. **AWS Kinesis** which ingests data from Edge server and publishes data to Elasticsearch
4. **Elasticsearch** for storing all log data and **Kibana** dashboard for visualization
5. **AWS Lambda** to execute a myriad of tasks serverlessly
6. **AWS S3** for storing all images
7. **AWS SageMaker** for image annotation, model training and optimization
8. **AWS Cloudwatch** for server logs and monitoring
9. **AWS SNS** for publishing notification externally

ABOUT TAPWAY

Tapway work with businesses to improve productivity and reduce manual labor by transforming videos feeds into intelligence and actionable insights.

TAPWAY SOLUTIONS

PeopleTrack

VisionTrack

VehicleTrack

**UNLEASHING
THE POWER OF
AI VISION TO
TRANSFORM
YOUR
BUSINESS.**