VIDEO CONTENT ANALYTICS IDEAL TOOL FOR ALMOST EVERY INDUSTRY

Video content analysis is the capability of automatically analysing a video to detect and determine temporal and spatial events via a computer programme known as computer vision system.

By **Philip Chan**

In the past and even right up to the present moment, the truth of the old adage that "a picture or photo tells a thousand words" can never be disputed. However, with the advent of digital technology advancements videos can play a larger role with offerings of tremendous benefits in complex situations through video content analytics as an ideal tool for every industry and in our everyday lives.

With the rapid technological development and growing complexities of socio-economic environment the world over, it has greatly impacted industries and peoples' everyday lifestyle. The applications of video analytics as an important tool for engineering, industrial, commercial, health and medical, security and/or even private purposes is fast gaining recognition.

The importance of video content applications of a vision-based approach lies in its ability to accurately determine the attributes of the captured images for detection, tracking, classification and behavioural understanding or counting over a period of time using a computer generated algorithm.

Its applications can be practically used in all sectors including private residences or homes; security and surveillance purposes, such as in parameter surveillance, border control; retail industry for customer mapping in retails outlets; transportation to analyse traffic conditions and to understand the behaviour of vehicles.

For the manufacturing sector, its application could be involved in the inspection of production lines to monitor the products moving through the conveyor belt to detect any defective items from the final production. As for industrial and workplace safety, it could be deployed to detect any incompliance of events automatically.

Meanwhile for the agriculture sector, it can be executed by using drone services to monitor the plantation, to detect or to count number of plants and also automatic spraying of pesticides.

The interesting digital advancement was shared by MIMOS Head of Complex Event Analytics, Advanced Informatics Lab, Puan Zulaikha Kadim, at a recent webinar entitled Video Content Analysis: Traffic Analytics in Complex Scene, which outlined on a case study on the three traffic highway networks in Kuala Lumpur and Selangor.

Zulaikha gave an extensive insight into her team's efforts in undertaking the survey, the methodology and processes involved, traffic volume count and classification, the architecture of the traffic analytics and the challenges as well as appropriate solutions and resulting accuracy of the digital algorithm.

She said the main purpose of undertaking a traffic analytics is to determine the traffic volume count and classification.

"The aim of this activity is to collect the number, movement and classifications of vehicles at a given time period, for example, 15 minutes, an hour or even a day."

TRAFFIC VOLUME COUNT AND CLASSIFICATION

This information is particularly essential to the potential development of any traffic engineering works including design, operation and also maintenance services. It is used to calculate the level of service for any road grid in the road system. It is also used to perform future planning; to exact plan or design of the traffic facility for the future; understanding current road usage and determining the future traffic trends.

With the relevant information, priority could be set for road improvement or future expansion in order that the level of service can be calculated or estimated based on the road performance, including the traffic density, delay and speed which is critical to traffic engineering.

In addition, if there are any proposed new developments in the area the traffic impact analysis will provide planners an understanding whether the existing or planned road network system is adequate to support any demanding traffic based on the proof of development. This will provide the framework of the current density and also an accurate estimation of the future traffic density.

TRAFFIC ANALYSIS METHODS: PROS AND CONS

Traffic analysis can be divided into two different parts – using manual process and automatic method.

This manual process was very popular previously and only needed to engage people to observe the traffic. Each person will bring their own tools to monitor the number of cars that pass through the road, in what directions, and some other information such as vehicle classification, and also what colour and models.

The advantages of the manual process are it doesn't require a huge budget for a simple road network as an individual can monitor a stretch of road. Additionally, it can be done at any time by just hiring people to conduct the counting manually, without any installation and need to purchase any hardware.

However, it is less efficient when the road network becomes complex with more than one lane coupled with heavier traffic and larger variety of vehicle class, thus requiring more manpower and increased budget to do this manually.

The disadvantage is when the road network is complex and requires more resources for counting manually. Health and safety issues of observers would be compromised with longer working hours. The accuracy of survey is subject to human error as constrained by human limitations due to tiredness, boredom, etc, thus affecting the counting accuracy.

In today's competitive world, companies are now preferring to adopt the automatic method, whereby this approach can be divided into contact and contactless.

Contact means that the vehicle has to be in contact with the sensor -- for example, pneumatic tube, Piezoelectric sensor or inductive loop – that requires some devices to be installed either on the road or beneath the road.

In this case, the road has to be cut and to put in the sensor for automatic counting. This system works well in low volume traffic. However, the sensor is also sensitive to the temperature and can be easily damaged by road deterioration and heavy vehicles. As such, it requires high maintenance cost during the installation and also high maintenance to ensure that the sensor can work perfectly until the end of the survey.

In terms of accuracy, it is dependent on installation as any misalignment in the angle of the installed sensor would affect the counting accuracy.

The more popular system these days is the Vision-based contactless traffic approach. In addition to the vision- based method, there are also infrared and radar sensor whereby it is either active or passive sensor not requiring it to be in contact with the vehicle. However, the sensor of both latter methods have limitations due to limited area of monitoring or a need to install multiple sensors to cover a multiple-lane road network.

VISION-BASED TRAFFIC ANALYSIS APPROACH

Zulaikha said for a vision-based approach, poles or a building beside the road network is normally utilise monitor the road.

"The video data will be fitted into a video processing engine which can be a hedge processing at the local location where the camera is or it can be a server-based processing. With this processor, extraction of the database or traffic information that can be put into the database to be used later for visualization of any analysis or estimations on the road trends.

"Vision-based traffic analysis offers a lot of advantage as against manual and contact-based systems. Besides capturing the image, counting of vehicles can be done and also the obtaining a variety of information. The camera can capture even the license plate, colour, models and vehicle direction, etc., which is not being given by any of other techniques," she added.

The system can also perform observation tasks, monitor all the lanes and all the vehicles at the same time. And, it is more accurate compared to manual and other sensors. The algorithm developed for vision-based traffic analysis can always be improved over time because the data is always there, and at the same time MIMOS can train its system to suit the data. It is easier to install, operate and maintain as well as relatively inexpensive.

MIMOS' PROVEN CASE STUDY

To prove the effectiveness and validity of the Vision-based traffic analysis, Zulaikha and her team conducted a survey involving the three highways in Selangor at NPE, Subang Jaya; LDP, Puchong and MRR2, Batu Caves.

The study involved traffic volume count and classification; architecture of traffic analysis; detection; tracking; vehicle classification and understanding vehicle behaviour; and accuracy result.

Four cameras were used with two installed at the NPE highway while one each was installed at the LDP and MRR2 highway. All four road networks were considered high traffic volume as they each had more than 40K vehicles passing through the route on a daily average count, or AADT which is the standard measurement for traffic. The LDP highway is the busiest among the four networks.

Camera contact was placed on the flyover bridge at the height of more than four metres and cameras were positioned either at the side of the flyover or in the middle in order to have a variety of camera orientation.

The challenges faced as observed from the data captured over 24 hours were basically illumination changes, object occlusion, weather conditions, night and noise in all these locations.

In tackling the problems, MIMOS introduced its own system by building an Architecture of Traffic Analytics consisting of four layers for any traffic analytics system. The first layer is the lowest layer which corresponds to image acquisition, while the second layer is the dynamic attributes attraction (to extract vehicle's dynamic and static attributes). The third layer is behaviour understanding to analyze the vehicle's dynamic and static attributes, understand vehicle behaviours, and finally perceive traffic status of the transportation system. The system ends with layer four to provide ITS services for efficient transportation management and control.

The detection part is very important as this is the first process in any ITS service. The vehicle traffic volume count can be divided into classic and deep learning. Classical is divided into feature-based and motion-based. The difference between feature-based and motion-based is that the former require only single image in order to detect a vehicle in the image. The motion-based approach requires multiple images to be analysed together in order to detect any object in the scene. This method includes the background subtractions, optical flow to know the flow between current and previous frames and also even frame difference.

DIFFERENCE BETWEEN MOTION-BASED AND DEEP LEARNING

Motion-based is very popular especially in real applications but not in the academic life. In real application, motion-based is much preferred because the system is very fast and accurate in some controlled environment. Because of these two reasons, most applications are still using motion-based algorithm in detecting object in the image.

Deep learning has a superior performance which helps solve most the limitations outlined in the motion-based approach. It provides accuracy of detection compared to the classical approach. It provides fast implementation by using pre-trained model.

IMPORTANCE OF TRACKING

Object tracking is to locate and keep track of the object in the image over the time. Its importance in the system is because the tracking will provide the trajectory information of the vehicle which is a valuable cue in making any decision in any analytics, especially for vehicle count and specifications tracking is needed to ensure that each vehicle is counted only once.

TRAFFIC VOLUME COUNT WITH CLASSIFICATION

The behaviour vehicle understanding is after obtaining all the vehicle attributes, the dynamic and also the static attributes to understand how the vehicle behaviour. This is specifically to get the traffic volume current and classifications.

To perform counting we use a virtual line whereby we monitor the movement of the vehicle, track movement of the vehicle from before the line and after the line to trigger the counter to update.

In the study, tests with data collected were from the three locations using four cameras. The total number of clips for testing is 39, duration of more than nine hours and total vehicles for this nine-hour data is 58,354. This is the accuracy of counting and counting specification. The result for average counting accuracy for all 58,354 vehicles is 97.53. The weighted average of counting per each class with the final average accuracy of quantity classification is 91.5%.

In the future, MIMOS plans to expand the work and is currently doing the junction counting as well as night scenario and different scenarios for vehicle counting and classification.

For collaborations and opportunities in the Video Content Analysis, contact MIMOS Berhad at +**603 – 8995 5000** or email to **info@mimos.my.**