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Motorcycle Speed Calculation while Driving with an Animation from a Smartphone

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Abstract
This research adapts basic technologies to develop a method for determining motorcycle velocity that may be used as evidence against those who exceed the speed limit in areas lacking speed detection devices. The speed was measured on Samsen roads in Bangkok, at Google Earth locations (1346'33.51"N 10030'25.96"E). The speeds of 40, 60, and 80 kilometers per hour were measured and recorded using two smartphones and placed in points A and B in two reference locations. The videos were then converted to image files to count the number of frames and time traveled on the motorcycle and estimate the movement speed. The measurement results showed that the values were not significantly different from those obtained from google earth at the significance level of 0.05. The data was analyzed by excel (t-Test: Two-Sample Assuming Equal Variances).

Keywords: Frame rate, Motorcycle, Velocity, Speed calculation

1. Introduction
Motorcycles are now popular vehicles in Thailand. The popularity of motorcycles is due to several factors such as convenience, speed and agility, the ability to reach the destination of the trip, the amount of fuel used, and maintenance costs lower than a car. Motorcycles are considered to be the first personal vehicles. However, the use of a motorcycle causes a danger from the user group, namely the risk of injury and death in a road accident.

From the Department of Land Transport statistics in 2019, comparing to the proportion of deaths from road accidents around the world, the highest percentage of fatalities in Thailand were caused by motor vehicle accidents (29%), followed by motorcycle accidents (28%), cyclists, and pedestrians (26%), and other road users (17%). Road accident deaths accounted for the highest number of fatalities caused by motorcycles, (74.40%), motor vehicle accidents, (12.30%), pedestrians (7.60%), cyclists (3.20%), and other road users (2.30%). It was clear that most fatalities were caused by road accidents in Thailand, with over 75 per cent of the population. As a result, Thailand is currently known for having the highest mortality rates globally when it comes to road accidents.

Street accidents are a major social problem that causes the loss of life and property. At present, the situation of traffic and transportation accidents has an increasing trend. According to road accident statistics from the Bureau of Safety Administration, Department of Highways, 73% of accidents on highways were presumed to be driving faster than the specified rate. The driving speed exceeding the legal limit is a common problem in Thailand, which is caused by improperly setting speed limits for the type of road use and land use on both sides of the road including a lack of strict enforcement of laws. The clarity of the enforcement of speed laws in Thailand is low compared to the enforcement of other road safety laws by the ineffective enforcement of speed control laws in Thailand caused by a shortage of law enforcement personnel and tools. In the past, autonomous speed detection technology systems are widely installed and operated on highways in Thailand. The agency responsible for road safety has recommended speed enforcement measures and implemented an automatic speed detection system (Kornprasert, 2017).

Statistics of the Royal Thai Police in 2019, when receiving reports of road accidents, found that the most accident-prone vehicles were: 1) motorcycles, 2) sedans, and 3) pickup trucks, respectively. There are many factors of accidents which can be divided into four groups: 1) the cause of the accident caused by the person, 2) the cause caused by the equipment, 3) the cause caused by the environment; and 4) the cause of the traffic light/sign, which is considered from the cases caused by the person (driver) from a road traffic accident reported in the year 2019, classified by vehicle type.

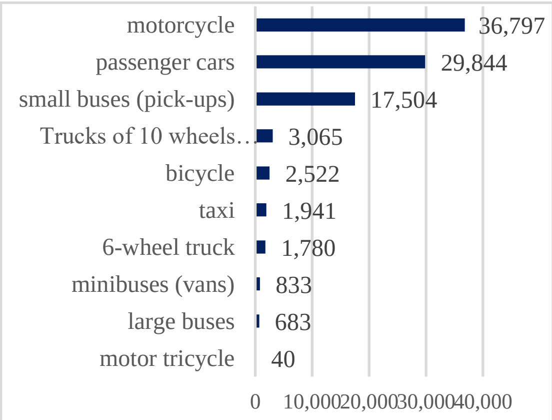

Figure 1. Statistics for car accident victims nationwide (Thai RSC, 2019).

The cause of motorcycle accidents is caused by 94% of drivers, with 54 percent of motorcyclists and 40 percent of motorcyclists being caused by motorcyclists. Causes of motorcycle accidents included: 52.30% of perception failure, 20.80% of decision failure, and offenses. Reaction failure was 18.8 percent, which was also found that 26.20% of all accidents caused by driver attention failure, and 40.30% of all accidents occur resulting from the decision to faulty traffic strategy. Over 85 percent of motorcycle accidents are caused by riders who have not been trained to ride safely but instead, learn how to ride a motorcycle from family, friends, or self-learning.

Strict enforcement of traffic laws is one of the ways that can lead to a significant reduction in motorcycling accidents. In which, imposing penalties on those who violate traffic laws, such as speeding beyond the legal limits. Arresting an act that violates the traffic law with credible evidence leads to punishment by the penalties prescribed by law. The researcher considers the importance of such problems. Therefore, it is necessary to study the speed of motorcycle driving on public roads. Speed, distance, and time detected from video recorded data were taken from the first to the second position. They can be used to determine the motorcycle speed, which may be applied for proving traffic offenses or as part of a traffic trial that can occur.

Rad, Dehghani and Karim (2010) studied a found that video processing was used for traffic surveillance, analysis, and monitoring of traffic conditions in cities and districts. The purpose was to offer other approaches to vehicle speed estimation. It collected images of traffic captured by still cameras mounted on expressways. The cameras were calibrated according to the geometric equations directly supported by the reference. Calibration of the camera for precise readings was achievable, but determining speed accurately was challenging. The designed system can be propagated to other traffic-related applications. The speed error detected was 7 kilometers per hour. The experiments were performed with different resolutions and different video sequences.

Shukla and Patel (2013) studied a new method of estimating the speed of ground vehicles, which was an automatic estimation of the vehicle's speed from a video sequence obtained from a permanently installed surveillance camera. The car movement was detected, which was followed by the different scenes using Lucas-Kanade algorithm distance travel by the vehicle. It was calculated using the center moves over the screens and the estimated vehicle speed. The speed of the vehicle was determined from different positions on the screens.

Kim, Oh, Choi and Park (2018). studied a method for estimating the speed of a moving vehicle with side camera images. A sufficient number of reference points of velocity vectors was a specified vehicle using various scene images, which involved two main steps. Firstly, there were enough points from the selected cars. These points must follow closely on at least two successive video scenes. Secondly, the tracked point displacement vectors and usage times were used. The velocity vectors of those points were calculated. The calculated velocity vectors were defined in the video image coordinate system. The displacement vectors were measured by pixel means. Then the magnitude of the vectors calculated in the image space were converted to the object area to determine the absolute value of these sizes. This transformation required an image to oppose the area data in mathematical terms achieved by the calibration mean and the orientation parameters of the video scene image. This research presented a solution to the problem of using side camera images mentioned.

Han (2016) studied different traffic accident types, including car crashes, pedestrian collisions, and hit-and-run accidents. In this paper, overspeeding was one of the main areas of traffic accident analysis. Therefore, analysis of vehicle speed during an accident was essential. The current

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article proposed a vehicle speed estimation (VSEM) method using a virtual plane and a reference line like a forensic science video. The reliability of VSEM was verified by comparing the results obtained from the Vehicle Speed Estimation (VSEM) method with the video of the test drive of the vehicle being driven with the Global Positioning System (GPS) based on the Vbox speed principle.

Doğan, Temiz and Külür (2010) found the use of original video footage (footage) of car cameras. The vehicle speed could be assessed directly from the recorded image without the need to locate the specific physical characteristics of the vehicle displayed in the recorded instrument. Moving car speed was estimated to analyze the actual results. The speed estimation cross-ratio was compared with the results of the original video analysis method (footage).

Chantruthai, Pansrinual and Jinwan (2017). found the speed of vehicles on highways in the community outside the city. Motorcycles are the vehicles in the community, followed by passenger cars and pickup trucks. The moving vehicle data in the community indicated that the passenger car speed exceeded the legal limit both in the area outside the community and in the community areas. The truck's travel speed would progressively decrease below the speed limit outside the village, however it was discovered that the return speed soared over the legal limit when entering the community.

Saisuksaard and Kronprasert (2018) found that the efficiency of using automatic speed cameras found that the speed control measures with automatic speed cameras caused the driver to use a significantly reduced driving speed. After installing an automatic speed detection system, personal vehicle speeds decreased by 7.7 percent. The bus used speed decreased by 8.8 percent. The psychological factors of drivers affecting speed behavior found that the cognitive factor controlling behavior had a high effect. Therefore, the best speed using the law enforcement measures based on speed control with automatic speed cameras could reduce the opportunity for drivers to exhibit more speed behaviors. As a result, the driver intends to reduce the speed of driving.

Based on the above research works, this article aims to propose a technique for the motorcycle speed calculation from a smartphone video file. This technique can potentially address motorcycle accidents in Thailand.

Video clip showing today's smartphones features in recording high quality video clips with sharper and higher frame rate from previous version that affects the accuracy of the vehicle speed calculation and using the Google Earth odometer to help find distance traveled by the car. Therefore, the researcher has initiated an idea that the aforementioned data can be used to calculate the speed of the car traveling on the road leading to its application as a tool to detect posed limit vehicles.

2. Objectives

1) To calculate the speed of a motorcycle using a video clip from a smartphone and Google Earth program.

2) To propose guidelines for finding evidence to punish those who drive faster than provided in the law.

3. Materials and Methods

3.1 Methodology

This research is a simulation of driving a motorcycle on a straight-line road. The road surface is Alfred on the daytime test, where the test in a place where there is a clear reference position on the Google Earth program (13°46'33.51"N 100°30'25.96"E) by using 1 test motorcycle, a 2017 Yamaha GT125 CC. Reference points A and B are records of the vehicle's movement with a video camera of a smartphone model SAMSUNG Galaxy A30 at the first and second position to use the data from the video file to calculate the time spent on the motorcycle in motion. Two methods were used to measure distances in this experiment: 1) measure the distance from Google Earth, and 2) measure distance with a standard distance meter (tape).

3.2 Variable studied

Independent Variable: This includes measuring the distance traveled by car in 2 ways: 1) measure distance from Google Earth and 2) measure distance with a standard distance measuring tool (tape measure).

3.3 Control variable

Control variable including motorcycles: The road environment in the experiment was the straight road. Paved road surface, dry road surface, day time trial. The researcher selected Samsen Road in front of St. Gabriel's School, which meets the definition of the control interpreter. The experiment was conducted during the period from 10.00 am to 12.00 pm because the traffic was not busy in which the experiments according to the experimental plan can be controlled effectively.

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3.4 Experimental method

This research simulates riding a motorcycle in a straightway through two reference points, A and B, at speeds of 40 km hr^{-1}, 60 km hr^{-1}, and 80 km hr^{-1}.

1) The measurement distance; Before measuring the distance, it is necessary to survey the area to be measured to know the exact route to be measured. There are two ways to follow. measure the distance traveled by car: 1) measure the distance from Google Earth and 2) measure the distance with a standard distance measuring tool (a tape measure), details as

1.1) The steps to measure distance with the Google Earth program are as follows.

(1) Launch the Google Earth program that will be used to analyze distances.

(2) Find an area to experiment. The measurement area is Samsen Road, in front of St. Gabriel's School.

(3) Mark reference point A to reference point B

1.2) Procedure for measuring distances with a tape measure as follows.

(1) Field the area for measuring the distances

(2) Mark the reference point.

(3) Measure the distance of reference A to reference B.

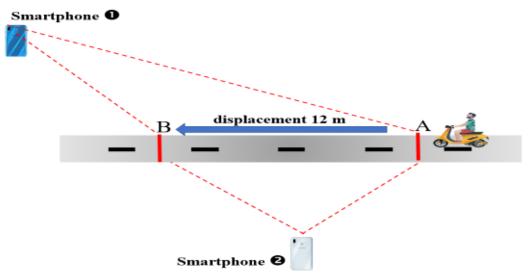

Figure 2. Determining the A and B positions for the experiment.

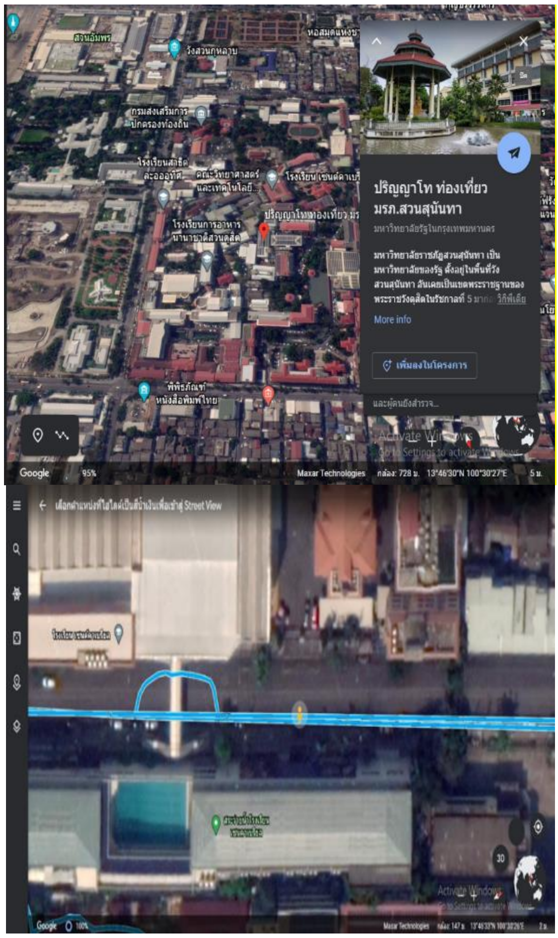

Figure 3. Samsen Road in front of St. Gabriel's School to set distance.

2) A smartphone was utilized to record the motorcycle's movement, with two identical smartphones being used for the recording. The motorcycle was then ridden at speeds of 40 km hr^{-1}, 60 km hr^{-1}, and 80 km hr^{-1} past reference location A to position B. At each speed level, the experiment was performed 30 times.

2.1) Location 1 was taken from a motorcycle's height (1^{st} smartphone camera). Arrange for the installation of a video camera on the bridge. Adjust the camera's direction in accordance with the motorcycle's movement. During the experiment, the motorcycle was driven toward the camera.

2.2) Location 2 captures photographs perpendicular to the motion of the motorcycle (2^{nd} smartphone camera). Install a surveillance camera on the sidewalk. Set the smartphone camera's direction perpendicular to the motorcycle's movement. The vehicles would move through the camera from right to left.

3) Converting video files to picture files.

3.1) A video file was created when a smartphone camera captures footage of moving cars.

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The vehicles that traveled from point A to point B were counted and recorded. The video to jpg converter was used to convert the video files to photos.

3.2) Calculate the travel time required to verify the frame rate of the recorded video file (Frame rate) by right-clicking the video file and selecting the properties menu. The frame rate of the video file showed in the details menu. It was expressed as the number of images recorded in 1 minute, for example, 30 frames/second, meaning that the video was recorded at a rate of 30 frames/second.

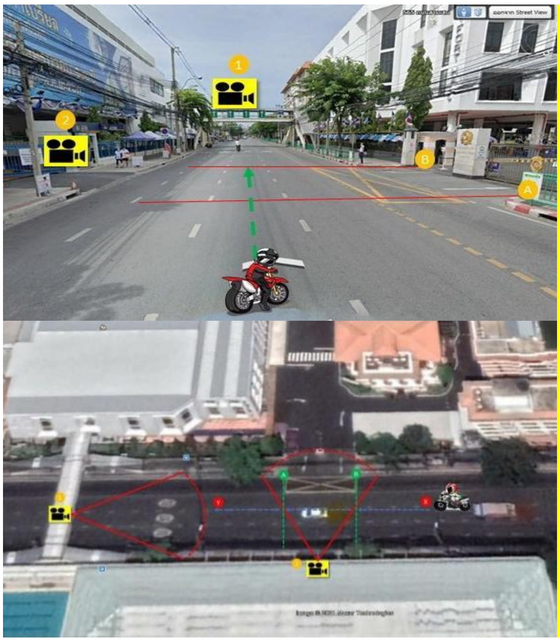

Figure 4. The location of the camera used to record and the direction of the recording of a motorcycle test ride, where 1, 2 were the positions of the camera. A, B were the reference points for measuring distances determined by the researcher.

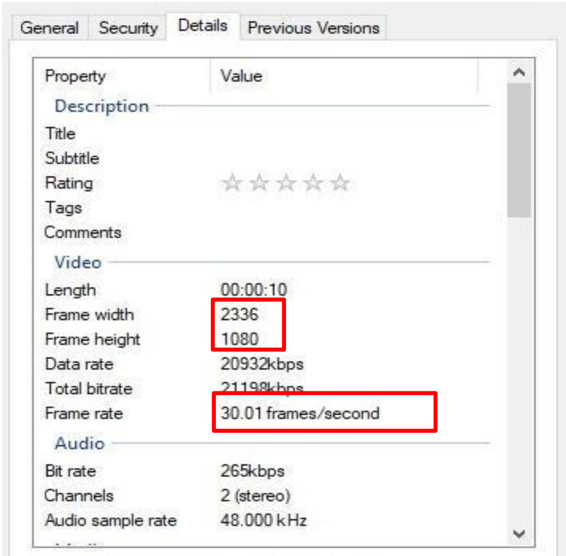

Figure 5. Find the frame rate with a free video to jpg converter.

4) Calculate the duration by calculating the number of frames required for the automobile to go from reference A to reference B using the formula below (1), where t is the amount of time the vehicle travels (seconds) between reference A and reference B, which is the frame rate of the video file.

$$t = \frac{n}{f} \qquad (1)$$

Motorcycle speed calculation can be found from equation (2), which is given by

$$v = \frac{s}{t} \qquad (2)$$

Where v is the average speed (meters per second) of the total distance with the traveling time t.

4. Results and Discussion

A tested motorcycle was at speeds of 40, 60, and 80 kilometers per hour. The time was obtained from video files from the smartphone camera of driving the motorcycle on a straight-line road. The road surface was Alfred. It was the daytime test on Samsen Road, from which the reference position on the Google Earth program was 13°46'33.51"N 100°30'25.96"E using 1 test motorcycle, a 2017 Yamaha GT125 CC. In a test ride moving through reference A and B was a record of the movement of an experimental vehicle with a video camera of a smartphone model SAMSUNG Galaxy A30 at the first and second positions to use the data from the video file to calculate the time spent on the motorcycle in motion. Two distance measurement

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methods were applied in this experiment: 1) measuring distances with Google Earth and 2) measuring distances with a standard distance meter (tape). The time and distance data obtained from the experiment used to calculate the speed of the vehicle test each speed level 30 times.

Table 1. The calculating speed at 40, 60, and 80 km hr^{-1} and counting the number of frames.

Speed (km hr^{-1})	Camera	Perpendicular angle (m)	
		Google Earth	Measurement
40	1	12.32	12.54
	2	8.28	8.23
60	1	12.32	12.56
	2	8.28	8.23
80	1	12.32	12.25
	2	8.28	8.23

However, according to the results, motorcycle speed calculation using data from mobile phones and distances measured by the Google Earth program was considered high accuracy, with the maximum discrepancy of 7.93%, which was in relation to the findings of Rad et al. (2010). This method would be beneficial for determining traffic violations, especially with vehicles driving over the speed limits; this method would be a good evidence source for offenders. For instance, if the legal speed limit is not more than 80 Km/h, and the actual speed of a motorcycle is 90 Km/h. Regarding the calculation, there was approximately 7.93% data discrepancy, resulting in the calculator displaying the data in the speed range of 82.07- 97.93 Km/h. From this, it could be proven that the previous vehicle exceeded the maximum speed limits. On the other hand, if an actual vehicle speed was at 85 Km/h, the speed calculation would range from 78.07-92.93 Km/h; this may cause future conflict if the driver's speed did not exceed the speed limits but got accused due to the false calculation.

Measuring distances by Google Earth, in some cases there may be inaccuracies of distance values depending on the accuracy of the user who determines the location from which the distance is measured. This can be caused by many factors, such as the sharpness of the image, current information, or even an angle that the program user chooses to use to determine the position.

5. Conclusions

This research calculated the speed of a motorcycle while driving with an animated smartphone. Speed test was on Samsen Road Bangkok, at speeds of 40, 60, and 80 km hr^{-1} at the Google Earth reference point (13°46'33.51"N 100°30'25.96"E), the test ride moves past the reference points A and B, recording the movement of the motorcycle with a camera. The 1st smartphone(camera) was firstly installed on the overpass position, where the second one was installed on the pavement perpendicular to the movement of the motorcycle. Data from video files were converted to image files to count the number of frames. Traveling time and distance of a motorcycle were used to calculate the speed of movement. It was assumed that the measured values were not different from those obtained from google earth when analyzing data analysis in excel using t-Test: Two samples were assumed to have equal variances. The result of the obtained speed is agreed with the hypothesis. It means that the values obtained from the measurements were not significantly different from those obtained from google earth at a significance level of 0.05.

6. Suggestions

This research presents the calculation of the speed of a motorcycle while driving with animation from a smartphone, which can apply to punish offenders in areas without speed detection. To prevent driving a motorcycle speed exceeding the legal limit will result in a decreased accident rate. This method can be applied to determine traffic violations with motorcycle driving speed exceeding the legal limit. This computational principle may be used as evidence for the arrest of the offender.

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