Journal of Forensic Sciences And Criminal Investigation
ISSN: 2476-1311

Juniper Publishers
key to the Researchers

Research Article
Volume 13 Issue 4 - April 2020
DOI: 10.19080/JFSCI.2020.13.555873

J Forensic Sci & Criminal Inves

A Method of Estimating the Distance and Relative Speed of an Object when a Vehicle Hits It, as Indicated in the Black Box Image Created at the Moment of Impact

Myung Cheol Park*, Jong Hyuk Kim, Won Taek Oh and Sang Hyun Lim

Traffic Accident Analysis Division, National Forensic Service, Republic of Korea

Submission: April 1, 2020; **Published:** April 13, 2020

***Corresponding author:** Myung cheol Park, Traffic Accident Analysis Division, National Forensic Service, Republic of Korea

Abstract

This paper proposes a method by which the distance and relative speed of a vehicle vis-à-vis the object it hit are measured using the phenomenon in which when a vehicle impacts another vehicle, a pedestrian, or another object, if the object is n times distant from the black box, its image looks about n times smaller.

Keywords: Forensic video; Car black box; Vehicle speed; Pixel; Distance; Relative speed; Impact; Collision

Method of Measuring the Distance and Relative Speed of an Object Hit by a Vehicle from the Images Created by the Vehicle's Black Box

a) Method of measuring the object filmed by the vehicle's black box

Figure 1 shows the method of measuring the distance of a tree filmed by a black box. The tree with 3 length was expected to be located 30 from the black box The aforementioned can be attributed to the fact that resembles , and as such, $\frac{\overline{DO}}{\overline{AO}}=\frac{\overline{DE}}{\overline{AB}}$ resembles ÄDOF and ÄAOC Thus, $\overline{DO}/\overline{AO}=\overline{FO}/\overline{CO}$. Therefore, $\overline{DE}/\overline{AB}=\overline{FO}/\overline{CO}$, so $3h/h=\overline{FO}/10m$, and $\overline{FO}$ is 30m. Figure 2 shows the method of measuring the distance of a stick filmed by the black box. At $t(=t_0-\Delta t)$ time, the reference stick was moved so that its distance from the black box could be assumed as $d=n_0 s_0$, and the reference stick was extended so that its extended length could be assumed as $h=n_h h_0$, with the top and bottom of the imaginary stick touching the imaginary lines. Then, $d=n_0 s_0 \fallingdotseq n_h s_0$ and $n_h=\frac{h}{h_0}$ $\therefore d \fallingdotseq \left(\frac{h}{h_0}\right)s_0$ was expected. In the above expression, can be attributed to the fact that the black box image magnification may vary according to the distance, and to the possibility of magnification may vary according to the distance, and to the possibility of distortion [1-4]. In addition, it was assumed that after the black box image was captured at , the pixel of h_0 would be p_0. Next, it was assumed that the pixel of captured from the black box image at was , and that the pixel of h_0 was p, and $n=\frac{p_0}{p}$.

Then, $d \fallingdotseq \left(\frac{h}{h_0}\right)s_0$, $\frac{h}{h_0} \fallingdotseq \frac{p_0}{p}$, and $n=\frac{p_0}{p}$.

The distance d of the reference stick moved from the black box was estimated using the expression below.

$$\therefore d \fallingdotseq ns_0=\left(\frac{p_0}{p}\right)s_0 \ldots (1)$$

b) Method of Measuring the Distance and Relative speed of a Pedestrian and the Vehicle ahead Filmed by the Black Box

Figure 3 & 4 shows the method of measuring the distance and relative speed of a pedestrian filmed by the black box. If the pedestrian's distance from the black box is and the distance between the vehicle and the pedestrian is , then $s=d-s_0$. Therefore, the distance is expected [5-9].

$$\therefore s \fallingdotseq ns_0-s_0=\frac{p_0}{p}s_0-s_0 \ \ldots (2)$$

Further, if, at , the relative speed of the vehicle and the pedestrian is , is expected in the expression below.

$$\therefore v \fallingdotseq s/(t_0-t)=\left(\frac{p_0}{p}s_0-s_0\right)/(t_0-t) \cdots (3)$$

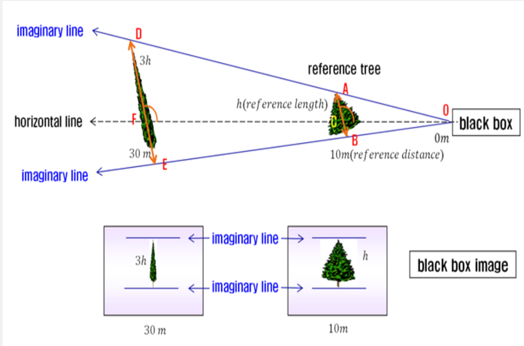

Figure 1: Method of measuring the distance of a tree filmed by the black box.

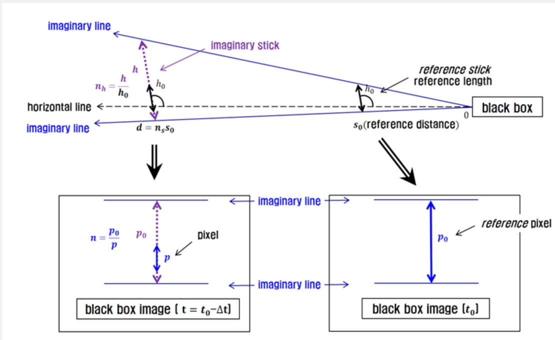

Figure 2: Method of measuring the distance of the stick filmed by the black box.

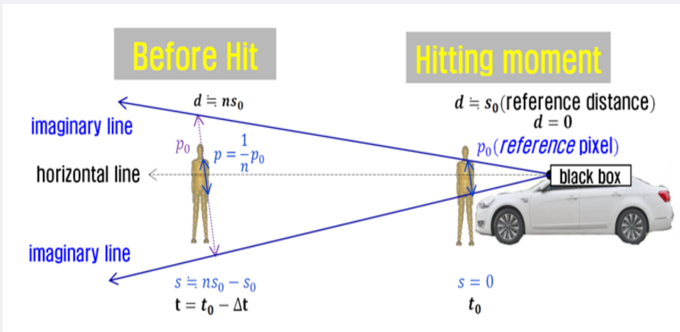

Figure 3: Method of measuring the distance of a pedestrian filmed by the black box.

Figure 4: Method of measuring a vehicle's distance from the vehicle ahead of it filmed by the black box.

How to cite this article: Myung Cheol P, Jong Hyuk K, Won Taek O, Sang Hyun L. A Method of Estimating the Distance and Relative Speed of an Object when a Vehicle Hits It, as Indicated in the Black Box Image Created at the Moment of Impact. J Forensic Sci & Criminal Inves. 2020; 13(5): 555873. DOI: 10.19080/JFSCI.2020.13.555873

Conclusion

This study proposed the following [10-14]. If, at the time when a vehicle hits an object, the horizontal distance from the vehicle black box to the part of the object that was hit is assumed as reference distance ; the pixel length of the part of the object that was hit is assumed as ; and at the time of rewinding the black box, the part of the object that was hit is assumed as , the expression $s=\left(\frac{p_0}{p}s_0-s_0\right)\yen a$ and correction factor are proposed for measuring the distance s from the vehicle to the object, and $v=\left(\frac{p_0}{p}s_0-s_0\right)\yen a/(t_0-t)$ and correction factor for measuring the relative speed of the vehicle and the object are proposed. In the experiment in this study, while the Hyundai Veracruz SUV was travelling, its installed black box filmed the dummy. Then the Veracruz black box filmed the rear side of the Sonata when it faced the front, when it turned, and when the Sonata offset it. Then the proposed method measured the distance from the black box images. The image distortion correction factor was applied to the expression $s=\left(\frac{p_0}{p}s_0-s_0\right)\yen a$. This confirmed a greater accuracy in distance. Thus, the correction fact**o**r for correcting the two said situations was applied to the expression $v=\left(\frac{p_0}{p}s_0-s_0\right)\yen a/(t_0-t)$, and this confirmed a greater accuracy in speed. In the experiment, the four black boxes filmed various impact experiments, and in the consequent impact images, the correction factor of 1.1 was unilaterally applied to the expression $v=\left(\frac{p_0}{p}s_0-s_0\right)\yen a/(t_0-t)$. As such, the vehicle's pedestrian impact speed average error was determined to be 4.1%, and the maximum error, 3.1 km/h (7.9%), at about 40 km/h. The vehicle's vehicle impact speed average error was measured as 3.1%, and the maximum error was measured as 2.1 km/h (5.3%), at about 40 km/h. This confirmed that the measured speed error was not big. Therefore, in this study, in the general case of a sedan hitting another sedan, a universal correction factor 1.1 was estimated. In this study, we proposed $v=\left(\frac{p_0}{p}s_0-s_0\right)\yen a/(t_0-t)$ and correction factor for the measurement of the relative velocity between the vehicle and the object. In order to reduce the error that occurs in a remarkably complicated situation, only the correction factor is introduced. However, many experiments have confirmed that the error is not large. This equation is very simple and can be used conveniently in actual situations. Thus, this study confirmed that the proposed method can estimate the distance from a vehicle to the object it hit in a traffic accident, and the relative speed of the object compared to that of the vehicle that hit it, using the images created by the vehicle's black box. In addition, this method is expected to be further verified and supplemented by widespread use in actual traffic accidents. For this method, the relative speed estimation will be further studied in cases where the black box is rotated and the vehicle is offset. The method will be used in the development of programs that are specially designed to calculate the relative speed in real time.

References

1. I Han (2016) Car speed estimation based on cross-ratio using video data of car mounted camera (black box). Forensic Sci Int 269: 89-96.
2. T Wong, C0 Tao, Y Cheng, K Wong, C Tam (2014) Application of cross-ratio in traffic accident reconstruction. Forensic Sci Int 235: 19-23.
3. G Edelman, J Bijhold (2010) Tracking people and cars using 3D modeling and CCTV. Forensic Sci Int 202: 26-35.
4. J Lan, J Li, G Hu, B Ran, L Wang (2014) Vehicle speed measurement based on gray constraint optical flow algorithm. Optik 125: 289-295.
5. D Jeyabharathi, D Dejey (2016) Vehicle tracking and speed measurement system (VTSM) based on novel feature descriptor: diagonal hexadecimal pattern(DHP). J Vis Commun Image R 40: 816-830.
6. NC Mithun, T Howlader, SM Rahman (2016) Video based tracking of vehicles using multiple time-spatial images. Expert Syst Appl 62: 17-31.
7. J Sochor, R Juranek, A Herout (2017) Traffic surveillance camera calibration by 3D model bounding box alignment for accurate vehicle speed measurement. Comput Vis Image Underst 161: 87-98.
8. Jong Hyuk Kim, Won Taek Oh, Ji Hun Choi, Jong Chan Park (2018) Reliability verification of vehicle speed estimate method in forensic videos. forensic Sci Int 287: 195-206.
9. R Fay, R Robinette, D Deering, J Scott (2002) Using Event Data Recorders in Collision Reconstruction. SAE 1: 0535.
10. J Lawrence, C Wilkinson, B Heinrichs, G Siegmund (2003) The Accuracy of Pre-Crash Speed Captured by Event Data Recorders. SAE 1: 0889.
11. C Wilkinson, J Lawrence, B Heinrichs, D King (2005) The Accuracy and Sensitivity of 2003 and 2004 General Motors Event Data Recorders in Low Speed Barrier and Vehicle Collisions. SAE 1: 1190.
12. R Brown, L Lewis, B Hare, M Jakstis, R Landis, et al. (2010) Confirmation of Toyota EDR Pre-Crash Data. SAE 1: 0998.
13. HC Gabler, DJ Gabauer, HL Newell, ME O Neill (2004) Use of Event Data Recorder (EDR) Technology for Highway Crash Data Analysis. Annual Research Report of NCHRP.
14. GA Nystrom (2010) Analysis of Multi-Vehicle Rear-End Accidents. SAE 1: 0055.

How to cite this article: Myung Cheol P, Jong Hyuk K, Won Taek O, Sang Hyun L. A Method of Estimating the Distance and Relative Speed of an Object when a Vehicle Hits It, as Indicated in the Black Box Image Created at the Moment of Impact. J Forensic Sci & Criminal Inves. 2020; 13(5): 555873. DOI: 10.19080/JFSCI.2020.13.555873