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Electric kickboard safety regulation violation checking system using image classifier

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Abstract. As the safety accidents of electric scooters have been increasing, the electric kickboard-related legislation was revised in 2020. The revised road traffic law about kickboards is mandatory to wear helmets and bans the onboarding of any passenger when driving electric kickboards. In this paper, we propose a system for checking violations of safety regulations for electric kickboards using an image classifier. First, the proposed violation enforcement system is installed where shared kickboards are frequently parked and stopped. Also, when driving an electric kickboard, our system determines whether the driver has worn a helmet and whether the passenger is on board or not. Then, our system emits a warning sound when the law is violated. The proposed system consists of MCU, camera, and buzzer. The proposed system implements the OpenCV to receive real-time video from the camera connected to the MCU and then estimates the violation of the law using the YOLO algorithm. In this paper, we compare and analyze the fastest v5s and the most accurate v5x among the four types of YOLO v5s, v5m, v5l, and v5x, and we adapt the exact algorithm. Our system determines whether the recognized person wears a helmet with the object recognition after receiving and learning the helmet/head dataset. We then establish a bounding box for the total size of objects recognized as human beings and objects recognized as electric kickboards to determine whether a passenger is on board or not. If our system recognizes two or more persons within the bounding box area of the electric kickboard, it estimates a passenger with our violation policy. Also, the proposed system makes an alarm when an electric kickboard driver is not wearing a helmet or more than one person is on board. Accordingly, the proposed system encourages that electric kickboard drivers drive in a safe state. Therefore, the proposed approach is expected to reduce

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injury in an accident by wearing a helmet and reducing the risk of an accident by riding a single person.

Keywords; Yolo, kickboard, detect, MCU

1. Introduction

Due to the convenience of single-seater transportation and the social distancing caused by COVID-19, the number of people using a type of contact transportation, shared kickboard, has increased significantly. [1]

As the number of people using Personal Mobility increased, the number of accidents also increased. The number of electric kickboard safety accidents filed with the Korea Consumer Agency's Consumer Injury Surveillance System (CISS) more than doubled to 243 by November 2019 and 571 by November 2020. [2]. With the recent increase in electric kickboard safety accidents, the Electric Kickboard-related Road Traffic Law was revised in December 2020. Under the existing Road Traffic Law, anyone aged 13 or older could operate without a license or safety helmet. However, under the revised Road Traffic Law, electric kickboards can be operated only when a license is issued. In addition, a fine for wearing a helmet and a punishment clause for riding an electric kickboard for more than two people were added [3].

Therefore, this paper proposes an electric kickboard safety violation system using an image classifier. The suggested electric kickboard safety regulations violation checking system is set up on the street where the shared kickboard is often parked and where the shared kickboard is frequently seen. Then checks whether or not an electric kickboard user wears a helmet and whether there is a passenger. Furthermore, this invention aims to provide buzzer notification in case of violation and guide the electric kickboard driver to take the initiative in operating in a safe state.

2. Related Work

Kang Tae-won et al. proposed a system that takes pictures of users before and while driving and determines whether they can wear helmets and rent kickboards in real-time. Using the model learned from YOLOv3, the deep learning-based search system is implemented to continuously check whether electric kickboard users wear helmets before and during driving[4].

Yonten Jamtshoa, Panomkhawn Riyamongkolb, Rattapoom Waranusastb presents real-time license plate detection using YOLOv2 for motorcycle drivers without helmets.

In addition, using the primary tracking method with the coordinates and horizontal datum of the boundary box, Only the helmet came out of the frame. It handled the situation where the helmet was recognized as missing[5].

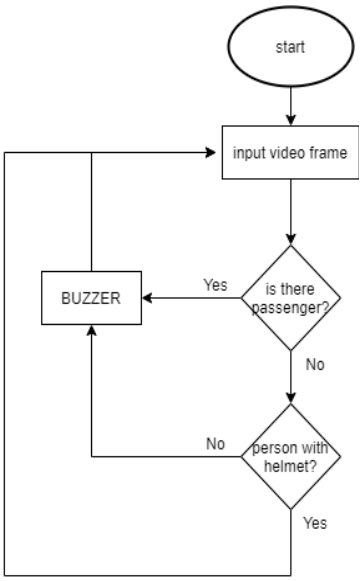
3. Electric Kickboard Safety Violation Checking System Design

3.1 Object Detection

Use yolov5 to detect objects in images. The YOLO algorithm stands for You Only Look Once and is a well-known model in Object Detection. The YOLO algorithm uses a method of processing the entire image simultaneously, so it has a faster and higher mean average precision (MAP) than the existing deep learning algorithm [5]. Currently, YOLO is being developed from v1 to v5, and this paper uses v5. v5 can be divided into four categories: s, m, l, and x, depending on the backbone type-s has the lowest number of layers, and x has the highest number of layers and the lowest number of layers. In this paper, YOLOv5s is used because the system operates in an embedded environment, YOLOv5s is used.

3.2 System Overview

Figure 1 shows the flowchart embodied in this paper.YOLOv5s is used to explore electric kickboards, people, helmets, etc., in real-time. The proposed system receives video frames as input and outputs buzzer alarms. The proposed system first checks if passengers are in the electric kickboard and then checks if the electric kickboard driver is wearing a safety helmet. The buzzer alarm is set off when people ride with another person or don’t wear a safety helmet.



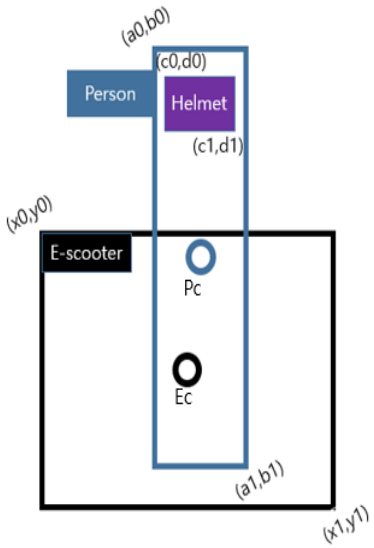


Fig. 1. System overview Fig. 2. Bounding box coordinate representation of three classes

3.3 Judgment of violation of law

3.3.1 determining whether or not a passenger is on board

Based on Figure 2, the proposed system finds the coordinates of (a0, b0), (a1, b1) from the boundary box of the Person object and finds the coordinates of the point PC. In this way, find the center point of the Person object and determine whether it is between the bounding box areas (x0,y0) and (x1,y1) of the E-scooter. If the center point in the Person object is more than two, it is judged that there is a passenger.

3.3.2 Determining whether to wear a helmet

First, determine whether an object is recognized as a helmet. If there is no object, it is judged that you are not wearing a helmet. On the contrary, If there's an object recognized as a helmet, x coordinates c0, c1 are obtained from the boundary box of the helmet object, and the center value is calculated. The helmet is determined to be worn between the boundary box areas (x0, y0), (x1, y1).

4. Experiment and implementation of an electric kickboard safety code violation checking system.

4.1 Hardware Implementation

The proposed system processes the video input from the camera in real-time and judges whether the driver of the electric scooter complies with the safety regulations. As a result, if it is judged that compliance with the law is insufficient, a buzzer is sounded to warn the user. Therefore, the proposed system uses an embedded board, a USB camera, and a buzzer to execute the above operation.

The proposed system hardware uses NVIDIA Jetson Nano board, USB camera, and Keys' manual buzzer module. A USB pin connects the camera, and a jumper cable connects the manual buzzer.

4.2 Image classifier

In this chapter, the Yolov5 model is learned and compared to select the most suitable image taxonomic model for deep learning-based real-time object recognition in the embedded module. Learning uses image data that directly labeled electric scooters, automobiles, people, heads, and helmets. Learned image classifiers evaluate performance as important model performance indicators in real-time object recognition. Real-time object recognition performance indicators use mAP values as the average area of the Recall, Precision, and Recall graphs as the percentage of the actual correct answers.

4.3 Image classifier training

Our experimental environment(Google Colab, Intel® Xeon® CPU @ 2.20Ghz and TeslaV100-SXM2-16GB) is used for image classifier training. The model used as an image classifier in this chapter is selected by comparing the fastest Yolov5s with Yolov5x, which has slower but more powerful performance, among the recently developed Yolov5 [6]. The weighted values of the Yolov5 model learned do not include electric scooters. Therefore, the learning data set of the image taxonomer model used in this paper uses five types of image data: electric scooter, human, head, helmet, and car, which are directly labeled with custom data set with electric kickboard data. In addition, 500 epoch iterative learning is carried out for high precision weighting.

4.3.1 Image Classifier Comparison

Yolov5s and Yolov5x, used as image classifiers in the proposed system, compare the post-learning mAP with the Recall and Precision values. Table 1 compares the average results of mAP, recall, and precision for Yolov5s and Yolov5x after 500 epochs of image classifier model learning.

Table 1. Yolov5s and Yolov5x Comparison Results

performance indicator	Yolo v5s	Yolov5x
mAP	0.532%	0.511%
Recall	0.53%	0.54%
Precision	0.699%	0.65%

In Table 1, Yolov5s has slightly higher mAP and precision than Yolov5x. In this paper, the image classifier model should be installed on a small board such as the NVIDIA Jetson Nano board and detect whether or not to wear a helmet and whether more than two people are on board. Therefore, Yolov5s, which has a high speed for object detection and better performance indicators, will be used as an image classifier to determine violations of regulations.

Fig. 3

Fig. 4

Fig. 5

4.4 Experiment result

Figures 3, 4, and 5 show how a passenger is on board, a situation in which a helmet is not worn, and a situation in which a helmet is worn in the proposed system. In addition, a boundary box is set according to each detected object, and a point is displayed in the center of each boundary box.This shows that the learned model searches for the target object and displays the central coordinates. Therefore, the proposed system can provide buzzer notifications when not wearing a helmet and boarding a passenger.

5. conclusion

In this paper, a system for enforcement of electric kickboard safety regulations was proposed. The proposed system consisted of an NVIDIA Jetson Nano board, USB

camera, and buzzer and was implemented using YOLO v5s. By sounding a notification on the input image when two or more people are not wearing a helmet or riding, it induces the electric scooter driver to drive in a safe state. Therefore, lowering the degree of injury in an accident by wearing a helmet and the effect of reducing the risk of an accident by riding alone is expected.

References

[1] *Heecheol SHIN*.*Jaeyong LEE*.*Sari KIM* (2016)," Study on the improvement of Laws and Regulations for Personal Mobilities ." THE KOREA TRANSPORT INSTITUTE 11.11(2016): 5-27,41-55

[2] korea consumer agency https://www.ciss.go.kr/www/selectBbsNttView.do?bbsNo=85&nttNo=35433&key=189

[3] The Road Traffic Authority

[4] https://www.koroad.or.kr/kp_web/krPrView.do?board_code=GABBS_050&board_num=135428

[5] Kang Tae-Won, Min Jang Kyu, Min Pyeong Hong, Park Jang Sik, Junho Jeong, Seungmin Oh, Gayoung Kim. "A Method for Detecting Helmet Wear Using Yolo" The Institute of Electronics and Information Engineers . (2020): 2117-2119.

[6] Yonten Jamtsho, Panomkhawn Riyamongkol, Rattapoom Waranusast, Real-time license plate detection for non-helmeted motorcyclist using YOLO, ICT Express, Volume 7, Issue 1, 2021, Pages 104-109, ISSN 2405-9595

[7] Jocher, G., Nishimura, K., Mineeva, T., Vilariño, R.: YOLOv5 (2020). https://github.com/ultralytics/yolov5. Accessed 10 July 2020