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Helmet Detection Based on Cascade Classifier and Adaptive Boosting

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Abstract - The increasing number of traffic accidents caused by motorcyclists not wearing helmets has led to an increase in the number of studies related to road safety surveillance. The research system used is an automatic system to detect whether the motorcyclist is wearing a helmet or not. Many studies use image processing systems, deep learning and computer vision. In this research, Cascade Classifier and Adaptive Boosting have been implemented for the process of identifying motorcycle riders with helmets and without helmets. The number of datasets used is 500 datasets with labels on the image of the driver with a helmet and the image of the driver without a helmet. Based on the test results, an accuracy of 90% has been obtained.

Keywords – Helm, Detection, Adaptive Boosting, Cascade Classifier.

1. INTRODUCTION

In the millennial era, especially in the 20th century, the number of vehicle users in Indonesia continues to increase, motorized vehicles are a type of transportation in demand by almost all levels of Indonesian society. Motorized vehicles are one form of transportation that has affordable prices, and are in great demand by various groups of people, so it's no wonder that several big cities in Indonesia choose motorbikes for everyday transportation to move from one place to another quickly compared to using other transportation facilities. public transportation facilities [1]–[3]. Motorized vehicles that have flexibility for users and have more affordable prices are the choice of private vehicles. When riding a motorcycle, the rider must bring vehicle certificates and wear a helmet [4]. Helmet is one of the requirements for protective equipment that must be used, especially for motorbike riders. There are various types of helmets such as full face helmets, half face helmets, and retro helmets. And each type of helmet has advantages and disadvantages of each [5], [6]. In addition to being a safety protective equipment, several types of helmets have very varied variants of image motifs and colors so that they can add to the style of the helmet user. Helmets are also needed by all groups from children to adults. Helmets as one of the safety gear for motorcyclists are still often overlooked. Due to the negligence of many motorists, the number of accidents involving motorcyclists without wearing helmets is also quite high [7], [8]. Some of the functions of the helmet include [9]:

1. As one of the equipment in driving that must be used by motorbike riders, because the use of a helmet is a regulation that must be obeyed by motorists in accordance with driving traffic regulations.
2. Protecting the head from collisions that might occur to motorists, because we will definitely spend a lot of time on the road driving, for that in anticipation, especially on our heads, it is mandatory to use a helmet for the safety of motorists.

3. Protect the view from various distractions that irritate the eye while riding a motorcycle.

Everyone who drives a motorcycle and motorcycle passengers must wear a helmet that meets Indonesian national standards. The obligation of road users in traffic is to comply with applicable regulations, one of which is that motorcyclists are required to wear helmets. Motorcycle users who violate these regulations will get warnings or sanctions, but there are still many motorbike users who are found not to be wearing helmets on the road because they are not monitored by officers or other things [10]. Of the various violations, one that is often found in traffic raids, many motorists do not wear helmets. One alternative solution in minimizing road violations is to implement visual violation detection, for example on city streets, there are still many motorcyclists who do not use helmets [11], [12].

One of the mandatory conditions used in driving a vehicle on the highway is to wear a helmet. Helmet is a term from the Dutch language which means a tool to protect the limbs that are used on the head [13]. In Indonesia, helmets are generally made of arccylonitrile butadiene styrene (ABS), the basic ingredients of kevlar and resin fibers. The function of the helmet is to protect the head from impact.

In this study using the Haar Cascade Classifier method, this method has high speed and accuracy because it combines several concepts (Haar Feature, Integral Image, AdaBoost, and Cascade Classifier) into a main method for detecting helmet head protection objects. The final result to be obtained is a system capable of detecting whether a motorist is using a helmet or not.

2. RESEARCH METHOD

2.1. Helm

There are several variations/types of helmets, namely full face helmets, half face helmets, and retro helmets which are detailed as follows [1], [2], [14]–[17]:

1. Full Face Helmet: is a helmet that covers the head completely, usually a full face helmet is used for long distance travel such as touring, bad weather (rain, storms and strong winds). In accordance with the name of the type of helmet that covers the entire head, a full face helmet has the safest level of security to protect the head in the event of an accident. Besides being used for touring, full face helmets are also used for racing and driving at high speeds. Because it can protect the face from the wind which can block the view of the rider.
2. Half Face Helmet: is a helmet that covers the head half of the face, this type of helmet is usually used for riders who use motorbikes for daily activities because it is lightweight and not too big. The half face helmet has a simple shape that makes it easy to put on and take off so it is suitable for all ages.
3. Retro Helmets: Retro helmets are helmets that are of the bogo type, for these helmets are usually used more for style and style, although these helmets are widely used for rider styles, retro helmets still have safety standards in the event of an accident.

In making the structure of the helmet itself, there are several layers designed to protect the head optimally in order to protect the user. A sturdy helmet usually consists of four main structures as follows:

1. Outer layer (hard outer shell): It is the outermost layer of a hard helmet commonly called a shell or helmet shell.
2. Thick inner layer (liner / inside shell): It is the second layer of the helmet for shock absorbers from collisions with the outer layer of the helmet, this layer is usually given sterofoam for the impact absorbers.

3. Soft inner layer (comfort padding): This is the part of the helmet that is soft because this part is in contact with the head. This section is usually a thick cloth.
4. Tie strap: A strap to tie to the chin which functions to keep the head and helmet from being easily detached in the event of an accident or collision.

Full Face Helmet Half Face Helmet Retro Helmets

Figure 1. Helmet Types Visualization

2.2. Haar Cascade Classifier

A classifier chain is a degenerate decision tree in which at each stage, the classifier is trained to detect almost all objects of interest while rejecting a small subset of non-object patterns [10], [18]. The idea of the Haar-like feature is a classifier that is trained with a number of sample images of an object. The classifier is trained using the Adaboost algorithm Haar Cascade Classifier [10] is a method commonly used in object detection. Haar Cascade Classifier is a rectangular feature (square functions), which provide specific indications on an image as shown in Figure 2. In principle, that is recognizing objects based on the simple value of the feature but not the pixel value of the object image [10], [13], [19], [20]. Haar Cascade Classifier is a combination of four algorithms so it has a good level of accuracy. The four algorithms are:

1. The scan of the test image uses a black and white rectangular feature called the Haar-Like feature.
2. Integral image for fast detection.
3. Adaptive Boosting (AdaBoost) machine learning method.
4. Cascade classifier for object detection in stages.

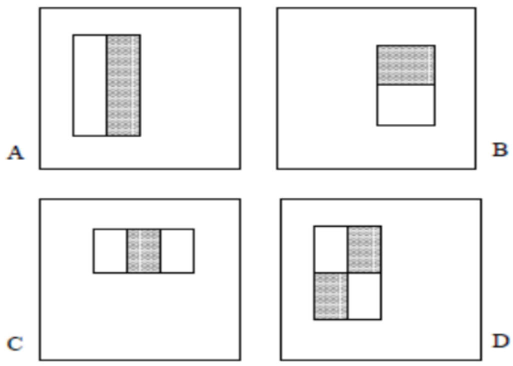

Figure 2. Haar Feature

The feature used in the Haar Cascade Classifier is a rectangular single wave consisting of black and white pixels. Cascade classifier is a stage classifier chain, where each stage classifier is used to detect whether the image sub window contains the desired object (object of interest). The stage classifier is built using the adaptive-bosst algorithm (Adaboost) [21]. The algorithm combines the performance of many weak classifiers to produce a strong classifier. Weak classifier in this case is the value of the haar-like feature [9].

Haar-like features generate a very large number of features. All features are selected using the adaboost algorithm. Through the process of iteration and training image weighting, each feature is tested one by one for how well it separates positive and negative samples [22], [23]. Training data on Haar requires 2 types of object images in the training process, namely:

1. The object is a helmeted rider
2. The object is a rider without a helmet

2.3. Proposed Method

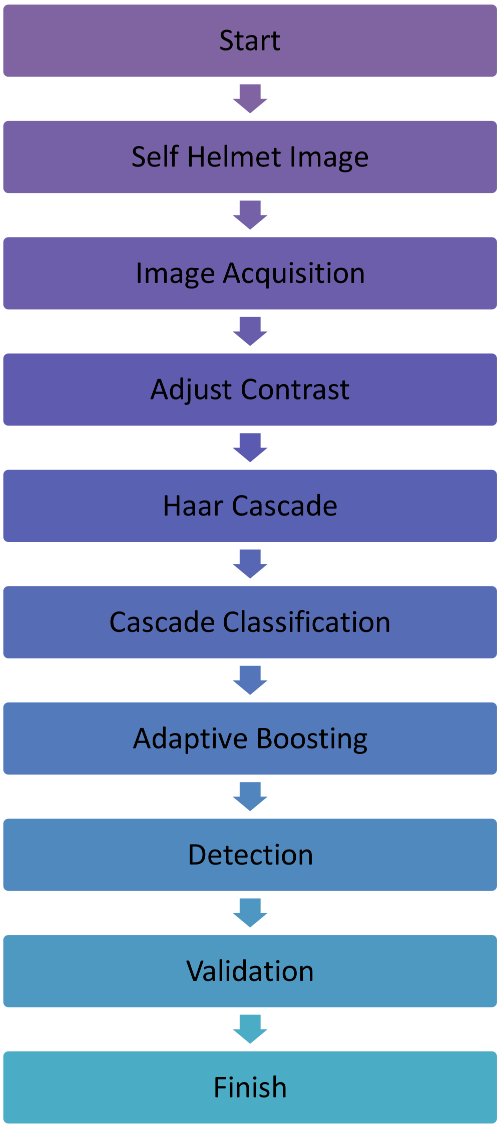

Figure 3. Proposed Method

Based on Figure 3, proposed method has been describe as follow :

1. Scanning is done by placing the Haar feature starting from the coordinate pixel (x,y) = (0,0) or the top left corner pixel. After calculating the following processes, the Haar feature moves to the right, namely coordinate (1,0) and the calculation process is again carried out. If it has reached the maximum x coordinate, then x returns to 0

and the Haar feature moves to the next y value, namely the (0,1) coordinate. The process continues until it reaches the last coordinate, namely the pixel at the bottom right corner.

2. Cascade Classifier, multilevel classification, or also commonly called multilevel filtering is the final algorithm in object detection using the Haar Cascade method. This algorithm works to get the best accuracy in object detection. The classification in this algorithm consists of a number of levels according to the stage determined at the time of making the dataset. The more the number of stages, the fewer sub-images will be filtered as objects with the strongest classifier values.
3. At this stage, calculations are performed on each scanned sub-image using the Haar-Like feature for n stages. The calculations performed for each classifier are calculating the difference between the average number of pixels in the dark area and the average number of pixels in the light area on the scan using the Haar feature which has been through Adaptive Boosting. If the difference value is greater than the threshold value, then the scanned sub-image is said to be an object.
4. There are four main processes in detecting motorbike rider objects using the Haar Cascade Classifier method, including: determining the Haar Feature, calculating feature values with Integral Image, analyzing the AdaBoost algorithm to determine whether a feature contains motorbike rider objects with a series of filter classifiers and performing analysis. Cascade Classifier to filter image values by assigning weight values to pass through each filter so that motorcycle rider objects can be identified in the image.
5. AdaBoost which aims to combine many less sharp images (weak classifiers) to become sharper images (strong classifiers) by giving weight to the weak classifiers images.
6. To be able to create an application system for identifying motorbike riders without helmets, several processes are carried out, including through the stages of video processing with digital image processing to obtain identification of motorbike riders, which can then be identified using helmets. The following are computer specifications used to support system development.
7. In this scenario, testing was carried out to determine the accuracy of the system based on the influence of the time data collection was carried out, namely in the morning, afternoon and evening, and two conditions were given to the helmet, namely for full helmets and half helmets, both of which are helmets with SNI (National Standard). Indonesia). Tests were carried out to find out at what time this system test can maximally find helmet objects on motorbike riders.
8. In this scenario, a test was carried out to determine the accuracy of the system based on the influence of the angle of data collection. The test was carried out at angles of 0°, 45° and 90°, and two conditions were given to motorcycle riders, namely single and two-wheeled riders. The test was carried out to find out at what angle this system test can maximally find helmet objects on motorbike riders

3. RESULTS AND DISCUSSION

In this study used 200 datasets. Object images are taken using a smartphone camera, with angles of 00 450 and 900. The image format used and the size of the image are different. The image is divided into 2 classes, namely helmeted and non-helmeted objects with front, side or rear view images and data distribution as shown in Table 1 dan Figure 4.

Table 1. Dataset

Class	Format images	Amount of image	Training	Testing
Helment	Png	25	25	5
	Jpg	40	29	11
	Bmp	35	27	8
Wihtout Helmnet	Png	20	12	8
	Jpg	25	17	8
	Bmp	55	35	20

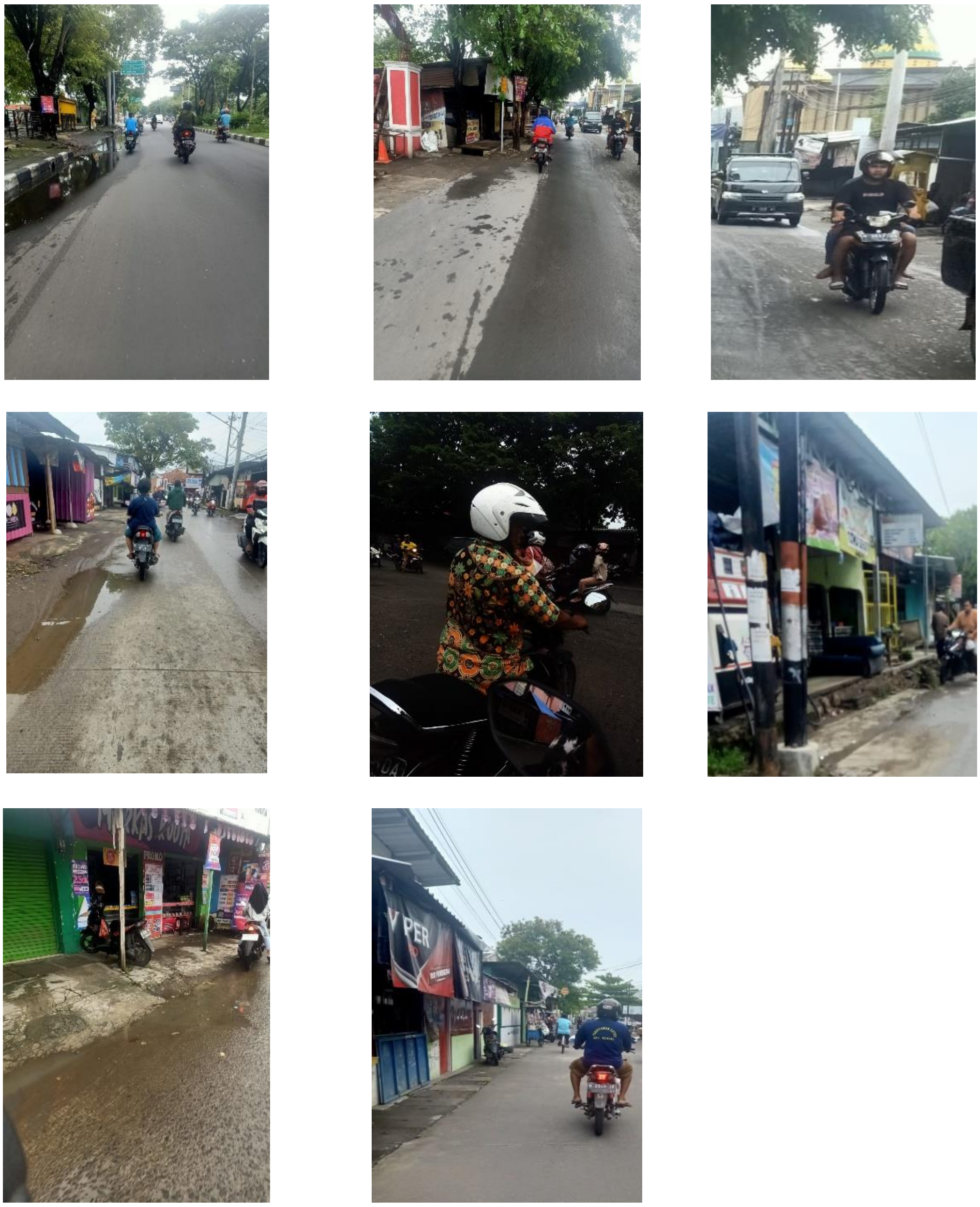

Figure 4. Sample of data collection

In Figure 5, the results of the identification of helmeted and non-helmeted objects have been shown. Out of all the objects, there are 8 incorrectly detected images while 192 correctly detected images. Most of the wrong images of objects are caused by objects that are too far in the corner of the image. In this study the cropping process was not carried out, so that in images with objects located at the edges, it is possible to detect errors as shown in Figure 5.

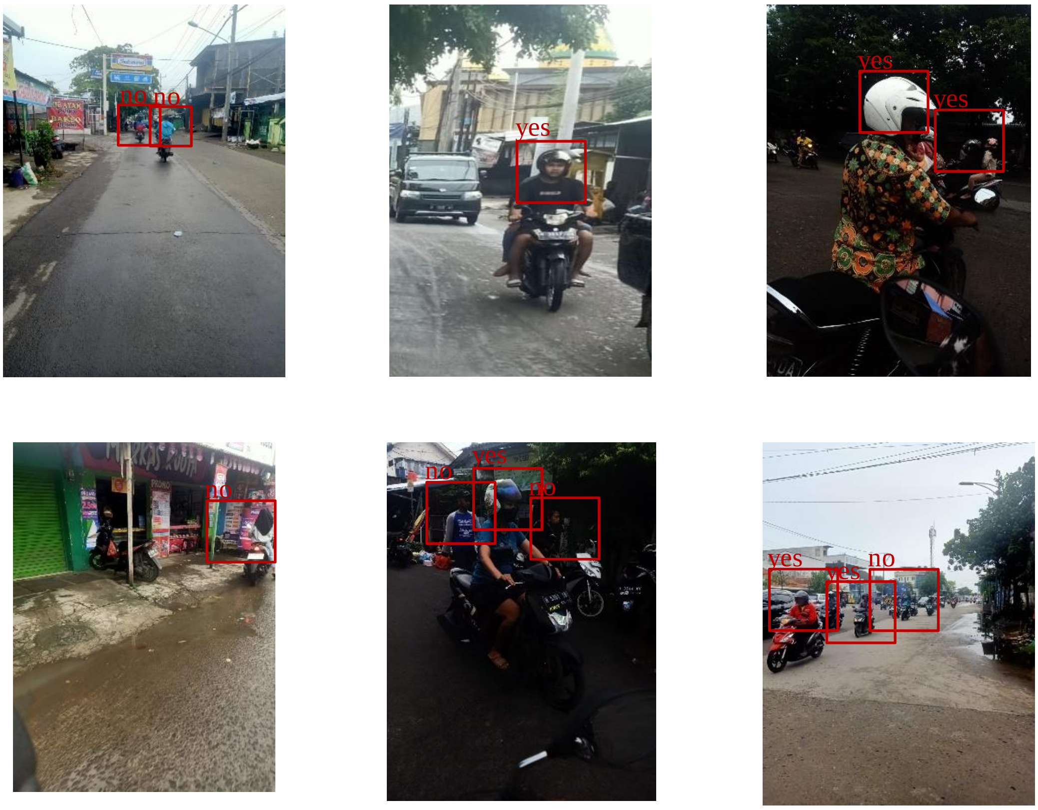

Figure 5. Sample of Image Recognition

Based on Figure 5, it is known that the results of image recognition are affected by brightness, object distance and object position. Images with more than 1 helmet object can still be recognized correctly.

4. CONCLUSION

In this paper, tests have been carried out with various conditions of motorcycle riders, whether they are wearing helmets or not. Of the 200 datasets divided by 100 datasets for each class, the highest test accuracy was obtained, namely 95%. Some of the test results that were declared undetectable were caused by objects that were blurry or too far away. The brightness of the object also affects the identification process. In future research, it is necessary to choose the right contrast value according to the needs of the object and use a photo distance of less than 10 meters so that the object is clearer.

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