Detection of Safety Helmet Using Principal Component Analyst (PCA) Method

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Abstract. The development of face detection can be utilized in various fields, one of which is to detect work safety tools such as protective helmets in a project that requires work security. The facial area is a part of the human body that is the focus of attention because it is the basis of detection, because the face plays a vital role by showing identity and emotions. Detection of work safety equipment in the form of helmets is a challenge because how to know the difference in face with helmet and not use helmet. Therefore, the face is used as an organ of the human body that is used as an indication of detection can even be developed into a person's recognition or face recognition. Facial recognition technology is a method used for detection, image matching, and video tracking. This research is to create a design concept to detect areas of the face that use android-based work safety helmets. In this system, the PCA method is used. The PCA method is used for the characteristic extraction of training imagery and test imagery. This research aims to design in detecting faces using helmets well with the expectation of accuracy of this method reaches 90%.

INTRODUCTION

Today, high-complexity work systems such as construction are in dire need of effective safety management. Based on data, more than two million workers at the international level have experienced work accidents every year[1]. With this fact, it takes the application of simple methods to become a reliable and efficient control solution with the development of IT-based devices so that work safety can be improved.[2]. At this time, Resilience Engineering (RE) conducts research on the concept of occupational safety management. Resilience Engineering (RE) It is used to develop a new concept of work safety and approach to occupational accidents. A series of human movements and physiological signals can be detected precisely and well under any conditions such as the development of personal protective e-textiles[3]. It is a positive approach to the success of a project in a work environment with high pressure and complexity to produce products that support safety management.[4].

The field of construction is a very dangerous industry because it has a hard working environment with all the high risks it incurs[5]. New Zealand provided Accident Compensation in 2016 reaching 20.9% in Europe (Eurostat 2016), reaching 30% and in the UK (HSE 2016). In China, 1,732 work accidents and 1,752 deaths occurred in the construction industry in the first half of 2018, up 7.8%[5]. Construction industry employees are at significant risk of being injured or killed compared to employees in the sector. Accidents not only cause economic losses but also have serious impacts on families, businesses, and communities. The global construction industry is witnessing unacceptable levels of risk, and massive security concerns. Not only in developing countries, the construction industry is also recognized by developed countries such as the US and the UK is a dangerous industry [6]. Data released by global statistics, the number of accidents to death and injury has a higher level of risk than in other fields. Although it has been highly relaxed in some research on safety management, accidents in the construction industry continue to be high [4].

The goal of the development of this project is to make a protection system detect on the helmet for work safety as well as in motorcyclists[7]. The system's proposed approach could automatically monitor whether workers wear helmets or not[8].

This research at an early stage demonstrates current safety practices relevant to monitoring in the field, then discuss potential roles and use computer vision for safety observation and inspection. It then uses specific methods to create computer vision applications that can directly be used for work safety monitoring. Overall, the study addresses technical challenges and potential problems when applying computer vision-based approaches in practice [9]**.**

BASIC THEORY AND METHODOLOGY

a. Image Engineering

Face detection techniques can be explained into two groups of first feature-based approaches and image-based approaches. Image-based approach using linear sub-room methods, neural networks and statistical approaches to face detection. The feature-based approach can be further subdivided into low-level analysis, feature analysis and active form models[10].

b. Preprocessing

Face detection is the first step in a facial recognition system. Facial recognition is a method used for facial detection in the form of images or videos. Face detection in this study uses an android camera so that the results of objects caught in the form of video. Video is a collection of frames or images recorded in sequence. Each frame is taken for face detection.

At a later stage is a cropping. Cropping is the process of minimizing an image by cutting at specific coordinates. The cropping process aims to eliminate noise, thereby getting a certain part of the image. Noise is some of the information in the image that is detected but the information is not needed for research. RGB images have three constituent colors: red, green, and blue. The constituent color can form a color combination on each pixel so as to form a new color. RGB images have 16 million colors. Grayscale image is a gray color image that has a color of 8bit or 256. Grayscale image color varization between black and white, But the color variation is very much [10]. The process of converting RGB to grayscale reduced the number of color images from 16 million to 256 warnsa. Equation (1) is a way of converting RGB images into grayscale.

$$Grayscale = (0.299 \times R) + (0.587 \times G) + (0.114 \times B) \quad (1)$$

Red layer pixels (R), green layer pixels (G), and blue layer pixels (B). Resize is resizing the size of an image into pixels. A pixel is the value of an iris between a row and a column. Sometimes the size changes to be smaller than the original file and vice versa [7]. In this study resize used a size of 125 × 150 pixels. In this resize process using the function provided from MATLAB, Namely Imresize.

c. Singular Value Decomposition

SVD is a method of representing matrix traffic that has a singular value for energy representation and can represent the overall matrix value. In addition, the singular value also describes a stable image and has an invariant transpose. rotational invariance, and image transformation so that singular value features can be images such as effective feature descriptions. Facial recognition by SVD method is the decomposition of singular values for projection and matrix reduction in the form of the arrangement of right and left singular vector values. In the SVD method it is used for the process of extracting image traits by factoring the complex matrix in image processing. SVD in linear algebra theory, that a rectangular matrix of dimensions $m \times n$ an be broken down or factored into multiplication of 3 matrices, namely orthogonal matrix U, diagonal matrix Σ and transpose of the orthogonal matrix V [10]. Here's the formula from SVD.

$$A_{(mxn)} x \sum_{nxn} x \, V^T_{(nxn)} \quad (2)$$

Column from U It is an ortonomal eigen vector of AAT. Column from V It is an ortonomal eigen vector of $A\,TA$. Σ Is a diagonal matrix whose elements are singular values or root power twos of the eigen values U or V and are arranged in descending order.

d. Principal Componen Analys

Principal Componen Analys (PCA) is used to take on features that protrude from the face area. The PCA method is a method that has been around for quite some time but is still practiced because of its simplicity, mainly used for comparisons between different algorithms. It is used for the reduction of the dimensions of facial photos without losing important characteristics of the face[11].

PCA has a mathematical process that converts possibly correlated variables into uncorrelated variables known as the main components. Orthogonal transformation of PCA relates to the main variable. In the orthogonal transformation process, the first major component has a high variance, and each component thereafter has the highest variation under orthogonal control over the previous component.[12].

For example, it can be exemplified in figure A given the optimal projection vector of 2DPCA, $U_1,\ldots,U_d$, used for feature extraction. Then, get the projected feature vector $Y_1,\ldots,Y_d$, so-called projective feature images from sample image A. Projective feature images are used to form m×d matrices $B=[Y_1,\ldots,Y_d]$. Because of one disadvantage of 2DPCA (compared to PCA) that more due coefficients are needed to represent the image, the image-based approach features the 2DPCA to reduce the dimensions of 2DPCA. This approach is called PCA images[13][14].

Effectively the PCA algorithm can reduce the dimensions of images on the human face and also identify information [15]. Mathematical calculations in PCA algorithms have three main stages. In the first stage is to create a transformation matrix using training data in the form of human face imagery. The second stage, facial image training data is arranged into matrix vectors. In the final stage, the test face image can be recognized by entering in the subheading of the eigenfaces then compared to the training face data in the sub-room of the eigenface domain.

e. Eulcidean Distance

Euclidean Distance is one of the most widely used classification methods. This classification is used by calculating the distance between two objects, this comparison can be done by calculating euclidean distance[15]. This method is done by looking for the smallest difference between the eigenface value of the training data and the eigenface value of the test data. The smaller the distance value generated, the data is classified into 1 group. The Euclidean Distance method is excellent for recognition, this method is also called Euclidean distance. Distance measurement is done by measuring the similarity of two image trait vectors between training and testing. Here is the euclidean distance calculation formula..

$$\varepsilon i = min\|u - unew\| \quad (3)$$

Symbol εi It is the value of euclidean distance, u is the eigenface value of the training data, while $u\,new$ is the value of eigenface test data.

DISCUSSION

The process of designing a face detection system using a real-time video-based helmet can be described block diagram system in figure 1.

Figure 1 Design Of Face Detection System using helmet

The first step is done in figure 1, namely shooting for training and video shooting with CCTV cameras for testing. In the video capture taken every frame that has been recorded to perform to perform an extrasion of features in order to be classified with the face on the template. Then classify the face using Euclidean Distance. System testing in this study consists of one experimental scenario to test performance against the accuracy of the system that has been designed. In this scenario it is conditioned with different levels of light factors.

RESULTS AND ANALYSIS

Plan Analysis

The evaluation process using good accuracy is the benchmark and indicator in this study. The output of this research is the development of methods that can be tested experimentally. For this reason, the process of designing research and work that will be done in more detail is described in the following diagram:

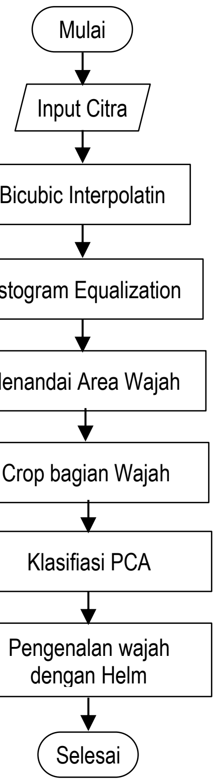

Figure 2. Research Design (Preprocessing + Post Processing)

The test plan on this system with scenarios tests the accuracy level of facial recognition with the condition of the camera position from the front, right side and left side. Then after the face using the helmet is detected it will be seen a box that marks the meaning that the system successfully detects.

Figure 3 Design Of Face Detection System using helmet

Result

To find out the results of the effectiveness of this study, tests were conducted into applications that have been installed into android to find out the results. The implementation can be seen from figure 3 where the helmet and face detected are shown with a box around the face area.

Figure 4 Results of Pca motode implementation

Being in the position of not using the helmet area on the take does not show the reaction will be seen in figure 4.

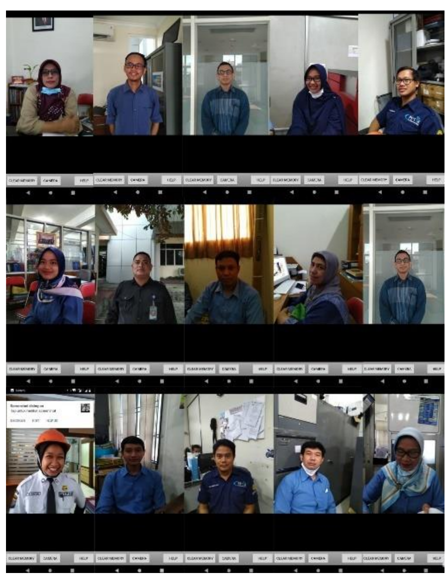

Figure 5 The results of taking pictures of faces without using a helmet

From the implementation results of the face detection application, it produces the following accuracy data:

Table 1 Results of implementation of face detection application using helm

Position	Number of Images	Detection	Failed
Depan	30	27	3
Samping kanan	30	25	5
Samping kiri	30	24	6

Based on the results above can be explained the accuracy rate of the front position 90%, from the right side 83% and from the left side 80%. So it can be concluded the level of accuracy from the detection of the face area using the helmet the accuracy rate is good with some records of detection failure due to the shooting position from the side of the eye area disappearing and poor lighting quality.

The results of this application were also tested on head accessories in addition to work protective helmets and the results could not detect the accessories shown blue detection box can not be seen around the face in figure 6.

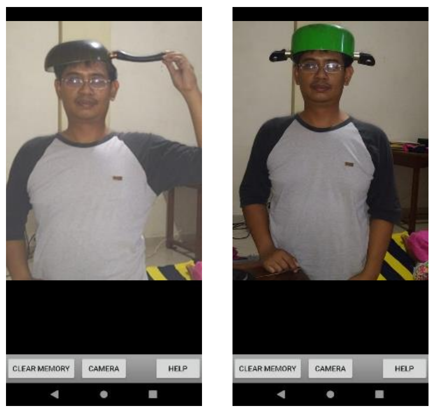

Figure 6 Experiments using other than safety helmets

CONCLUSION

Based on the results of research that has been done in this study, it can be concluded the heavy point on the expected results on accuracy from various sides. In addition, the intensity of light also greatly affects the results of this system. The higher the intensity of light, the better the accuracy obtained in the face detection system. At high light intensity, the percentage of accuracy in this study will be compared to the results. In this study has not been developed lighting as a benchmark for the accuracy of detection systems using the PCA method so that it can be known how detailed the light can guarantee the level of accuracy.

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