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Safe Security System Using Face Recognition Based on IoT

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Abstract : Face recognition is widely used in various applications, especially in the field of surveillance and security systems. This study aims to design and build a safe security system using face recognition via camera based on internet of things. This system uses the Raspberry Pi 3B and the OpenCV library as face recognition data processing which produces output on the Selenoid to open and close the safe, LCD 16x2 to display system status, IoT-based email delivery when smugglers occur. This study performs face recognition through the face detection stage using the Viola Jones method, feature extraction using the PCA (Principal Component Analysis) method and face recognition, then matched with the existing profile data in the directory. The results of this study indicate that the safe is open when a face is detected and will send a face capture to the e-mail address of the owner's safe if the detected face is not recognized. Tests carried out on the safe security system using face recognition based on IoT build reach validity 90,25%.

Keywords: Safe Security, Face Recognition, PCA, IoT, Raspberry Pi 3B

INTRODUCTION

Face recognition has recently become an important development in the field of computer vision, besides that many scientists and engineers around the world have focused on making algorithms and methods more powerful and accurate for this type of system and its application in everyday life (Kortli et al., 2020). Face recognition applications can be used to strengthen security and monitoring systems, including being applied to smart home security (Khattar et al., 2019)(Munir et al., 2019)(Nguyen et al., 2018), identification (Kim et al., 2017), and monitoring (Harikrishnan et al., 2019). The application of face recognition in a smart home security system by using training data from social media to increase the accuracy of the classification (Nguyen et al., 2018), apply face recognition in crime identification (Harikrishnan et al., 2019), and face recognition applications for attendance monitoring (Qezavati et al., 2019). These applications are very likely to be developed because of the study of accuracy in face recognition. Face Recognition is very important to have a reliable security system in recent years to secure your home, office, industry and property with the utmost safest (Harikrishnan et al., 2019). Conventional security systems have many problems and flaws, sometimes so unable to provide real-time data (Mantoro et al., 2018). Face recognition is one of various popular methods for biometric technology, which can uniquely verify and identify a person by mathematically extracting different face features and using different algorithms to recognize a person (Ejaz et al., 2019). At this time the field of security systems is very important to be developed in an intelligent system including home security, office security, home appliances and people security. Intelligent security systems can use the Internet of Things (IoT) to improve people's security (Aydin & Othman, 2017)(Othman & Aydin, 2018b). In other words, a security system can be created by utilizing IoT which has the ability to control automatically. IoT is becoming widely used in the life side, such as smart security, smart city, healthcare, smart transportation, smart network and online business (Othman & Aydin, 2018a). Computer vision can bring more security systems in the IoT Platform for security systems. Its has the ability to recognize people in

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the wrong area and at the wrong time, someone who might be harmful to the environment (Elngar & Kayed, 2020). Face is the most active growing recognition system in recent years which is one of the studies including credit card verification, public security, criminal identification, access control, and others.

At the end of this decade there have been many theft cases that do not have strong evidence of who the perpetrators of the theft cases are. Usually the targets of theft are people who usually store valuables in safes that have weak security (Cavas & Ahmad, 2019). The development of science and technology is so rapid, so that all humans will be able to respond quickly to these developments and follow them to obtain safe and efficient services. (Kumar et al., 2019). Safes with traditional security systems such as analog locks in analog safes and pin locks in digital safes are not enough. Adding a layer of security such as a security camera can prevent or reduce the chance of a safe being stolen by using face recognition (Faisal & Hossain, 2019). However, face detection is sometimes challenging because some of the characteristics of human faces are unstable, due to the position of the face, the distance of the face from the camera, lighting and using attributes such as hats and glasses that affect the detection accuracy. To overcome these problems, the system uses the Viola Jones method (Ramana et al., 2019), for face detection and the Eigenfaces method for face recognition (Zafaruddin & Fadewar, 2018). Eigenfaces are generated using a mathematical process called Principal Component Analysis (PCA), because PCA reduces the dimensions of face images without losing important features in the image, people's faces are stored in the database without significant loss of efficiency. Therefore, face recognition using PCA is more useful for security systems using faces than other recognition techniques (Surve et al., 2020). Based on this, a safe security system was developed using face recognition using the PCA (Principal Component Analysis) method.

METHOD

The research methodology contains the stages of work in conducting research. The research conducted is to build a safe security system using face recognition based on IoT. In this study, the safe can be opened based on the face that is introduced, whereas if the face is not recognized, the system will send an email to the owner of the safe in real time which contains that there has been a burglary of the safe. In general, this system consists of several stages including image input retrieval, image processing, feature extraction, classification and system evaluation. Therefore, the methodology of this research, show in Figure 1.

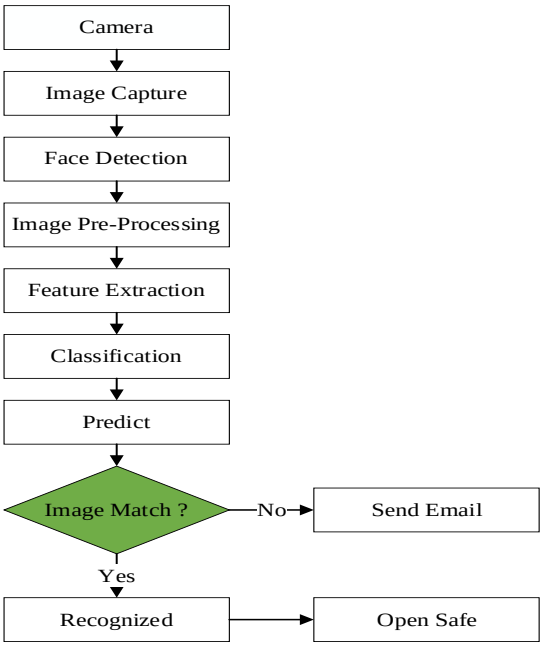

Figure 1. Research Step

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Based on Figure 1 above, the research methodology in this paper begins with taking pictures through the camera, the results of image capture are obtained, after that face detection is carried out through image capture, then image pre-processing of the detected faces, including gray scale, image resize and image enhancements. After image pre-processing, then feature extraction, then tran classification, and after that the image prediction from the classification results is carried out, if the detected face is recognized, the safe will open, but if the detected face is not recognized, the system will send an email to the owner's safe.

Step 1: People's pictures are taken using a camera to be used in further processing and the pictures are stored in the data collection directory. In executing the file, the user will be asked to enter the name of the face from the data to be introduced. then the camera will be active to take data in the form of photos. The captured data will be stored in the face profile directory. Face recording was carried out on 5 people who were used in face recognition which is shown in table 1.

Table 1. List Of Safety System Training Data Using Face Recognition

Name	Face Data
Niko	
Ikhsan	
Wahyu	
Rivan	
Ario	

Step 2: After image capture, the next step is face detection to determine the size and location of people's faces in the input image. Techniques are used to identify patterns and locations in recognizing people's faces comprehensively. Variability in the size and shape of people's faces across races, irregular illumination in images is a major problem hindering the automation of face detection. Using neural networks can simulate the human inference engine on a computer for pattern recognition, classification, and association. This study uses the Viola-Jones method which uses the Haar Cascade filter base feature for face detection. The algorithm equation used is shown in equation (1).

$$F(x_i) = sign(\sum_{t=1}^{L}(a_{ti} * (f_{ti}\,(x_i) + s))) \quad (1)$$

Where, F is the classification function, f_{ti} is the corresponding classifier, a_t is the AdaBoost coefficient ($a_t > 0$), x is the input sample, and s is the sum of each rectangle determined by using (2) to find pixels A, B, C, and D in the image.

$$S = D - B - C + A \quad (2)$$

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Step 3: In the pre-processing stage, the image is cut from the face detection results in the input image. After getting the results of cutting the input image, then changing the image size to 48x48 from the face detection results, then improving the image quality from the size changes by making contrast improvements. The results of improved quality control produce RGB images which are then converted to grayscale.

Step 4: After pre-processing the image, then the results are extracted to obtain the important features of the image. Feature extraction is the process of taking the characteristics contained in the object in the image. Feature extraction is done to bring up the pattern that will be used in the face recognition process. Feature extraction in this study uses the Principal Component Analysis (PCA) method.

Step 5: The classification process is the process of grouping objects into appropriate classes. After the data is classified, face recognition is performed, if the detected face is recognized, the safe will open, but if the detected face is not recognized, the system will send an email to the owner's safe.

RESULT

Safe Security System Design

In general, the form of a safe security system using face recognition consists of a safe frame and electronic circuit. The safe frame is used as the housing of the system which has an electronic circuit in it. The electronic circuit serves to provide data in the form of digital signals and analog signals that will be processed by the Raspberry Pi in accordance with the Pyhon 3 program module that is created and issued as an output. The block diagram of a safe security system using face recognition, shown in Figure 2.

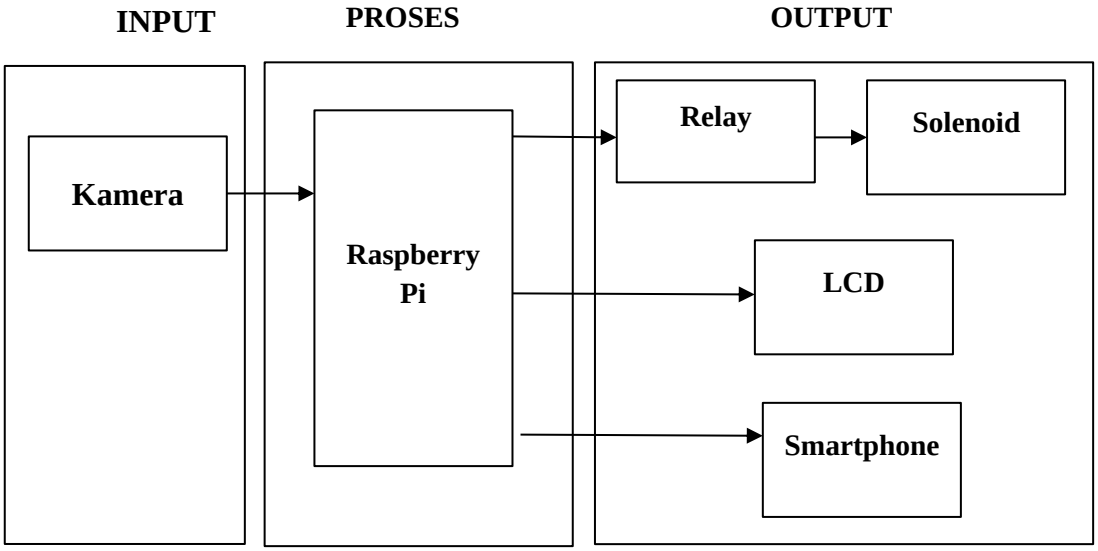

Figure 2. Safe Security System Block Diagram

Face Recognition

The face recognition process on the system is carried out in real-time. The detected face is displayed in the camera frame window. The location of the face is indicated by a box shape around the face and at the bottom there is the name of the detected face. Furthermore, if a known face is detected, the system will display the location of the face on the camera. When the process of comparing faces with face data in the directory.../src/profiles does not match, the location of the detected faces will also be marked with a square following the face and named Unknown. The results of known face detection, show in Figure 3.

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Figure 3. Faces Recognized

If the detected face is recognized, the safe will open and appear on the LCD “Open Safe”, shown in Figure 4. (a) and (b).

Figure 4. (a) Open Safe (b) LCD Display “Safe Open”

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If an unrecognizable face is detected, then the face location is marked with the name “Unknown”, the safe does not open and appears on the LCD “Face Not Matching”. The faces that are detected as unknown, show in Figure 5. (a) and (b).

Figure 5. (a) Unrecognizable Face (b) LCD Display Face Unrecognized

If the detected face is not recognized, the system will send a notification to the owner of the safe via email that there is a hack. The display of e-mail received from the system, show in Figure 6.

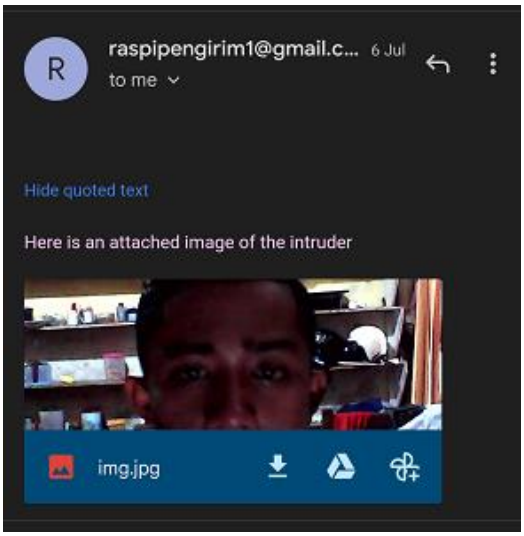

Figure 6. E-Mail Notification

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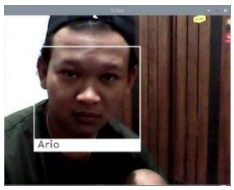
The test data performed, shown in table 2.

Table 2. Safe Security System Test Data Using Face Recognition

Registered Name	Name Detected	Testing	Information
Niko	Niko		Brankas Terbuka
Ikhsan	Ikhsan		Brankas Terbuka
Wahyu	Wahyu		Brankas Terbuka
Rivan	Rivan		Brankas Terbuka
Ario	Ario		Brankas Terbuka
Unknown	Unknown		Brankas Tidak Terbuka dan Kirim Email

Tests carried out include face recognition based on face position, distance from face to camera, lighting and using attributes such as hats, shown in table 3 and Figure 7.

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Table 3. List Of Testing Types

Testing Types	Truth Rate	Error Rate
Face recognition based on face position	89%	11%
Face recognition based on the distance between the face and the camera	92%	8%
Face recognition based on lighting	95%	5%
Face recognition using other attributes (Hats, Glasses, etc.)	85%	15%
Validity	**90,25%**	**9,75%**

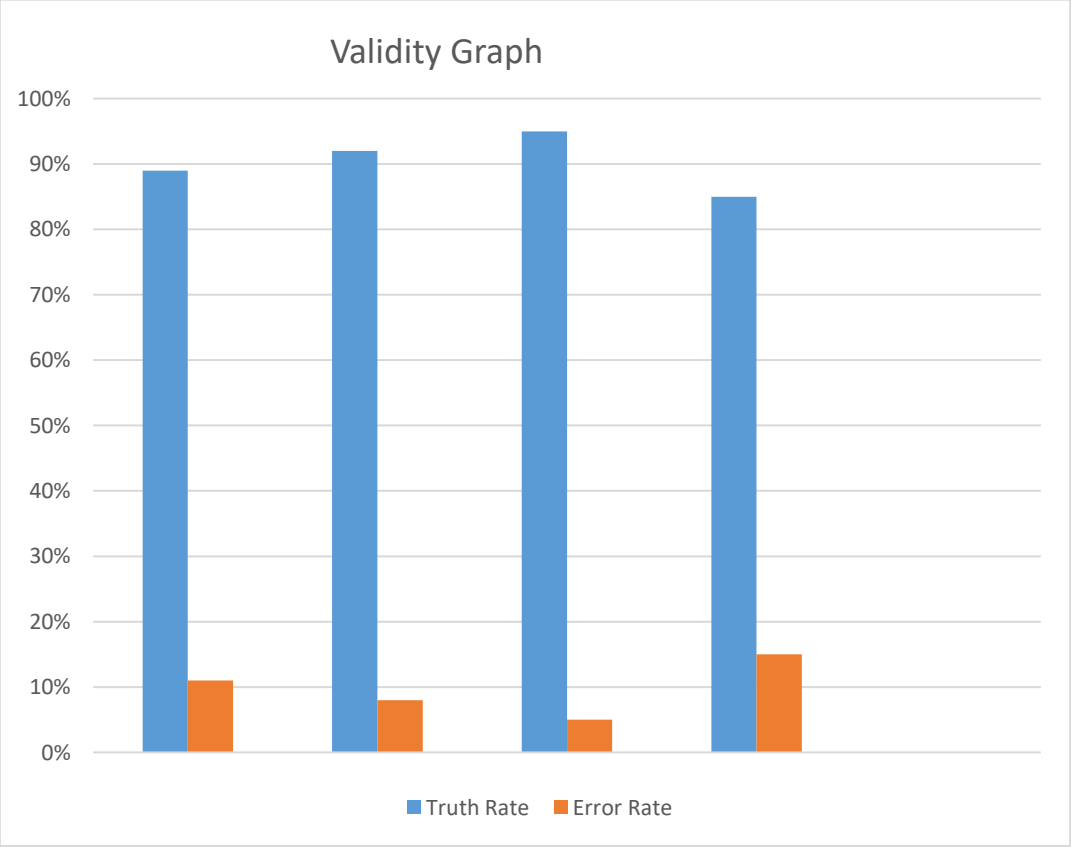

Figure 7. Face Recognition Validity Graph

DISCUSSION

This study uses real data as testing data and test data obtained from camera captures stored in the data collection directory, face recognition using the OpenCV library on the Raspberry Pi 3B. The same research was done before with an accuracy rate of 96%, but without being influenced by the attributes used in the facial area. This face recognition system is influenced by the position of the face, the distance between the face and the camera, lighting, and the attributes used in the face area. However, the highest error rate is influenced by the position of the face when performing face recognition.

*name of corresponding author

CONCLUSION

The safe security system using IoT-based face recognition can function properly to recognize people's faces using the OpenCV library on the Raspberry Pi 3B based on existing training data. Based on the tests carried out, all the existing test data in the training data can be recognized properly, while the test data that is not in the training data cannot be recognized and the system sends an email automatically using the Internet of Things. Face recognition has the ability to increase the security of the safe so that it can carry out its duties better. In this paper, we develop a face recognition system using raspberry pi 3B that works successfully with security alert messages to authorized persons in the form of IoT-based email. Tests carried out on the safe security system using IoT-based face recognition that were built reached validity 90.25% validity.

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