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Face Recognition Using Histogram of Oriented Gradients with TensorFlow in Surveillance Camera on Raspberry Pi

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Abstract: The implementation of face recognition with TensorFlow deep learning uses the webcam as a surveillance camera on the Raspberry Pi, aiming to provide a sense of security to the requiring party. A frequent surveillance camera problem is that crimes are performed at certain hours, the absence of early warning features, and there is no application of facial recognition on surveillance cameras. The function of this system is to perform facial recognition on every face captured by the webcam. Use the Histogram of the Oriented Gradient (HOG) method for the extraction process of deep learning. The image that is input from the camera will undergo a gray scaling process, then it will be taken the extraction value and classified by deep learning framework with TensorFlow. The system will send notifications when faces are not recognized. Based on the analysis of the data is done, the conclusion that the implementation of face recognition is built on the Raspberry Pi using a Python programming language with the help of TensorFlow so that the training process of the sample is much faster and more accurate. It uses a Graphical User Interface (GUI) as the main display and is built using Python designer, using email as an initial warning delivery medium to the user as well as using the webcam as the main camera to capture image.

Index Terms: Face Recognition, Deep Learning, TensorFlow, Surveillance Camera, Raspberry Pi

1. Introduction

In the present day, crime can happen anywhere, anyplace and any situation, from the small thing as well as the big thing there must be crime [1]. With the passage of time and the development of technology has emerged a variety of the latest innovations in technology one of the security [2, 3]. To provide convenience in maintaining the security of criminal action, then we need a tool that monitors activities around us for 24 hours, better known as a surveillance camera [4, 5, 6].

Surveillance cameras are common surveillance tools that we find in various public areas such as offices and shopping centers [5, 7]. The installation of surveillance cameras in an area is the most modern and effective way of monitoring and preventing criminal acts in the area [8, 9, 10, 11, 12].

The most common problem is when a criminal offense is performed at a certain hour that cannot be seen by the admin or the person who usually sees the surveillance camera [13], the surveillance camera is now also mostly unable to give early warning when a criminal offense occurs [14]. As imaginable, these types of surveillance cameras are mostly less effective at monitoring or providing information within 24 hours to admins or people who are entitled to view or check, usually crimes committed outside of business hours will be known tomorrow the day because of the absence of early warning features to the admin [13].

Therefore, we formulated the use of a surveillance camera that has a face recognition feature to monitor and provide reports to the person who has the right in the event of a criminal offense. Face recognition is one of the branches of research related to the counting and analysis of data related to human characteristics [15, 16]. Face detection in the computer depends on several aspects, including the condition of facial expressions, light, and accessories used by the face [17, 18]. Deep learning methods are able to leverage very large datasets of faces and learn rich and compact representations of faces, allowing modern models to first perform as-well and later to outperform the face recognition capabilities of humans [15, 17, 19, 20, 21].

As additional security, we gave the idea of facial recognition to make this surveillance camera safer. Several kinds of surveillance cameras can be used and can be connected with Raspberry Pi. Raspberry Pi is a Single Board Computer (SBC) that is quite popular although there are some other SBCS [22, 23, 24], there are BeagleBone, Intel Galileo, PandaBoard, CubieBoard, and others. Raspberry Pi is usually abbreviated with RASPI or RPi [23]. The function of this system is to perform facial recognition on every face captured by the camera. Use the Histogram of the Oriented Gradient (HOG) method for the extraction process of deep learning. A HOG is a feature descriptor generally used for object detection [25, 26]. HOG are widely known for their use in pedestrian detection [27]. A HOG relies on the property of objects within an image to possess the distribution of intensity gradients or edge directions [28, 29]. The image that is input from the camera will undergo a gray scaling process, then it will be taken the extraction value and classified by deep learning framework with TensorFlow. The system will send notifications when faces are not recognized. This paper aims to contribute with this surveillance camera can help the community or agencies in monitoring and give reports to the right direction.

2. Literature Review

Surveillance cameras, or security cameras, are video cameras used for the purpose of observing an area. They are often connected to a recording device or IP network, and may be watched by a security guard or law enforcement officer[7]. The most common problem is when a criminal offense is performed at a certain hour that cannot be seen by the admin or the person who usually sees the surveillance camera [14]. In this paper we combine security cameras with AI face recognition. A technology capable of identifying or verifying a subject through an image, video or any audiovisual element of his face [17,18]. Face recognition is a broad problem of identifying or verifying people in photographs and videos, and the deep learning models first approached then exceeded human performance for face recognition tasks [15,20]. This process can be seen in Fig. 1, some of the most direct benefits that deep learning algorithms can bring include achieving comparable or even better-than-human pattern recognition accuracy, strong anti-interference capabilities and the ability to classify and recognize thousands of features. With deep learning technology, the average accuracy of face recognition increases significantly.

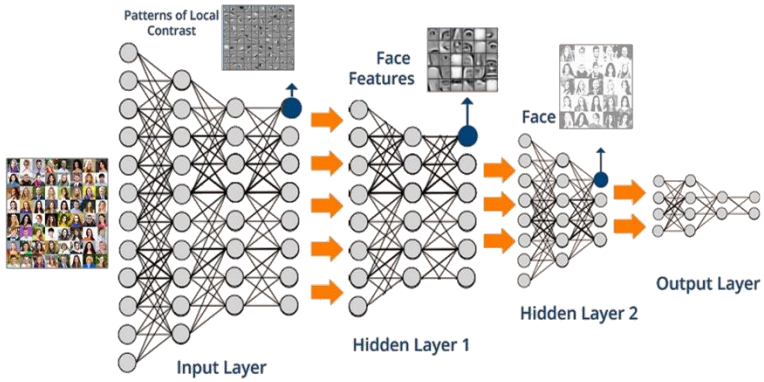

Fig.1. Deep Learning in Facial Recognition Cameras

3. Research Method

Fig.2 shows, the diagram block on this face recognition device. Raspberry Pi as a control center to handle input and output data on the system and works as a center where orders from users are received. The webcam functions to take data samples or in this case, sample photos to be given to the face dataset process. Also, the webcam functions as face recognition. The face dataset serves to take samples of people's faces that will be recognized and send the results of the face dataset to the Raspberry Pi as a reference for facial recognition.

Before the facial recognition, the sample photos obtained will be carried out first training and the training results will be stored in a file that has been provided. Face recognition functions to capture the face on the webcam and will be processed directly to the raspberry pi, then the raspberry pi will recognize whether the face that has been processed matches the existing sample. The internet functions as a medium for sending emails to admins or users. Notifications sent via the internet are direct. And the last, Email functions to receive notification alerts when an unrecognized face, a face that is not recognized in the photo by the webcam, is then sent to the user as proof that an unknown person enters the room.

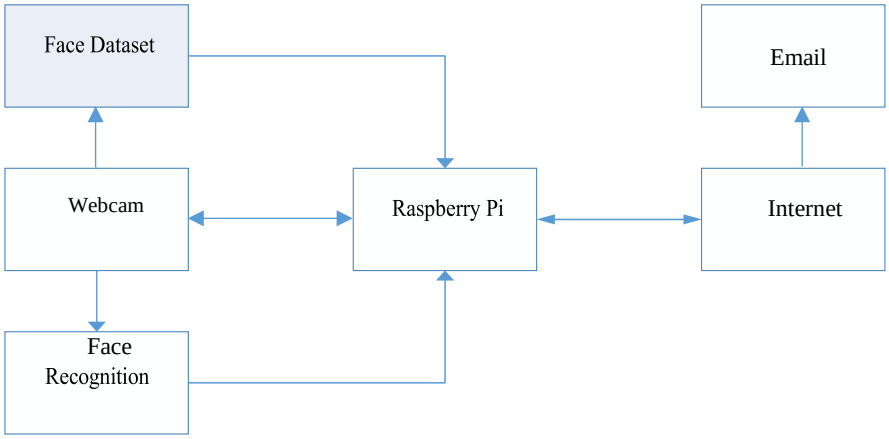

Fig.2. Block diagram process surveillance camera on Raspberry Pi.

4. Result and Discussion

Fig.3 shows, face recognition schemes with webcams and RPi. The schema of this block explains all the functions of the ports used on the Raspberry Pi. USB Power port functions to connect the raspberry pi to the electricity so that it can turn on the raspberry pi. HDMI port functions to connect the monitor with Raspberry Pi so that the GUI display from Raspbian can be executed. USB Port 1 functions to connect the raspberry pi and keyboard so that it can receive text input from the user. USB Port 2 functions to connect the raspberry pi and mouse to make it easier for users to move the cursor. USB Port 3 functions to connect a raspberry pi and a webcam to retrieve the dataset and process facial recognition.

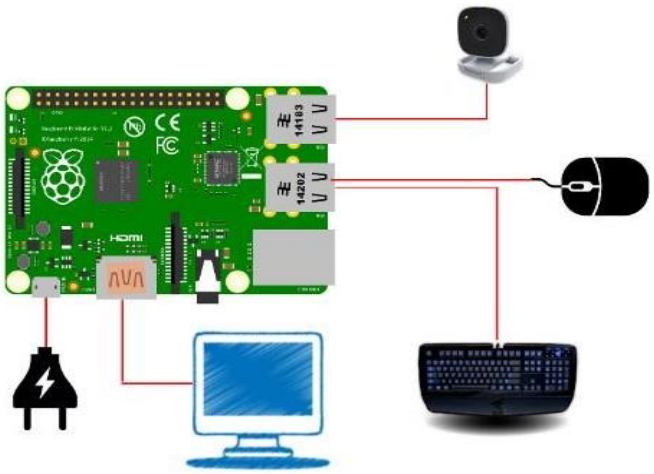

Fig.3. Port diagram of surveillance camera on Raspberry Pi.

Fig. 4. explains about the outstretched flow in the main system of this tool, in this facial recognition tool the first process that is executed is to open the interface that has been provided, in this case, is the Graphical User Interface. After opening the admin interface then have to choose three functions, among them, the face register function, facial training function, and facial recognition function.

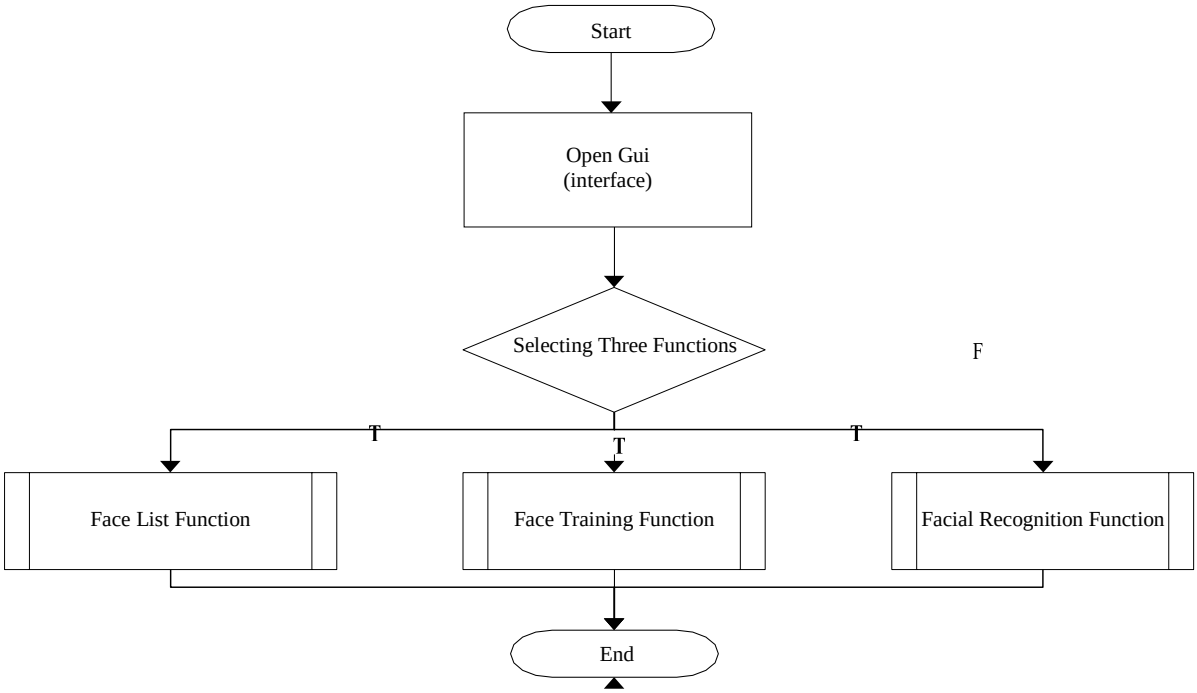

Fig.4. System Flowchart in facial recognition tool

Fig. 5.(a) describes, how to process when the face list function is executed. After the admin selects this function then the process is continued by running the face sampling process, after the sample is obtained then the sample is stored into the storage directory in this case is the dataset directory. Flowchart in Fig. 4.(b) explains how the process when facial training do. The first process after the admin selects this function is to take a sample of the face that has been stored in the dataset directory, then perform the training process with the Histogram Of Oriented Gradient (HOG) method, then save it into the encodings file for later as a facial recognition reference.

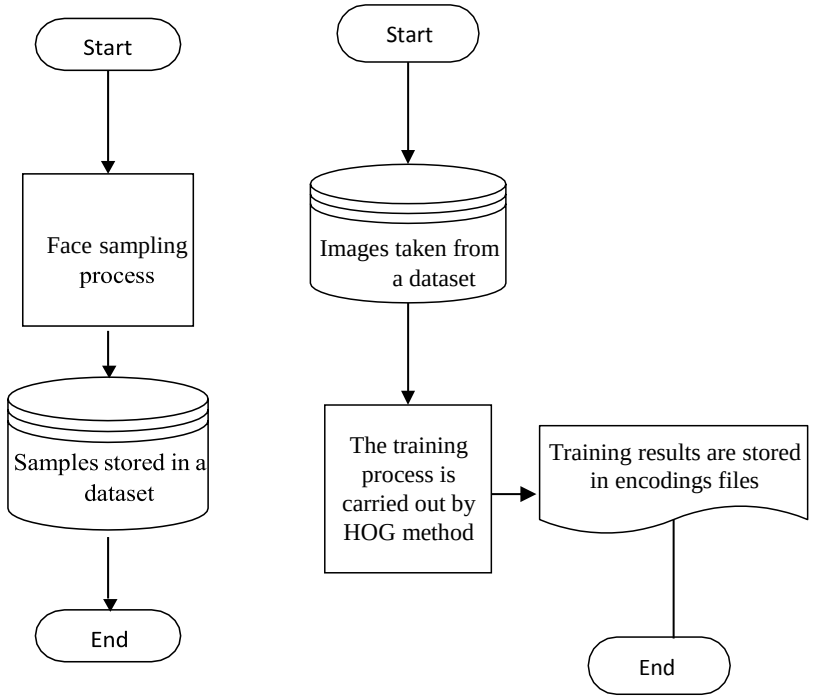

Fig.5. Face List (a) and Training Face (b) flowchart

To access the interface of this device, the user must be connected directly to the Raspberry Pi, because the application is stored in the directory of the Raspberry Pi can be seen in the Fig. 6 (a). In the application or interface above there are 3 functions, the first is the function of registering faces which are used to take face samples from new users who will be taken so that the next process can be carried out. Second, the training sample function is used to run

the facial feature extraction algorithm using the Histogram of Oriented Gradient algorithm. The third is the facial recognition function. It is used to run the facial recognition process by utilizing the extraction results from the methods that were previously used during the training sample process.

Fig. 6.(b) shows, user registers a face on the system. The system here is tasked with detecting the face frame in the process window that has been provided, in this case, the process window is displayed on the Raspbian terminal after the face samples totaling 50 samples are obtained, then the samples are stored in the directory on raspberry pi, and stored based on the name of the sample in each files, to facilitate the training process and separate samples from one sample to another.

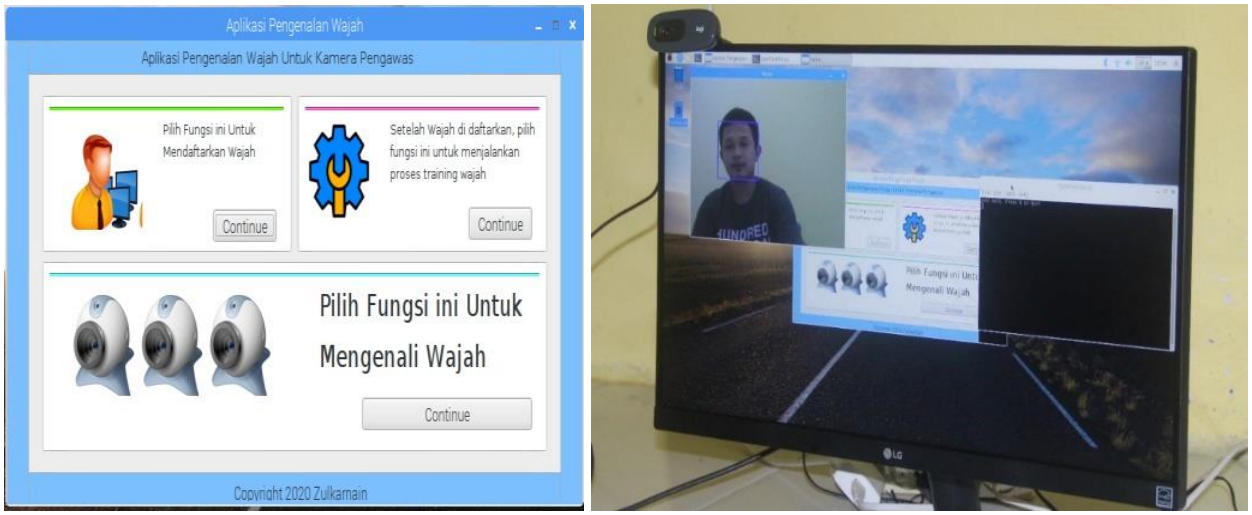

Fig.6. Application interface (a) main menu and (b) sampling process on register menu

The samples that have been stored are 50 samples so that later the facial recognition process will be stronger and the facial extraction process will be much more detailed. The sample obtained was then converted into grayscale form to make it easier to find the extraction feature

Training and recognition process presented in Fig. 7. Fig.7.(a) explains how the system describes when running training on the sample. How is the extraction process from the image or sample obtained, The extraction process uses the Histogram of Oriented Gradients (HOG) method and the extraction request process requires a TensorFlow environment which is then stored in the encodings file. Fig. 7 (b) describes and shows how the system performs facial recognition. In this process, the TensorFlow method used in this case is Similarity Detection, which functions to compare the extraction results and the image captured on the webcam. If the face is known, it will display the label or username based on the folder stored in the dataset directory

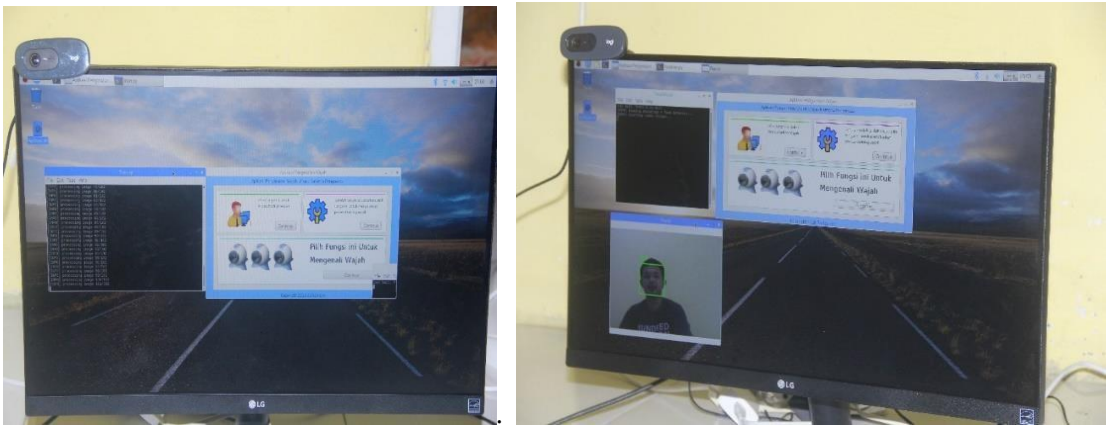

Fig.7. Training and recognition process, (a) training the image sample (b) face recognition process

Fig.8. shows, process when face is not recognized. In this process, the TensorFlow method also runs in this case Similarity Detection functions to compare the extraction results with the image results obtained via webcam. If the face is not recognized, then the system labeled on the face frame with unknown information and also on the terminal page displays the text "Process Sending an email " and the next process is to send an email to the registered user

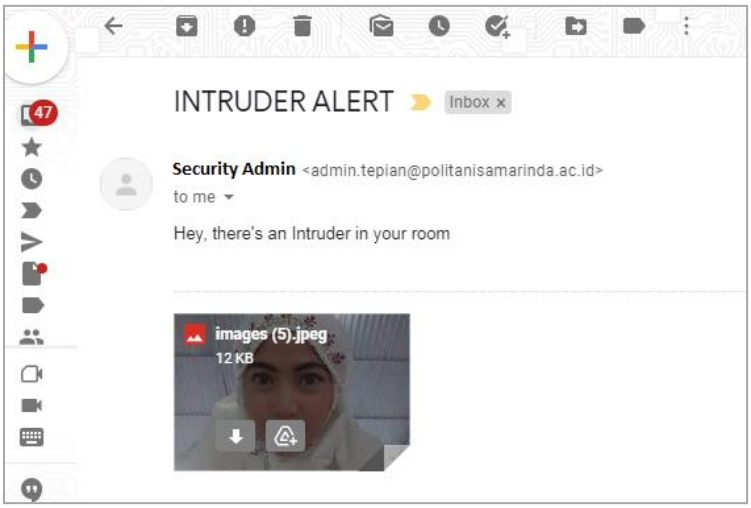

Fig.8. Email notification to admin, when user's face isn't recognized

5. Conclusion

Developing face recognition tool with TensorFlow using a webcam as a surveillance camera, it takes three main sub- processes, namely a webcam as input, Raspberry Pi as the control center, and email as an output for initial warnings to users. TensorFlow from Google is used as a virtual environment software so that the training process is much faster and can be run easily. In this tool, the communication between the user and the device uses a Graphical User Interface (GUI) and internet media, so that notifications can be received anywhere. The image that is input from the camera will undergo a gray scaling process, then it will be taken the extraction value and classified by deep learning framework with TensorFlow. The system will send notifications when faces are not recognized. Provide more security to users because there is an early warning feature when a crime occurs, in this case when the face is unknown

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