Using Deep Learning with Thermal Imaging Camera to Record Employee Attendance System

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Abstract

Today every country in the world faces a COVID-19 situation, making life different from daily life or work life. Therefore, organizations or companies adopt a primary diagnostic method for COVID-19 by having a system to scan an individual facial temperature using a thermal imaging camera to check if that person has initial symptoms of COVID-19 or not. This research focuses on the development of an attendance record system with a thermal imaging camera combination with Deep Learning to optimize the collection and processing of data to classify or identify employees precisely and reduce step to record the working hours of employees. The experiment found an average of face recognition the mean accuracy was 81.85%, and the mean processing time was 0.26 seconds. The research was satisfying when compared the research on the development of a time recording system with face detection and recognition using the Haar-Like Feature technique to detect faces and using the Local Binary Patterns Histogram to recognize faces with accurate of facial recognition at 48%. According to the experiment, the result was highly satisfying in terms of accurate data and processing time. Moreover, the developed system produces accurate and precise information with convenience and safety.

***Keywords*:** Employee attendance system, Deep learning, Thermal imaging camera

I. INTRODUCTION

The coronavirus disease-2019 (COVID-19) pandemic [1] caused by the new coronavirus SARS-CoV-2, has spread around the globe with unprecedented consequences for the health of millions of people. While the pandemic is still in progress, with new incidents being reported every day, the resilience of the global society is constantly being challenged. Under these circumstances, the future seems uncertain. SARS-CoV-2 coronavirus has spread panic among civilians and insecurity at all socio-political and economic levels, dramatically disrupting everyday life, global economy, international travel and trade. The disease has also been linked to the onset of depression in many individuals due to the extreme restriction measures that have been taken for the prevention of the rapid spreading of COVID-19. In Thailand [2], Thai Ministry of Public Health announced on January 12, 2020, that a 61-year-old female tourist of Chinese nationality, domiciled in Wuhan, China, was infected with COVID-19. It was the first confirmed case outside China. As a result, the Thai government has declared a state of emergency in all local areas throughout the Kingdom. As a result, people have to change their way of life, work, and live in the New Normal style, which is caused by applying advice on preventing infection and spreading the infection to others in their daily lives. Wash hands when appropriate. Avoid unnecessary exposure and travel. Social distancing, wearing masks in public places, and checking body temperature in various places if any person whose temperature exceeds the standard value may risk developing a fever. A body temperature of more than 37.5 degrees Celsius is considered a person at risk of getting or transmitting the virus.

The spread of the COVID-19 virus in the world has urged governments to make rules to prevent the spread of the deadly virus, such as curfews, lockdowns, and physical distancing measures in society (social distancing). The way to defeat the virus is to initially screen people who have a fever and show symptoms of COVID-19 or not. It will be isolated to prevent the spread of the virus. From such outbreaks Wearing a mask at all times in public and checking body temperature before entering the service is essential to prevent the spread. There are several methods for measuring body temperature. Depending on the equipment used, such as thermometers, digital thermometer, infrared body thermometer, or thermal imaging camera, etc., that depends on the company which type of equipment to use to be the most suitable.

In normal circumstances, the employee's working hours using the fingerprint scanning to the employee attendance system. But with the coronavirus outbreak, the company came up with the idea of using thermal imaging cameras to check if that person has initial symptoms of COVID-19 or not and apply the technology of thermal imaging cameras to record the working hours of employees to reduce the work process and provide accurate and precise information.

Presently, the 21st century is called the era of information technology where technological advances have made information, news, knowledge in various sciences and fields widely applied from the general public to industrial, social and economic levels, such as the introduction of face detection technology. It can be applied to personnel management, employee attendance record, or development of identity verification system for various documents such as fingerprints, car license plate inspection systems, and a face detection system to identify people identify people. By the way, face detection is a difficult and complicated method. But nowadays, methods for detecting faces in various programs have been developed to be more accurate and easier to use [3].

II. LITERATURE REVIEW

This section discusses the relevant knowledge of "Using Deep Learning with Thermal Imaging Camera to Record Employee Attendance System" and presenting relevant literature reviews.

A. Face Recognition

Facial recognition technology is a technology part of artificial intelligence technology that recognizes a person's facial features by taking image data to look for special effects, saving the information to a database, and then identifying the person through the comparison of facial data processing. Of the person recorded in the database. An example of the current face recognition technique and will be discussed is the Local Binary Pattern Histograms (LBPH) technique [4].

Local Binary Pattern Histograms (LBPH) recognition is a local binary pattern identification technique that is a technique for distinguishing patterns in images by applying the LBP values calculated in each pixel. Histogram for identifying special characteristics in the face. The work is divided into 2 steps as with Eigenfaces recognition: Pre-processing and testing procedures.

For the testing process in the Local Binary Pattern recognition technique, it takes the image to be tested to calculate the LBP value and divide the image into parts together with calculating the histogram of each area. Then, calculate the Chi-square between the images to be tested and every practice image.

B. Face Detection

Using Deep Learning with Thermal Imaging Camera to Record Employee Attendance System uses the Harr cascades. [5] face detection technique, a technique that has high face detection speed and accuracy compared to traditional face detection techniques. The concept of this technique is an examination of the pixel groups on images is similar to the Harr-like feature, as illustrated in Figure 1, to determine whether the pixel group is a human face.

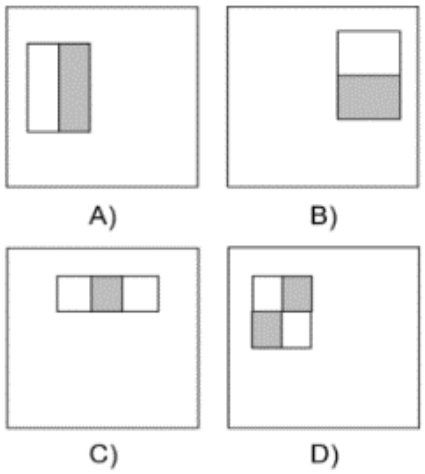

Figure 1: Harr-like feature

C. Deep Learning Model [6]

Deep Learning is an automated learning method that mimics the functions of the human neurons by bringing the neural network system overlaying multiple layers and learning sample data. It is used to detect the pattern or classify the data.

Generally, the neural network system only learns a few levels because there is no training data or not enough computer ability. However, over the years, technology has evolved more and more, making it easier and more accessible to the layers of the network. The more layers, the more complex and deeper the network becomes, which is the origin of the term "Deep Learning". According to the model of Machine Learning, in general, when raw data is entered, it will not be processed automatically, but requires domain knowledge for a feature to categorize Hand-Craft Features. However, if it is deep learning, it receives raw data immediately and automatically processes it to obtain the sample data needed to detect patterns or categorize the data. The learning ability, automation features make Deep Learning very useful for use in

different situations. Challenges to be faced are finding suitable neural networks and finding variables affecting the network's training performance. It is still difficult to know what features Deep Learning can learn. In addition, Deep Learning is similar to machine learning, that is, it is unable to handle carefully crafted input, so it may lead to wrong inferences on the model.

From relevant studies found that Shireesha Chintalapati and M. V. Raghunadh [7] developed a system for checking enrollment students using face recognition techniques to identify and send a summary of attendance to the teacher's email at the end of the class. The operation of the system is initiated by taking each frame of the camera image and converting it to a black and white level to detect faces within the image. When a face image is obtained, it is memorized through histogram equalization process and resized to a size of 100 x 100 pixels, which is then used in the grouping process for identification purposes, with face recognition techniques. Eigenfaces recognition, Fisherface recognition and Local Binary Pattern Histogram recognition are available. The results of the experiments using the system showed that the Fisherface recognition technique was the most accurate for both still image and video identification with 95% and 78% accuracy, respectively. This research had problems with accuracy when used in rooms where the amount of light was not the same as in the recognition images, and there was no system for correcting the identification results because the results are sent to Email only at the end of the class.

J. Sanuksan and O. Surinta [8] examines a deep convolutional neural network (Deep CNN) for plant recognition in the natural environment. The primary objective was to compare 4 CNN architectures including LeNet-5, AlexNet, Google Net, and VGGNet on three plant datasets; PNE, 102 Flower, and Folio. The images in the PNE and 102 Flower datasets include a complicated background because they were taken in a natural environment. On the other hand, the images in the Folid dataset are only leaf images that were taken in a laboratory environment using a white background. The comparison of deep CNN using Google Net and VGGNet Architecture show that Google Net outperformed while working on the PNE and 102 Flower datasets when using a training time with iterations of 10,000 epochs. Google Net also faster than the VGGNet architecture. However, the experiment showed that the VGGNet architecture outperforms the other CNN architectures on the Folio dataset and used only 1,000 epochs for training. In our experiment, we can create a model from the deep CNN using Google Net architecture, and this is because it showed better results with the plant images that were taken in the natural environment.

III. RESEARCH METHODOLOGY

A. Theoretical framework

This section provides an overview of the function and design of “Using Deep Learning with Thermal Imaging Camera to Record Employee Attendance System” in Figure 2.

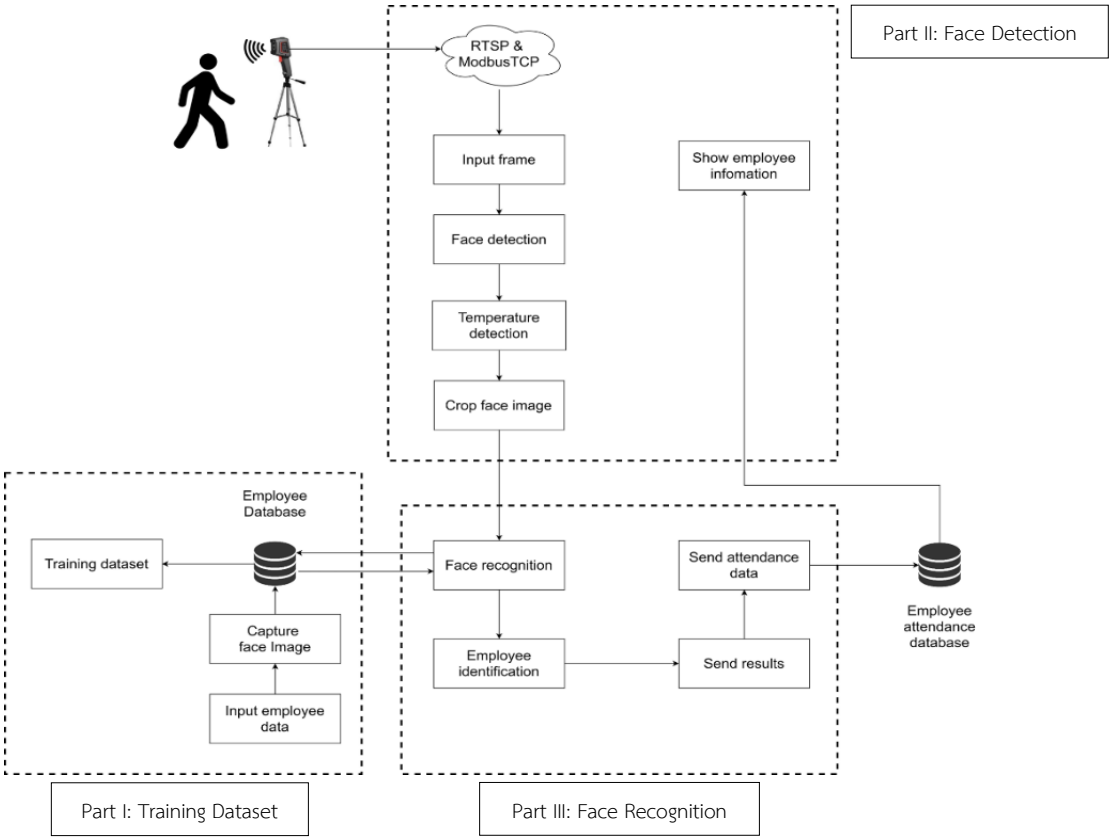

Figure 2: Theoretical framework

The framework consists of 3 modules as follows:

Part I: was the initial data preparation and recording process for a test on 20 employees, whose working principle was based on the Flowchart in Figure 3.

Part II: Design of Temperature Sensing Procedures and Facial Detection Processing. This research using the Haar cascade technique for verification as it is a highly accurate and less time-consuming technique, so it was suitable for real-time detection of human faces. When the detection system detected a human face, it would be framed by a developed system capable of simultaneously detecting multiple faces. The installed system with a thermal imaging camera was at the company's door and gate for one month for the temperature sensing and recognition processing and examining the results. The temperature sensing and recognition processing were held at the company's door and gate for a period of 1 month, based on the flowchart principle in Figure 4.

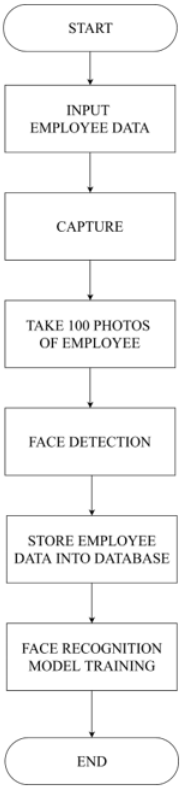

Figure 3: Flowchart for prepare and record data

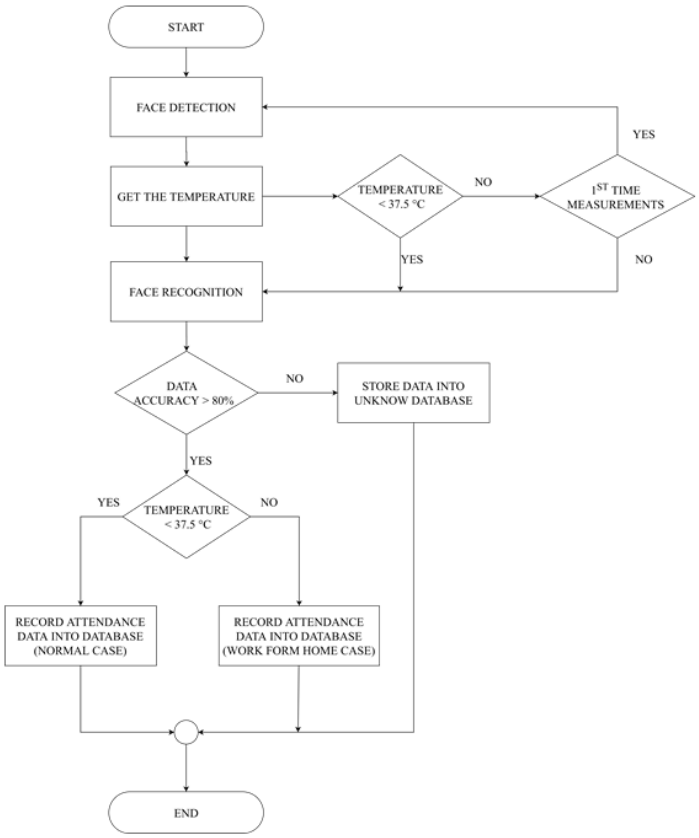

Figure 4: Facial Recognition Processing

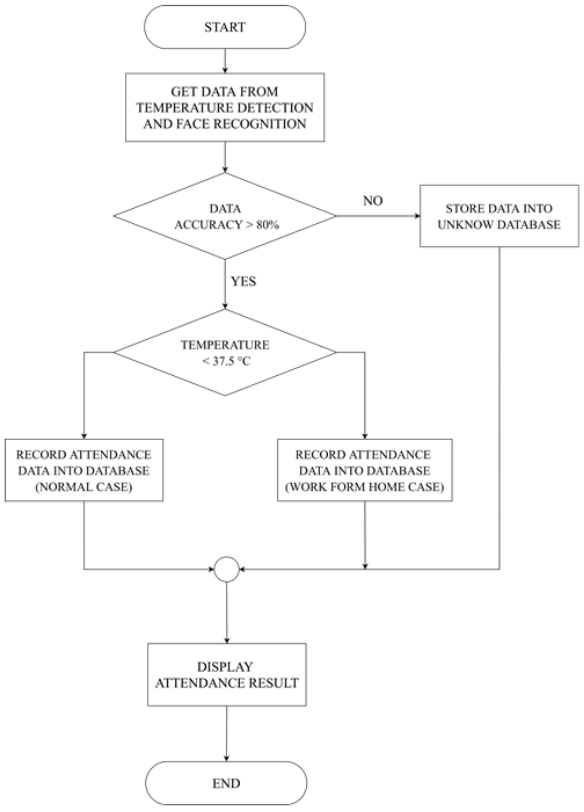

Figure 5: Attendance record system and display of employee attendance data

Part III: Face Recognition. The record-keeping to connect with attendance record system and display of employee attendance data. For recording data to connect to the attendance recording system, the data is stored in CSV format, where data was stored, which was displayed according to the Flowchart in Figure 5.

Analysis result or a design of the conceptual framework of "Using Deep Learning with Thermal Imaging Camera to Record Employee Attendance System" – the system divides its operations into 3 parts:

Part I: Training Dataset – Test of the 20 employees. First, encoded data and names of employees were keyed in and clicked the record button for taking five pictures of each employee. This research selected 1 to 5 pictures to represent one employee to find appropriate pictures for individual classification. Each picture contains a straight face picture, 15-degree left side face picture, 15-degree right side face picture, face down picture, and face-up picture.

They then conducted face detection from the pictures and training a face recognition model in Figure 6.

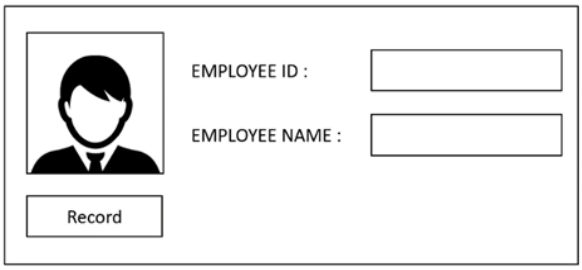

Figure 6: The screen shows the employee's input

As soon as the process of face encoding finished, all data were recorded in a database to prepare the data for face detection accordingly.

Part II: Face Detection – It is the process of searching for individual faces from pictures. An obtained face was processed for the following procedure to ensure the detected picture is easy to classify by using Haar Cascade algorithm since it has high accuracy and time spent on the processing is so tiny that it is suitable for real-time face detection. When the system detects a human face, a square will appear. The developed system can detect many humans faces at the same time. A thermal imaging camera is checking the results of temperature scanning and the recognition processing at the entry gate of the company for one month.

Temperature scans the face recognition processing starts from detecting face, measuring temperature on the face, processing face recognition results, checking face recognition accuracy, checking temperature, and recording data in the database. The researcher studied the working process of a thermal imaging camera and the process of face recognition. Therefore, the developed the script using Python language to communicate with the thermal imaging camera, acquired temperature values through protocol Modbus TCP of the camera, transferred pictures from the thermal imaging camera in the form of visual image using protocol RTSP, and processed face recognition results from the original database in Figure 7.

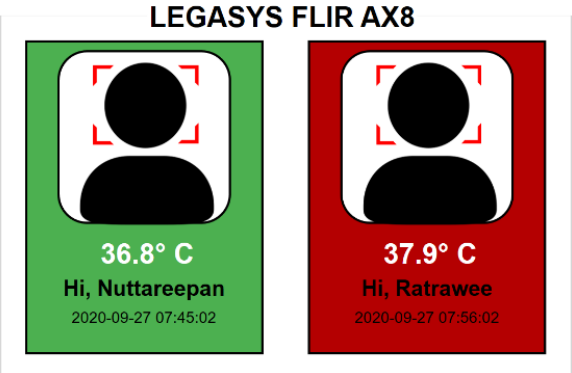

Figure 7: Example of a screen for scan temperature and processing face recognition

Part III: Face recognition is when the detected faces are processed with LBPH algorithm and compared to the face database to identify that the detected face matches someone. For example, the system shall analyze the detected face while a person is walking past the camera. Compared the detected face to pictures stored in the existing database for data recording that connects to the employee time attendance system—stored the data in CSV files.

For connecting devices used with thermal imaging attendance systems, the following:

1) Thermal imaging camera
2) Gigabit PoE Injector
3) Ethernet cable M12 to RJ45
4) Ethernet cable
5) Jetson Nano
6) Monitor & HDMI Cable

The first step is to connect the thermal imaging camera to Gigabit PoE with Ethernet cable M12 to RJ45. After that, connect the Gigabit PoE and Jetson Nano with Ethernet cable and connect the HDMI cable to Jetson Nano and Monitor to display the image. Next, the plugged-in all devices of the system. The system

will start automatically. Then, the user can place the device in the correct position. Things to consider are the optimal distance for detecting human faces and the distance at which detect the temperature.

IV. RESULTS AND DISCUSSION

Based on "Using Deep Learning with Thermal Imaging Camera to Record Employee Attendance System" with LBPH algorithm, time spent on testing the system in conjunction with a thermal imaging camera was one month (20 working days) to ensure accuracy of collected data. The fastness and safety of face recognition and face recognition processing time among 20 employees. Data in CSV files for being processed accurately and precisely. The obtained data for other approach management. The research result can be summarized as follow Table 1:

Table 1: Average of accuracy and time spent to processing

Average / Data	Accuracy	Time processing
Dataset1	83.51	0.25
Dataset2	80.46	0.26
Dataset3	81.84	0.31
Dataset4	80.29	0.27
Dataset5	81.54	0.26
Dataset6	82.41	0.26
Dataset7	81.93	0.26
Dataset8	82.19	0.27
Dataset9	81.24	0.25
Dataset10	82.07	0.25
Dataset11	81.25	0.24
Dataset12	82.34	0.25
Dataset13	82.23	0.23

Table 1: Average of accuracy and time spent to processing (cont.)

Average / Data	Accuracy	Time processing
Dataset14	80.88	0.29
Dataset15	81.67	0.25
Dataset16	83.24	0.23
Dataset17	81.20	0.28
Dataset18	82.47	0.29
Dataset19	81.77	0.23
Dataset20	82.54	0.24
Grand Total	**81.85**	**0.26**

Meanwhile, the LBPH is the most accurate algorithm in the acceptance criteria compared to the time spent on the processing. It will test the system with 20 employees and compare the results each week, various 100,200,300 and 400 data processing. The total data of one month (20 business days) to test the system within Table 2.

Table 2: The table present the time processing times and data accuracy

Week	Data Processing	LBPH	
		Data Accuracy	Time Processing
1	100	82.06	0.26
2	200	81.52	0.25
3	300	81.37	0.26
4	400	82.49	0.25
Average		**81.85**	**0.26**

The experimental result based on collecting data of face recognition accuracy using the LBPH algorithm found that accuracy values ranged from 80-85%, as shown in Figure 8 and Figure 9:

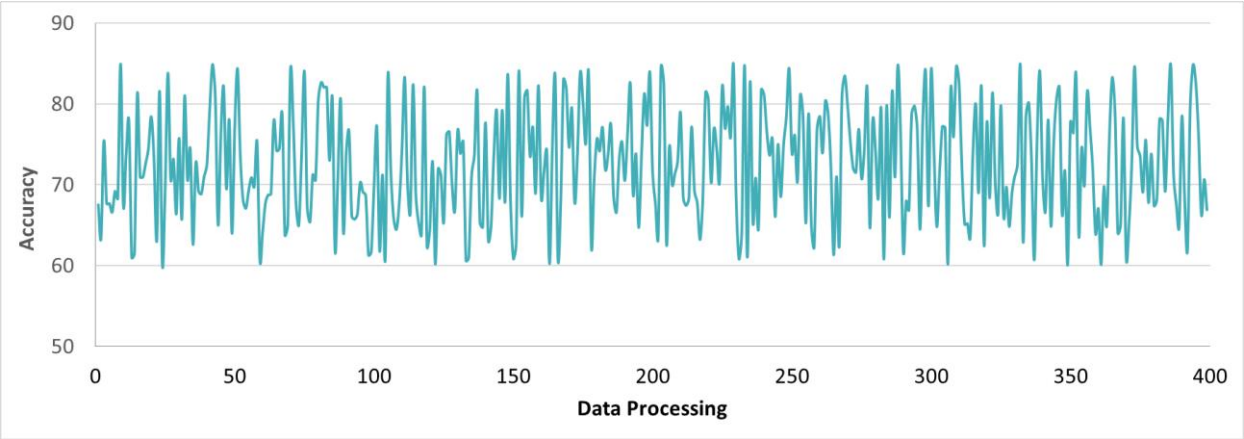

Figure 8: Data accuracy of LBPH algorithm

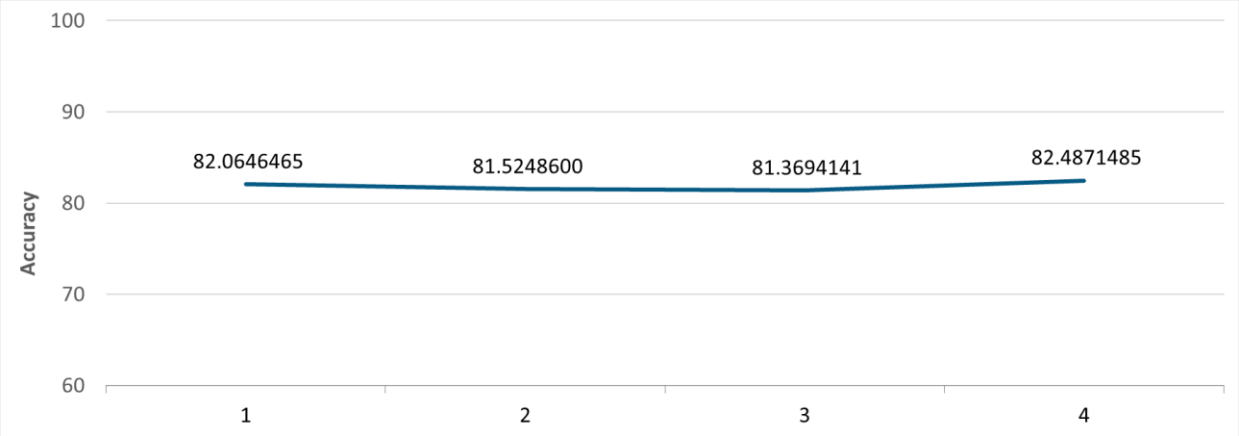

Figure 9: Average data accuracy of LBPH algorithm

Moreover, the experimental result found that the time spent on the processing ranged from 0.1 to 0.4 seconds per 1 time of face processing, as shown in Figure 10 and Figure 11:

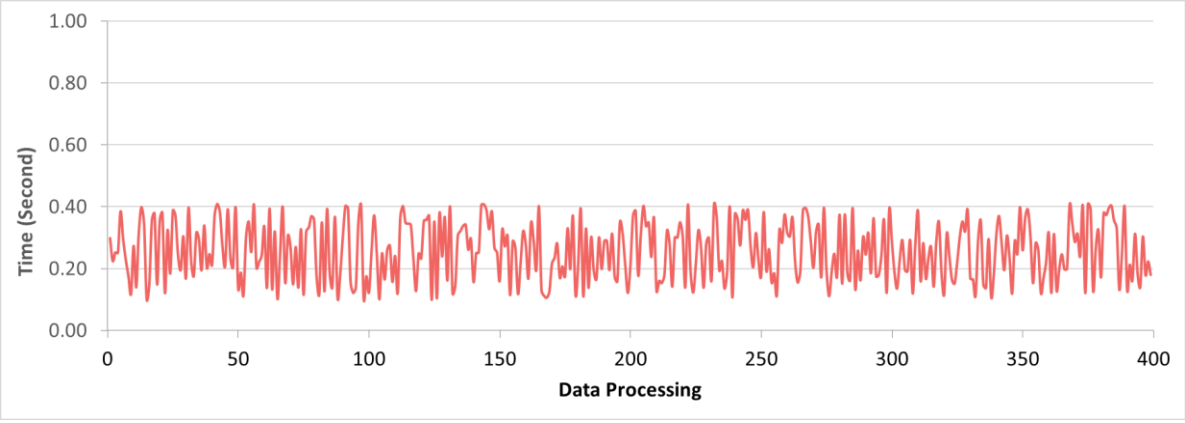

Figure 10: Time processing of LBPH algorithm

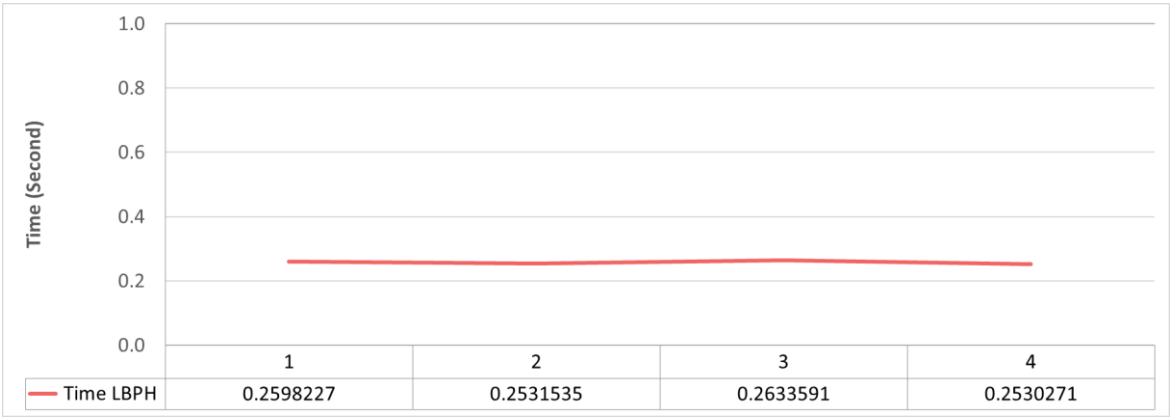

Figure 11: Average time processing face recognition of LBPH algorithm

A one-month trial to determine the mean accuracy of facial recognition using LBPH technique with 20 employees found that the mean accuracy of LBPH technique was 81.86 percent and the average processing time is 0.25 seconds, which compatible the paper of Attendance monitoring system with face recognition technologies [9] has been proposed to improve the accuracy of face detection and solve the conventional problems. The experiments were conducted on the accuracy of Eigenface recognition, Fisherface recognition, and Local Binary Pattern Histogram (LBPH) recognition to select the best face recognition technology for the proposed system. Experimental results show that LBPH recognition has the highest accuracy of 94.21%.

V. CONCLUSION

From the research "Using Deep Learning with Thermal Imaging Camera to Record Employee Attendance System" time spent on processing and data accuracy working with a thermal imaging camera, the LBPH algorithm used with the thermal imaging camera.

In terms of time processing and accuracy suitable for working with a thermal imaging camera, it is found that LBPH algorithm used with the thermal imaging camera enables the system to be convenient, fast and safe. The obtained data are accurate and precise. Employees could check data in real time. The system gains more efficiency and is convenient for searching for data and checking time attendance statistics, helping reduce errors and delay and helping solve problems related to an increase in the number of documents [3]. Meanwhile, LBPH algorithm is advantageous as it withstands changes in levels of illumination and it is the most accurate algorithm [10]. Based on this study, LBPH algorithm is considered the most accurate algorithm in the acceptance criteria when compared to the time spent on the processing.

Regarding time processing and accuracy, this research is suitable for working with a thermal imaging camera using the LBPH algorithm to develop record employee attendance system using temperature and face recognition using a thermal imaging camera—advantage in terms of time spent on processing and ability to withstand changes in levels of illumination. However, in the light coming in different positions, it will decrease facial recognition accuracy. Therefore, it is necessary to develop the process of making a picture database to increase the algorithm's efficiency for being used in an actual situation accordingly.

This research uses the FLIR thermal imaging camera model AX8, a relatively inexpensive thermal imaging camera, easy to use, and a protocol to connect to system development with Python language. In the

market with a high resolution and frame rate, when applying the technique of Face detection and Face recognition to process with the thermal imaging camera, it has been chosen. The results in processing results that for specific applications. If choosing to use other thermal imaging cameras with higher resolution and frame rate, appropriate use may vary. Therefore, in order to find suitable techniques for other devices, it is best to compare techniques. To find the efficiency of the processing time and additional accuracy values to verify that the results are suitable and within the recipient criteria.

Moreover, for the techniques in this research, users want a system that can be processed quickly. The accuracy is within acceptable criteria. Choose to consider using the LBPH technique in system development based on the results from the research. The choice of technique depends on the purpose for which the system is in the future.

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