Moslem Prayer Monitoring System Based on Image Processing

Niksen Alfarizal[1], Iskandar Lutfi[1], Nyayu Latifah Husni[1(✉)], Evelina Evelima[1], Ade Silvia Handayani[1], Sri Maryani[1], Wahyu Caesarendra[2], Seyed Amin Hosseini Seno[3], Astriani[1], and M. Sobri[1]

[1] Politeknik Negeri Sriwijaya, Jalan Srijaya Negara, Bukit Besar, Palembang, Indonesia
nyayu_latifah@polsri.ac.id
[2] Universiti Brunei Darussalam, Jalan Tungku Link, Gadong 1410, Brunei
[3] Ferdowsi University of Mashhad, Azadi Square, Mashad, Iran

Abstract. The research has purpose to monitor the movement of moslem prayer and count the cycles (rakaat). This is conducted because of Majority of Indonesia religion is Islam. Even though moslem prayer is an obligatory act of worship, however, most people often forget the count of their prayer cycles. Therefore, the research team focused on conducting research in the field of monitoring this prayer movements and cycles. Actually, the similar research has been conducted by many previous researchers, however the researchers used prayer mats equipped with the sensors. Thus, it becomes the drawback of the system in which it cannot be washed. This of course causes the impracticality of the prayer unit that has been produced. Therefore, the researchers tried to innovate a prayer movement monitoring device using image processing that utilizes a camera. The proposed system uses the pose detection systems to detect one's movement. The system will be matched the movement that it captures with the datasets and decide what movement that has been conducted. From the experiments, it can be concluded that the proposed system can work well.

Keywords: Moslem prayer · Rakaat · monitoring · image processing

1 Introduction

Humans tend to find new technology to make life easier. This technology basically will be synchronized and adjusted continuously to obtain better results in the future. The development of technology has reached a realm that is useful in various aspects of life. Thus, the existence of this technology could help humans in various ways physically and spiritually.

Worship is a spiritual activity that is routinely conducted as a tribute to God. This worship itself has various forms and ways to be conducted. One of which is moslem prayer (Salat). It is an activity of respecting the God and also a praying (wishing to God). This Salat also has several requirements and procedures that must be fulfilled, such as purifying or cleansing oneself by performing ablutions and then reading intentions and prayers in the salat process, etc.

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To facilitate the process of this worship activity, several efforts [1–6] have been made, such as reminding Salat times and also helping to inform Salat activities. However, as humans there will always be new problems. One of which is human memory in which it has a condition when the brain is overworked. In this condition, humans experience a condition of forgetting or not remembering something. This condition of forgetfulness can interfere with the process of praying which causes humans to forget some of the requirements such as prayer recitation and also the number of prayer rakaat.

In performing Salat, either obligatory or sunnah, there are several obstacles experienced by Muslims, including forgetting the number of rakaat that have been performed and difficulties in determining the Qibla direction. This is evidenced by a survey conducted by researchers on 86 respondents from the general public aged 17 to 50 years. From this survey, it can be concluded that 7% of Moslem still often forget the number of rakaat of prayers that are being performed [7–9]. The research in [7] discussed the method of calculation rakaat by using sujod movements. Kasman's research uses new techniques in detecting body posture more efficiently [8], while Ismail's research developed by using a compressive sensor that can read body posture [9].

2 Proposed Method

2.1 The Steps of the Research

The steps of the research can be seen in Fig. 1.

Based on Fig. 1, this research was carried out as follows:

- Problem identification that is important for determining the subject matter that occurs that becomes the background of research.

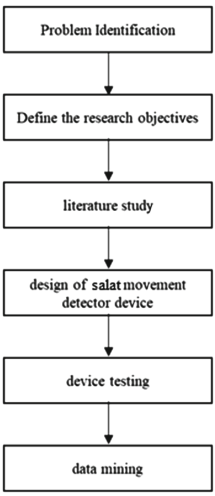

Fig. 1. Research steps

- Literature study is useful to know more about the development of devices based on existing references and research that have been conducted previously.
- Design the marker lines that provides limitation of the subject movement. This is needed in the implementation of the post predict method to determine the salat movements that are being done by the subject.
- Testing devices for trials. The purpose is to find out the shortcomings and limitations of the device and solutions to improve and refine the device.
- Data capture from test equipment based on trials that have been made is then analysed.

2.2 Principle of the System

The design of the monitoring system for the number of rakaats in this device has several specifications, including hardware design, software design that are integrated each other. The hardware design is divided into several stages of designs. Figure 2 shows a description of each stage.

In this research, mediapipe library was used. By using this mediapipe library, the movement will be read and then interpreted using landmarks or points on the body. In this project the body parts that are read are only the upper body. The position of ruku, sujod, sitting between two sujod, etc. will not be read as a movement. It will not be read as a movement due to the movement detected by the device is the movement of reclining, i.e., the movement during the qunut prayer and tabiratul ikhram. Landmarks read by the computer will automatically read the movements that have been set so that it can calculate the number of rakaat based on the benchmark movements from the computer's memory.

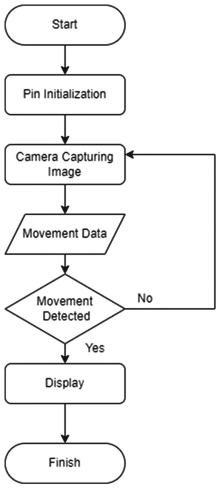

Fig. 2. Flowchart of device work principle

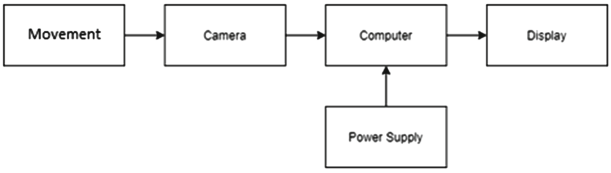

Fig. 3. Diagram block of device working principle

2.3 Block Diagram

Hardware design is the process of explaining the internet-based electric power monitoring system using a computer as a data processor. The prayer movement will be read by the webcam, then processed by the computer and matched with the movement data that has been stored. It then will be displayed on screen so that the results can be read. The block diagram in Fig. 3 shows how the flow of the process of monitoring the number of rakaat Salat works. This pose detection model (BlazePose Detector) is inspired by the lighter BlazeFace detector model. It is used in face detection from MediaPipe, as a proxy for body detection. It explicitly predicts two additional virtual points that describe the centre of the human body, rotation and scale as circles. It is also inspired by Vitruvian Leonardo who predicted the centre point to be the hip, the radius that limits movement, and the angle of inclination connecting the shoulder and hip centre points.

When the users perform the prayer movement, it is read and matched by the webcam and then compared with the movement data that has been inputted previously by the computer as the core part of the device. Thus, the result can be displayed with the number of rakaat and also the determination of the prayer position.

2.4 System Design

The Salat movement detection device does not require too many components in the construction. Therefore, it can be more practical to use and build. The device used in this device is a computer as the main driver in the experiment, then a webcam as a movement reader or sensor from the device so that data from the movement is obtained, and the use of phyton software as a command giver to the device.

One of the main tasks for modelling commonly used in machine learning is a dataset as a point to evaluate the resulting motion. By using the points that have been created by detecting objects, the movements performed can be detected and then compared with the existing database so that the reading results are obtained to be used as a reference for determining prayer movements. Nearest Neighbour interpolation method moves the empty space with the nearest neighbouring pixel when reducing or enlarging the image scale. Nearest Neighbour uses the nearest pixel value in the original image to provide the pixel value in the original image that will be enlarged or reduced. For example, there is an image with a size of 4 x 4 with a total of 16 pixels where each pixel is represented by the values A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P. Then the image will be enlarged to a size of 6 x 8 with a total of 48 pixels using Nearest Neighbour.

3 Experimental Result

3.1 Measurements and Testing Steps

To reduce errors in measuring and testing, it is necessary to take the following steps:

- Prepare the circuit and device to be tested.
- Check the circuit first to ensure that the entire circuit is in good condition.
- Determine the number of tests to be performed.
- Take measurements repeatedly to be more thorough.
- Record the measurement data that will be used as a reference to make an analysis.
- Measurement and testing is complete, then turn off all equipment.

3.2 Rakaat Counting Case

Table 1 shows a comparison table of the image results read by the camera as a body indicator using the skeleton.

Based on Table 1, it is shown five times experiments of calculating the rakaat of prayers, where the prayer has five special times and also has a difference in the number of rakaat performed. The test is carried out by determining the movement detected by the camera and determining the error that occurs when reading the movement, so that the percentage of reading can be determined. After the movement is detected, the number of rakaat will be determined.

After getting a comparison of the real value data with the value displayed on the computer, then the next steps are testing the motion detection based on the reference that has been made and determining the percentage of success with the percentage formula:

$$P = \frac{Total\ Detected\ Movement}{Total\ Test} \times 100\%$$

By using this formula, the percentage of movement readings that are successfully detected by the computer and recognized by the camera can be known. To conduct an experiment to calculate the rakaat of prayer, the first step is to detect the movement so that it can be arranged to become a rakaat. The data tested are shown by Table 2.

By testing the movement, it can be seen that the object read by the camera by detecting the movement can be used as a benchmark for calculating the rakaat. There

Table 1. Rakaat counting test

Rakaat	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Shubuh	Success	Success	Success	Success	Success
Dzuhur	Success	Success	Success	Success	Success
Ashar	Success	Success	Success	Success	Success
Maghrib	Success	Success	Success	Success	Success
Isya	Success	Failure	Success	Success	Success

Table 2. Movement detection test

Trial	Huddled Up	Ruku	I'tidal	Sujod	Sit
1	succeed	succeed	succeed	failed	succeed
2	succeed	succeed	succeed	failed	succeed
3	succeed	succeed	succeed	failed	succeed
4	succeed	succeed	succeed	failed	succeed
5	succeed	succeed	succeed	failed	succeed

are several factors that can affect camera readings so that testing is carried out with various conditions, namely by testing the detection distance on the camera and also testing in a lighted room and a dark room. Movement testing is done during the morning prayer when the light is not too bright and too dark. The following is a test of the prayer movement that is being tested using a webcam camera during the morning prayer, with lamp light and within an effective distance so that the test can be done properly.

3.3 Movement Detection Case

Figure 4 is a test of takbir movements where the user raises the hand that is usually used in connecting other prayer movements, the result shows 100% readings sucess in 5 trials with good lighting and effective distance range.

Figure 5 is a test of the sneezing movement that has a movement of bringing hands together then reading surah al-fatiha and reading short surah. Testing was carried out 5 times in good light conditions and effective distance, so that the detection results had a 100% rate of sucess.

Figure 6 is a test of the ruku movement which has a bowing motion and recitation of the ruku prayer. The experiment was carried out with good lighting and effective distance, however, because there are parts of the body that are covered by mukena (the special cloth for women moslem), the movement becomes less accurate in reading the movement.

Testing the prostration movement in Fig. 7 cannot be done due to the range of the camera in performing the detection. If the user is too far away, then the user cannot be detected, however, when the user is within the effective distance, the camera cannot capture the prostration movement, therefore the prostration movement is considered an error because it is not detected.

Testing the movement of sitting between two prostrations using points located on the shoulders and wrists for key movements is shown in Fig. 8. The test was repeated to determine the efficiency of the proposed device.

3.4 Measurement of Detection Variable

It can be seen that the movement reading for prayer movement detection has a detection distance as far as 2 m, then the use of the proposed device will be limited by using the

range 1.45 m, so that the movement reading will be more effective. A certain distance will change the focus on the camera causing the reading to be disturbed by determining

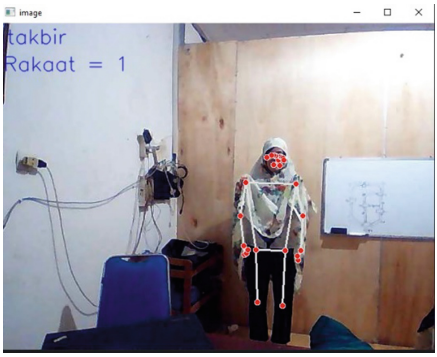

Fig. 4. Takbir movement detection

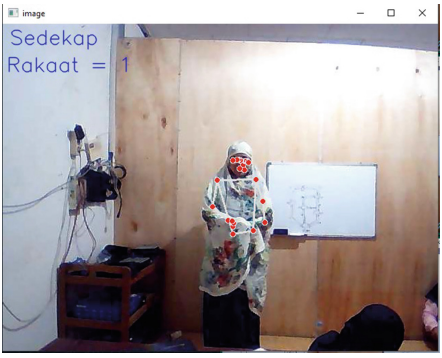

Fig. 5. Huddled up movement detection

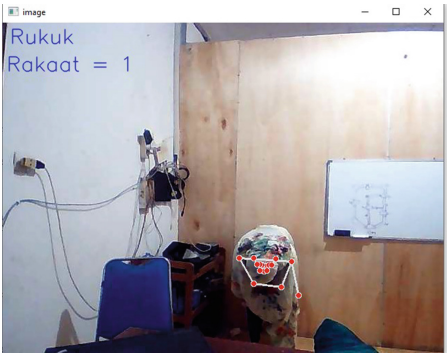

Fig. 6. Ruku movement detection

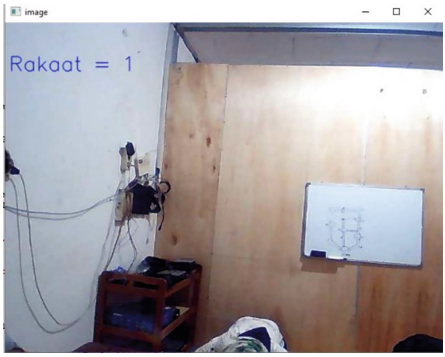

Fig. 7. Prostration movement detection

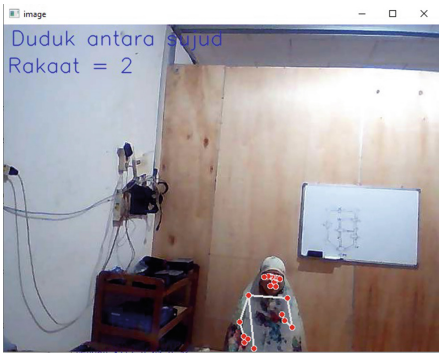

Fig. 8. Sitting between two prostrations movement detection

Table 3. Range detection test

Movement	Minimum detection distance (m)	Maximum detection distance (m)
Huddled Up	0,1	2
Ruku	0,1	2
I'tidal	0,1	2
Prostrations	0,1	2
Sit	0,1	2

the effective distance from the user so that the reading can be done more accurately (Table 3).

Light can affect camera detection because the working system of a camera is the reflection of refracted light. The data for the light effects can be seen in Table 4.

Table 4. Rakaat counting test based on light

Salat Name	Bright rooms	Dim rooms	Dark rooms
Shubuh	Detected	Not Detected	Not Detected
Dzuhur	Detected	Not Detected	Not Detected
Ashar	Detected	Not Detected	Not Detected
Maghrib	Detected	Not Detected	Not Detected
Isya	Detected	Not Detected	Not Detected

After testing, it is known that this prayer movement detection system uses a method of reading point coordinates on a pixel box that detects objects and then draws skeletons or landmark markers on the user's body, but by testing it is known that there are several factors that can affect object detection such as camera detection distance and lighting that does not support detection, by testing it is known that the effective use of the device is rarely 1 - 2 m by considering reading the whole body, other supporting factors that influence by conducting experiments in various light conditions it is known that the percentage of readings in a dark room is 0% and when bright lighting conditions the reading of movements reaches 100%.

4 Experimental Result

Based on the results of measurements, research and discussion on the moslem prayer movement monitoring system, it can be concluded:

1. In testing the movement has a success rate of 80% because there are several influencing factors, such as light and distance.
2. In testing rakaat, the success rate is 100% because the detected movement has a point that can be used as a reference.
3. Lighting can affect the translation results because the object will fade so that the camera cannot recognize the object.
4. Distance can affect reading efficiency because when the object is not in the effective range, the coordinates will change so that the translation results will be different.

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