TELKOMNIKA, Vol. 13, No. 4, December 2015, pp. 1446~1455
ISSN: 1693-6930, accredited A by DIKTI, Decree No: 58/DIKTI/Kep/2013
DOI: 10.12928/TELKOMNIKA.v13i4.2236

Double Difference Motion Detection and Its Application for Madura Batik Virtual Fitting Room

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Abstract

Madura Batik Virtual Fitting Room using double difference algorithms motion detection is proposed in this research. This virtual fitting room consists of three main stages, i.e. motion detection, determination of the region of interest of the detected motion, superimposed the virtual clothes into the region of interest. The double difference algorithm is used for the motion detection stage, since in this algorithm, the empty frame as the reference frame is not required. The double difference algorithm uses the previous and next frame to detect the motion in the current frame. Perception Test Images Sequences Dataset are used as the data of the experiment to measure the performance accuracy of this algorithm before the algorithm is used for the Madura batik virtual fitting room. The accuracy is 57.31%, 99.71%, and 78.52% for the sensitivity, specificity, and balanced accuracy, respectively. The build Madura batik virtual fitting room in this research can be used as the added feature of the Madura batik online stores, hence the consumer is able to see whether the clothes is fitted to them or not, and this virtual fitting room is also can be used as the promotion of Madura batik broadly.

Keywords: *Motion Detection, Double Difference, Augmented Reality, Virtual Fitting Room*

1. Introduction

Motion detection is an important stage in many applications, especially object tracking application. The more accurate of motion detection, then the accuracy of the object tracking will increase. The motion detection and object tracking can be used in many applications, for instance, navigation, gait recognition, surveillance system, etc. Therefore, many research focus on the motion detection algorithm [1-5].

This research proposes motion detection algorithm for Madura Batik Virtual fitting room. The Building of Madura Batik virtual fitting room is proposed in this research since currently, a home industry of Madura batik is growth increasingly. The growth is caused by the existence of Suramadu Bridge. In term of Madura batik, the Suramadu Bridge gives two main benefits to the Madura people. First, because of the bridge, the tourism in Madura is increasing, and many tourists bought Madura batik as their souvenir. Second, the bridge makes the delivery process of Madura batik from Madura to the region outside Madura is easier. Hence, these two main benefits make the sale of Madura batik is increasing nowadays.

Some of home industry of Madura batik notices the opportunity to increase the Madura batik; therefore they use the information technology as the promotion of Madura batiks, such as online store, e-commerce, etc. The promotion of Madura batik using online store also gives benefit to the consumer, i.e. the consumer would not need to travel a long way to buy Madura batik. The consumer is able to choose the Madura batik from the web, and the transaction will be done in an online transaction. However, unlike the physical store, the online store does not provide the fitting room. Hence, the consumer is not able to try the clothes, whether the clothes is fitted to them or not. The existence of virtual fitting room is required in the online store as an added feature. This feature makes the consumer see whether the color or the pattern of the clothes is fitted to them or not.

The Virtual fitting room is proposed in this research using the double-difference motion detection algorithm. This algorithm is used, since in the previous research using the frame difference motion detection, the first frame of the data video should be an empty frame (there is no foreground in the frame) [6]. Following is the remainder of the paper, the second section

Received June 22, 2015; Revised November 4, 2015; Accepted November 22, 2015

explains the motion detection algorithm, the third section explains the building of virtual fitting room, the fourth section describes the experiment and the last section is the conclusion section

2. Double Difference Motion Detection

Motion detection algorithm is required in this research for building the virtual fitting room. The objective of motion detection in this research is to find the location of the consumer in each frame of the data video. The simplest algorithm for motion detection is frame difference algorithm. This algorithm compares each pixel in the successive frame or compares each pixel in the reference and current frame. If the pixel in the same location from the compared frames is changed, then the pixel is recognized as the moving pixel. To compare the pixel, the difference between the compared pixels is calculated as shown in (1). The pixel is detected as the motion pixel or the foreground, if the result of the difference in (1) is bigger than the set threshold. On the contrary, if the result of the difference less than the set threshold, the pixel is recognized as the background pixel.

$$D(x,y,t) = F(x,y,t) - F_0(x,y) \quad \begin{cases} if \quad D(x,y,t) > Th & \text{then set as foreground} \\ if \quad D(x,y,t) \leq Th & \text{then set as background} \end{cases} \tag{1}$$

where $F(x,y,t)$ is a pixel value on (x,y) in frame t, and $F_0(x,y)$ is the pixel on (x,y) in the reference frame.

Generally, the reference frame is the first frame of the data video, where the frame is empty frame or the frame consists of only the background image and the foreground is not available in reference frame as depicted in Figure 1. As seen in Figure 1. The reference frame is empty frame, hence the foreground or the moving pixel in the current frame is detected easily.

Figure 1. Left: the reference frame, Middle: the current frame, Right: the detected motion [5]

In the real system, the reference frame that consists of an empty frame is difficult to achieve. Usually, the foreground image is unpredictable, i.e. the foreground image can be in the first frame, or it appears in the second frame, or probably the foreground image appears in any frame of the data video. Hence, the reference that consists of an empty frame is rare in the real system.

However, if the difference is calculated between the successive frames, or the difference is calculated between the current and previous frame then the ghosting effect is appear in the result of the difference. Figure 2 shows the ghost effect of frame difference method. The Figure 2 shows that the previous frameis used as the reference frame, and the the objectappears in the previous and the current frame. Therefore, the result of the difference between the successive frames presents the ghosting effects, and this effect will decrease the motion detection accuracy.

Figure 2. Left: the previous Frame, Middle: the current frame, Right: the detected motion

Double difference image generation algorithm for motion detection is used to overcome the problem. This algorithm calculates two kinds of differences of the successive frames, i.e, first, the current frame and the previous frame, and second, the difference between the current frame and the next frame. The result of the differences is combined with the AND operation [6]. The diagram of the algorithm can be seen in Figure 3.

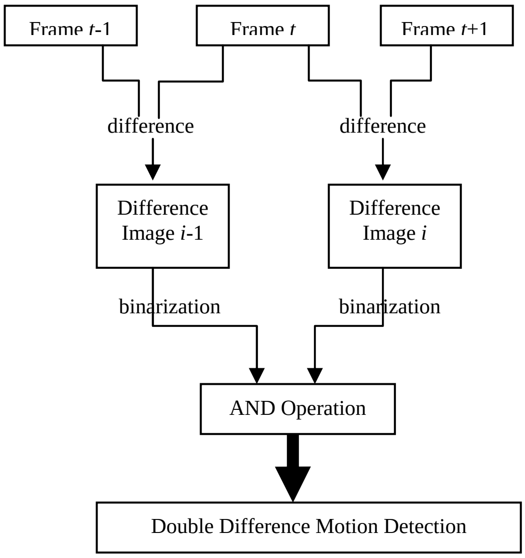


Figure 3. Double Difference Motion Detection Diagram [5]

The use of the two kinds of differences calculation and the result is combined with AND operation makes the ghosting effect is disappeared.

The empty frame as the reference frame is not required in the double difference algorithm. Hence this algorithm is more suited to implement in the real system.

3. Research Method

The Madura batik virtual fitting room is proposed in this research. The virtual fitting room is used for the consumer to see whether the color and the pattern of the clothes are fitted to them or not. The build of virtual fitting room in this research used the augmented reality technology, i.e. the technology that creates the combination of the real objects and the virtual objects such that the boundary between the objects can't be distinguished [8, 9].

In this research the Madura batik virtual clothes plays as the virtual object. Meanwhile the body of the consumer plays as the real object. The purpose of the Madura batik virtual fitting room is to combine these objects. To combine the virtual clothes into the body of the consumer in the data video, the augmented reality need the location of the placement. Two kinds of placement of virtual objects into the real objects, they are marker and markerless. A marker is required in the marker augmented reality. This marker is used as the location of the placement of the virtual objects into the real objects. The example of marker and the marker augmented reality are shown in Figure4.

This research uses markerless augmented reality. To combine the virtual object and the real object, this research uses the region of interest of the body of the consumer instead of the marker image. Hence, the first stage in this research is motion detection. The motion detection is used in the next stage, i.e. the determination of the region of interest.

Figure 4. Left: Marker, Right: Augmented Reality with Marker

The diagram of the Madura batik virtual fitting room can be seen in Figure 5. The Madura batik virtual fitting room consists of three main stages. First, motion detection to detect the motion in the frame of data.Second, the determination of the region of interest based on the detected motion. The region of interest is determined from the entire pixel that are recognized as the foreground image or the moving pixel. The example of the region of interest from the detected motion can be seen in Figure 6. The final stage is superimposing the Madura batik virtual clothes on the body of the consumer according to the region of the interest. The virtual clothes are also resized based on the region of interest. Hence, the virtual clothes will be fitted to the body of the consumer

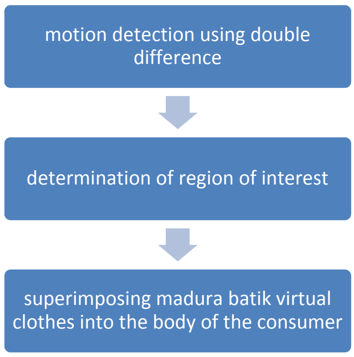


Figure 5. The virtual fitting room diagram

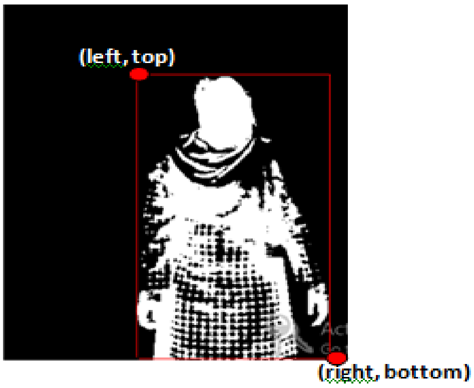


Figure 6. Region of Interest of the detected motion

4. Results and Analysis

Two main experiments are conducted in this research. The first experiment is done to measure the accuracy performance of the double difference algorithm before the algorithm is implemented in the virtual fitting room application. In this experiment, we use the Perception Test Image Sequence dataset. The ground truth of the detection motion is provided in the database. The first experiment is completed with motion detection using conventional frame difference (a first frame for reference frame) as the comparison for the double difference motion detection method.

The second experiment is the implementation of the double difference motion detection for the Madura batik virtual fitting room.

There are five environments of the dataset in the first experiment. Two data are used in the experiment in each environment.We used balanced accuracy to measure the performance of the motion detection algorithm as shown in (2)

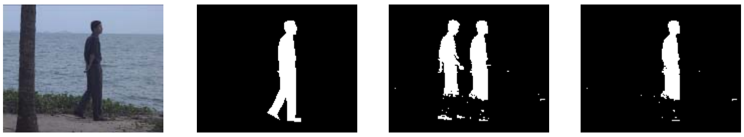
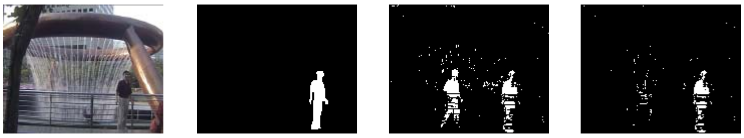
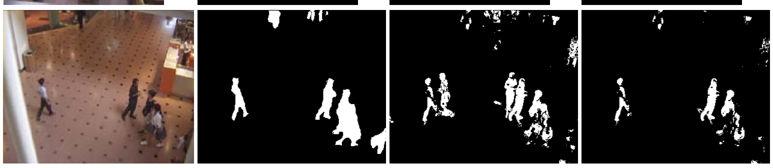
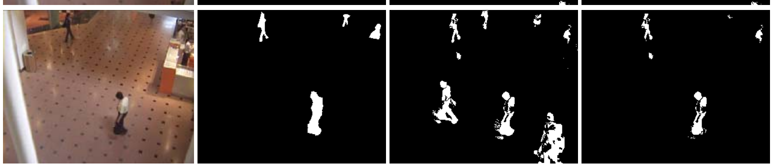
$$Sensitivity = \frac{TP}{TP+FN};\ Specificity = \frac{TN}{TN+FP};\ BalancedAccuracy = \frac{Sensitivity + Specificity}{2} \quad (2)$$

TP (True Positive) is the number of true detected motion pixels, TN (True Negative) is the number of true detected background pixels, FP (False Positive) is the number of false detected motion pixels, and FN (False Negative) is the number of false detected background pixels.

The sensitivity is used to measure the accuracy of detected motion pixels and the specificity is used to measure the accuracy of detected background pixels. Meanwhile the balanced accuracy is the average accuracy.The accuracy of the first experiment using the double difference motion detection is shown in Table 1.

As seen in Table 1, the average sensitivity accuracy for the frame difference method is 61.63%, meanwhile for the double difference method is 57.313%. The average specificity accuracy for frame difference and double difference method is 97.48% and 99.71%, respectively. The average result shows thate frame difference is better since sensitivity rate is higher compare to the double difference method. However, the frame difference (without aempty frame as the reference frame) method yield ghost effect in the motion detection process n as depicted in Figure 7. The sensitivity rate for the frame difference is higher, since when the detected motion is superimposed to the provided groundtruth, the number of TP pixels (white pixels) is more compare to the number of TP pixels from double difference method. Unfortunately, the frame difference will give ghost effect, and this effect will give falsely detected motion. Therefore, specificity is also required in the measurement of accuracy. Table 1shows the specifity accuracy for the double difference method is higher compare to the frame difference method.

Table 1. The Accuracy of the Frame Difference and Double Difference Algorithm for motion detection, SN is sensitivity accuracy and SP is specificity accuracy

Current Frame	Ground Truth	Detected Motion: Frame Difference	Detected Motion: Double Difference	Performance Accuracy (%): Frame Difference SN	Frame Difference SP	Double Difference SN	Double Difference SP
				62.64	99.64	55.59	99.98
				65.42	95.79	50.89	98.73
				62.25	97.07	61.44	100
				72.07	94.05	70.56	99.95
				72.99	98.32	67.02	99.84
				55.65	96.88	52.57	99.3
				46.26	99.8	46.26	99.98
				64.71	99.02	64.43	100
				53.16	96.29	44.57	99.47
				61.14	97.92	57.31	99.71
Average accuracy				61.629	97.478	57.313	99.707

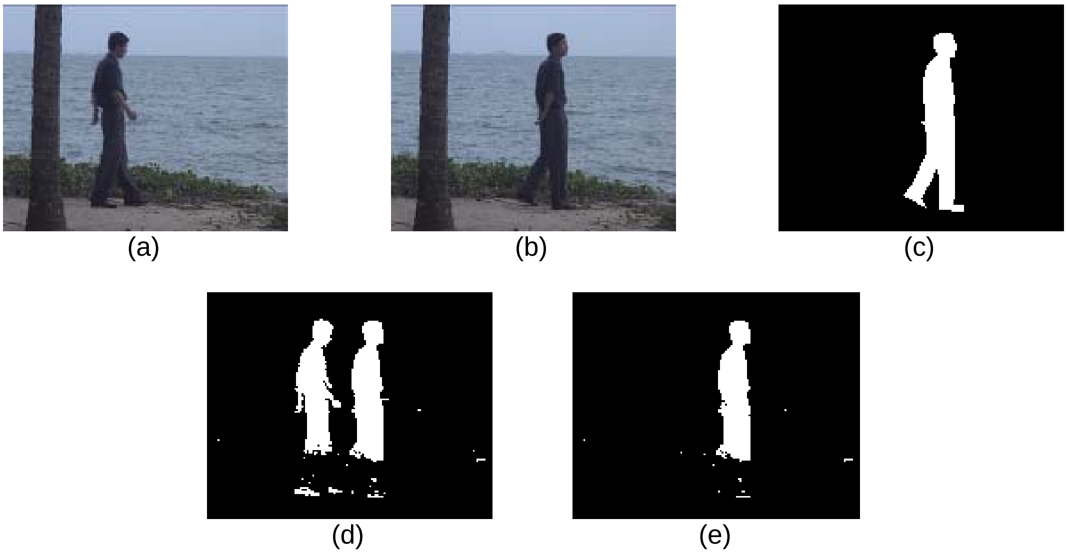


Figure 7. (a) Previous Frame; (b) Current Frame (c) groundtruth; (d) detected motion with frame difference; (e) detected motion with double difference

The average of balanced accuracy for double difference method is 78.51% with the sensitivity accuracy is only 57.31%, and specificity achieved 99.71%. This means that the double difference algorithm gives less performance for detecting the motion pixels; meanwhile the algorithm gives the best performance for detecting the background pixels. As seen in Table 1, however even the sensitivity accuracy is low, the result of detected motion is sufficient enough to provide the region of interest in the virtual fitting room proves.

The improvement of double difference algorithm for motion detection compare to frame difference algorithm is the reference frame is not required to be the empty frame (the target object is does not exist in the frame). Unfortunately, to detect the motion of the current frame, the next frame is required in order to eliminate the ghosting effect caused by the difference calculation between frames. The example of the difference calculation to detect the motion in the dataset can be seen in Figure 8. Figure 8 shows that combination with AND operator of the both difference calculation (current - previous frame and current – next frame) will eliminate the ghosting effect that caused by difference calculation process.

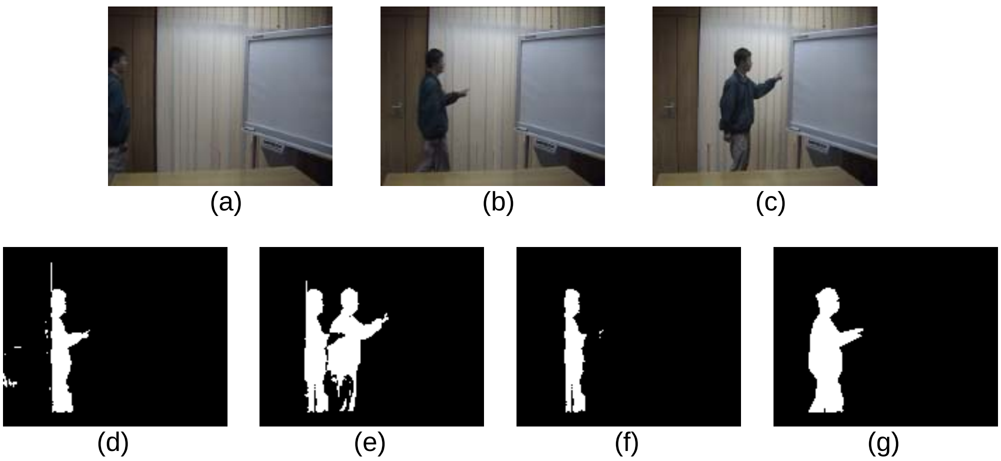


Figure 8. (a) previous frame; (b) current frame; (c) next frame; (d) difference between current and previous frame; (e) difference between current and next frame; (f) the detected motion ; (g) ground truth image

The second experiment in implementation of the double difference motion algorithm, i.e. building Madura batik virtual fitting room. To build the virtual fitting room using augmented reality, then virtual objects that are combined into the real objects are created first. The Madura batik virtual clothes plays as the virtual objects in the research. Therefore we have created the virtual clothes using batik originally come from Madura, some of created Madura batik virtual clothes can be seen in Figure 9.

These virtual clothes are embedded to the body of the consumer based on the location of the region of interest of the detected motion. The experiment is done in the different environment of a virtual fitting room. This scenario proves that the motion detection algorithm is work correctly in a different environment. The experiment of the virtual fitting room can be seen in Figure 10 and Figure 11.

Figure 9. Virtual clothes from Madura batik

Figure 10. Top left: the first frame; Top right: the third frame; Bottom: the sixth frame

Figure 10 shows that the location of the Madura batik virtual clothes is moved along with the location of the body of the consumer, since the virtual clothes is embedded to the region of interest of detected motion. Figure 10 also shows that the reference frame is not the empty frame, since foreground object is found in the first frame. This research overcomes our limitation in the previous research [4]. In the previous research, the reference frame should be the empty frame; hence the motion in the current frame is detected easily.

Figure 11. Virtual fitting room in the different environment

The variety of environment in the virtual fitting room can be seen in Figure 11. Figure 11 shows that, the virtual fitting room works well even in the different environment.

Unfortunately, this research has a drawback, i.e. the virtual fitting room does not work in real time. Since in the double difference motion detection algorithm, to detect the motion in the current frame, we need to calculate the difference between the current frame and previous frame, and also we need to calculate the difference between the current frame and the next frame. Hence, this method is one frame delayed from the real time.

4. Conclusion

The Madura batik virtual fitting room is built in this research. Motion detection algorithm is required to obtain the location of the region of interest, hence the Madura batik virtual clothes is embedded to the region. The double difference algorithm is used for the motion detection stage and the advantage of this algorithm is the reference frame does not have to be the empty frame. The disadvantage of this algorithm is the one frame delayed from the real system.There are two experiments are conducted in this research. The first experiment is to measure the performance accuracy of double difference motion detection algorithm, and the second experiment is to implement the algorithm for the virtual fitting room. The first experiments show that even the algorithm gives low performance i.e. 78.51% accuracy. However this performance is sufficient enough for the determination of region interest in the virtual fitting room stage. The implementation of this algorithm for the Madura batik virtual fitting room is done in the second experiment. The experiment shows that the motion detection algorithm gives a good result for the embedding of virtual clothes in the real objects in the video. Unfortunately, the characteristic of the algorithm makes the virtual fitting room is not completely works in real time, since the algorithm requires next frame to detect motion in the current frame.

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