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User experience measurement on virtual dressing room of Madura batik clothes

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The exoticism of Madura batik has become one of the tourist charm of the Indonesian Madura island. Madura batik created by skilled hands with a high level of artistic imagination to produce diverse and unique batik. Our virtual dressing room use augmented reality technology to create solution of an efficient shopping experience by superimposing the 3D model of a Madura batik cloth within the live Kinect sensor's. The superimposed 3D model of Madura batik will then transformed using 3D rigid transformation and bond to the movements of customer so it appears as if the customer is wearing the virtual dress in the live video view. We built the system using SimpleOpenNi library, and Microsoft Kinect SDK. User Experience (UX) measurement on the adaptation key performance indicators which include Attention, Importance, and Arousal showed 96% of respondents said that they were satisfied while the Quality key performance indicators which include Impression, Valence, and Enjoy showed 97% respondents were satisfied.

Published in: 2017 International Conference on Sustainable Information Engineering and Technology (SIET)

Date of Conference: 24-25 Nov. 2017

Date Added to IEEE *Xplore*: 01 March 2018

ISBN Information:

INSPEC Accession Number: 17613567

DOI: 10.1109/SIET.2017.8304135

Publisher: IEEE

Conference Location: Malang, Indonesia

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I. Introduction

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Metrics

User Experience Measurement On Virtual Dressing Room Of Madura Batik Clothes

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***Abstract*— The exoticism of Madura batik has become one of the tourist charm of the Indonesian Madura island. Madura batik created by skilled hands with a high level of artistic imagination to produce diverse and unique batik. Our virtual dressing room use augmented reality technology to create solution of an efficient shopping experience by superimposing the 3D model of a Madura batik cloth within the live Kinect sensor's. The superimposed 3D model of Madura batik will then transformed using 3D rigid transformation and bond to the movements of customer so it appears as if the customer is wearing the virtual dress in the live video view. We built the system using SimpleOpenNi library, and Microsoft Kinect SDK. User Experience (UX) measurement on the adaptation key performance indicators which include Attention, Importance, and Arousal showed 96% of respondents said that they were satisfied while the Quality key performance indicators which include Impression, Valence, and Enjoy showed 97% respondents were satisfied.**

Keywords*— *Virtual dressing room; Kinect; Madura batik; Augmented Reality; 3D-rigid transformation

I. INTRODUCTION

Dressing room or fitting room is important part in the store which sell garments. An in-store changing room is used by consumer to choose a dress or garment product that fit and match to them. The comfortability of dressing room facility is also important to note by an apparel store. Spacious room, room lighting, and room design will greatly affect consumers to shop at the store [1] [2] [3].

Batik is one of Indonesia's cultural heritage recognized by UNESCO. Madura batik is one of the kind of batik that many interested foreign consumers, because of the uniqueness and diversity of the style and color. The sale of Madura batik clothes through online and conventional market always requires dressing room. The virtual dressing room media is expected to change the consumer shopping experience and increase the buying desire.

The most time consuming thing when buying clothes is when trying fit and match on the body. Building a virtual dressing room based on augmented reality technology can be a solution to this problem. It enables consumers to try on apparel to check size, fit or style, but virtually rather than physically [4].

Some of the technologies that may used in virtual dressing are as follows: Three-Dimensional Display: provides a visual display of a consumer with an avatar created by the size of the input adjusts consumers, Two-Dimensional Display: is the application of the creator of the image where the consumer as if seeing her wearing these clothes, body Scanners: recommend the appropriate size based on the detection of the body, Digital Signage : virtual mirror, where consumers can interact virtually with the featured products, Tablets and Smart Phones: mobile applications, where consumers can interact digitally with the virtual product displayed, Internet Connectivity: virtual product that can be tested displayed online, and shared on social media, Cameras: recording video and taking pictures / photos when consumers are trying the product, 3D Cameras: using face detection and mapping similar to the consumer to be displayed on the glass virtual, Motion Detection Technology (like Kinect): to show clothes who tried to follow the movement of consumers, Multi-touch Technology, Bluetooth Connectivity, Inventory Management and Synchronization Software, Robotic Mannequins: create images that have the size and shape of a digital database dressing room, and Cloud Database Technology [5].

We present a virtual dressing room for Madura batik clothes within live Kinect sensors. The virtual dressing room is used for the consumer to fit in virtually and see the color and pattern of the Madura batik clothes. We use Augmented Reality technology to build a virtual dressing room application to reduce frustration and time spent in classical dressing rooms.

Depth sensor Kinect makes customer possible to detect the movement of their body, then body tracking to the attached dress could move along with user movement. At the last, it looks natural and realistic when display on the screen. The drawback is that the dress usually displays in 2 dimensions, so it looks like the dress is attached only to the front of the body. Our system used 3D virtual dresses which wrapping around the consumer body.

The smoothing enhancement for body movement we use 3D-rigid transformation: rotation, translation, and scaling on Madura batik 3D-model. Finally, for measuring relevant user reactions and experiences we measure adaptation key performance of the User Experience (UX) to 100 respondents.

The rest of the paper is organized as follows. First, we give related work on Madura batik clothes in virtual dressing rooms using web camera and phone camera. Next, we provide an overview of the proposed approach, as well as the details of Madura batik virtual dressing room and user experience measurement. Then, we provide experimental results. At the end, we give conclusions and further research directions.

II. Previous Work

Some research that we have done about dressing room for Madura batik clothes still not using depth sensor device. Initially, we used the web camera to build a virtual dressing room. We used Double Difference Motion Detection method to get the user's shadow line. The shadow as a marker on augmented reality to display 3D model Madura batik that has been prepared. The system could automatically resize our virtual cloth based on the region of interest which superimposed on the body of the consumer. Through this method, our virtual batik model will always be fitted to the body of the consumer [6].

Unfortunately, the method [6] has a drawback, i.e. the virtual dressing room does not work in real time, which is one frame delayed from the real time. Because of the double difference motion detection algorithm method, we have to calculate the difference between current frame and the previous frame, also we need to calculate the difference between the current frame and the next frame.

Then, we tried to use the camera on mobile phone in building a virtual dressing room. A virtual dressing room that we build using this mobile application, showing some 3D model Madura batik clothes that can be done resizing, rotating and translating [7].

The augmented reality mobile application can render outfit model in various location, rotation, and size smoothly. It just The detection process takes only ~ 1-2 seconds. Unfortunately, The cloth pieces could not be fitted on the consumer. Because it is not possible to take photos of consumers from very close range (the length of human hand).

III. The Proposed Approach

We expect that Kinect utilization for virtual dressing room will be more effective than our previous research. Reducing time-consuming stages and trial experience of wearing Madura batik clothes through virtual dressing room, is expected to increase the consumer's desire to buy Madura batik clothes.

Our application uses Processing, an open-source computer programming builds on the Java language for implementing this virtual dressing room.

A. Skeletal Tracking by Microsoft Kinect

Kinect contains two cameras (one infrared camera and one video camera) and a special infrared transmitter that produces a grid of dots that measure the distance of objects from the Kinect and to compose a "depth map" of the image. Kinect can recognize up to six consumers in the field of view of the sensor by using the infrared (IR) camera. But, the system only supports up to two consumers can be tracked in detail. Our application can locate the joints of the tracked consumers in space and track their movements over time. To be recognized, consumers simply need to be in front of the sensor, making sure the sensor can see their head and upper body [8].

The Kinect sensor sends the depth image to the computer using infrared emitter which produces a projected pattern of infrared light. This pattern of light is used to calculate the depth of the people in the field of view that allowing different body parts.

The block diagram of this research is described in figure 1.

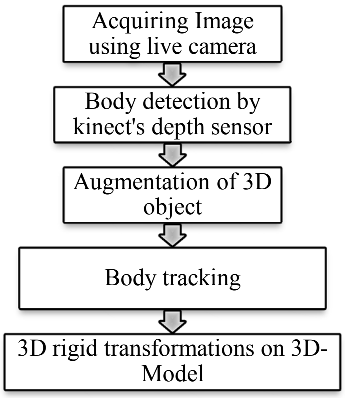

Fig. 1. Diagram virtual dressing room Madura's batik clothes

1) Acquiring Image and Body Detection

The consumer will stand in front of the Kinect sensor, which has an RGB sensor and a depth sensor. Figure 2 and 3 shows the output produced by the body-tracking of our software with lines joining the various elements.

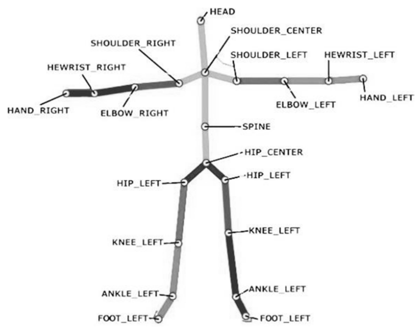

Fig. 2. Skeleton joint structure in Kinect[8]

Using these sensors, the consumer will be calibrated and his skeleton will be tracked. Just the position and orientation of the head has been tracked that will be used for the virtual cloth reference.

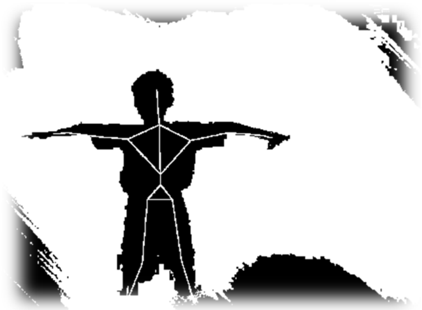

Fig. 3. Implementation of skeleton tracking

The Simple Open NI library and Microsoft Kinect SDK is used for framework tools, which acts as a middleware for the Kinect sensor, tracks the gestures of the consumer. The gestures are deciphered, and their corresponding semantics is given to the Processing.

2) 3D Object Virtual Clothes

Our object model is the geometrical object that created by using Blender3D software a standard CAD 3D model. We created Madura batik models for both male and female consumer. Several models of our virtual clothes of Madura batik are depicted in table 1.

TABLE I. 3D OBJECT VIRTUAL DRESS

Madura Batik		
Batik Material	**3D Female Model**	**3D Male Model**
		
		
		
		

3-D meshes of clothing are designed in Blender3D software and imported to Obj and mtl file. In this research, Blender3D created Obj-files for the 3d vertex modeling object, mtl-files for describing the surface shades (material libraries) properties of objects and jpg-file for texture material. Because the 3d object in the single pose, then the virtual object cloth just is used one pose for a consumer. One of Madura batik texture material shown in figure 4. 3D object material clothes process shown in figure 5.

Fig. 4. Acquiring Madura batik garment for texture material 3D-object

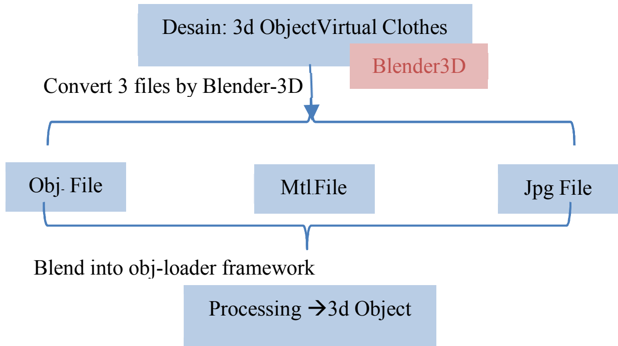

Fig. 5. 3D object material virtual clothes schema system

3) Cloth Transfer and tracking body motions

The next step in the implementation, according to position and orientation information 3D object virtual cloth can be embedded on the front of the human body.

The steps of this process are: First, Kinect is seeking the reference point information (boundary neck and head), and then this information is used as a reference point for virtual clothes added to his / her body. Second, the value of the Y coordinate of the virtual cloth arranged to correspond to the reference point. So also with the size of the virtual cloth scaled advance (the process of setting the value of the Y coordinate and scale of virtual cloth is done with some experimentation to get the position by the consumer's body).

The experimental results of processing system when simulating the virtual cloth based on consumer gestures tracking can be seen in figure 6.

Fig. 6. Virtual Cloth transfer on consumer body

4) 3D-Rigid Transformations

Homogeneous transformation matrix for 3D bodies and 3D models of Madura batik has been made. We use a rigid transformation which consists of rotation (R), translation (T) and scaling (S). These three values transform the rigid object from a three dimensional coordinate to the reference coordinate. The transformation of each joint point from one of the three dimensional coordinates to the other is transformed by the value of certain rotational, translational and scaling values. The most commonly used definition in graphics describes a rotation by Euler angles (φ, θ, ψ) as a product of three rotations. The matrix M for the rotation is, therefore, a product of three others [9].

$$M = R_{yz}(\psi)R_{zx}(\theta)R_{xy}(\varphi) \quad (1)$$

The matrix M formula shows that objects are first rotated by angle   in the xy-plane, then by angle   in the zx-plane, and then by angle   in the yz-plane. The number   is called pitch,   is called yaw, and   is called roll.

The general form of rigid transformation that we use can be written :

$$T = \begin{Bmatrix} S_x(\cos\theta\cos\varphi) & \cos\theta\sin\varphi\sin\psi - \sin\theta\cos\psi & \cos\theta\sin\varphi\cos\psi + \sin\theta\sin\psi & T_x \\ \sin\theta\cos\varphi & S_y(\sin\theta\sin\varphi\sin\psi + \cos\theta\cos\psi) & \sin\theta\sin\varphi\cos\psi - \cos\theta\sin\psi & T_y \\ -\sin\varphi & \cos\theta\sin\psi & S_z(\cos\theta\cos\psi) & T_z \\ 0 & 0 & 0 & 0 \end{Bmatrix} \quad \ldots\ldots(2)$$

The order of operations of this transformation is critical. The matrix transformation T represents the following sequence of transformations:

1. Roll by ψ
2. Pitch by φ
3. Yaw by θ
4. Translate by (Xt,Yt,Zt)
5. Scale by (S_x,S_y,S_z)

Fig. 7. Transformations on Madura batik 3D model

B. *User Experience Measurement*

User Experience Surveys are needed to understand perceptions and human attention to software applications that users use. The survey is also necessary to understand other aspects that affect the user experience, such as a person's motivation and cognition when interacting with software applications. The method for measuring relevant user reactions and experiences.

There are several indicator statements to measure the user experince of a software application. In this study we chose to measure someone's experience based on 6 things: attention, importance, arousal, impressed, valence and enjoy [10].

TABLE II. USER EXPERIMENT SURVEY INDICATOR [10]

Indicator Name	**Description**	**Psychological Component**
Attention	Time distortion, focus on the application world instead of the real world	Attention
Importance	The meaning of the application, was relevant, close, personal and sensitive	Motivation - cognition
Arousal	Active, stimulated vs. passive, unaroused	Emotion
Impressed	Amazed and impressed by the application-world, the application elicited real feelings	Feeling
Enjoy	Using the app was pleasant, enjoying and exciting, I'll recomend it to my friends	Feeling
Valence	Positive valence, happy, not bored or anxious to the application	Emotion

User Experience (UX) measurement on the adaptation key performance indicators which include Attention, Importance, and Arousal and the Quality key performance indicators which include Impression, Valence, and Enjoy showed as showed in Table II has been made to 100 respondents. The statements in the user experience questionnaire are adapted to those indicators. This statement can be both positive and negative, which is described using a Likert scale of measurement scale consisting of positive and negative statements in equal numbers. Likert scale used to scale and measure attitudes, opinions, and perceptions of a group of events or social phenomena.

TABLE III. RESPONDENCE OPTION ON LIKERT SCALE

Positive statement		**Negative Statement**	
Strongly agree	5	Strongly agree	1
Agree	4	Agree	2
Undecided	3	Undecided	3
Disagree	2	Disagree	4
Strongly disagree	1	Strongly disagree	5

IV. EXPERIMENTS

The experiment tests performed on the consumers which 3(three) categorize, short consumer (100cm), medium (150cm) and a tall consumer (180cm). The tests conducted to determine the consumer whether the consumer's height take effect on consumer detection.

In the first experiment, we conduct trials in the room with no light (dark-room), we obtain of nothing (0% object-detected), while the lighting conditions are changed with a bright light we get the percentage of 100% object-detected. The trial was also done outdoors. When the test is done outdoors, in the morning (06.00am to 08.00am) we obtain the 77.7% object detected. But when the day (10.00am to 12.00am) and night (18.00pm to 21.00pm) we only get 5.5% object detected.

The experimental scenario:

a. We put Kinect on the floor at 75cm high
b. Five distance between the consumer and Kinect symbolized by the alphabet A, B, C, D, and E.
c. A=100cm distance, B=150cm distance, the distance C=200cm distance, D=250cm distance, and the E=300cm distance.
d. Tests carried out in the room with good conditions which is done indoors and using bright light.
e. The result from our experiments :
   i. consumer with short stature we obtain 5.5% in accuration when consumer standing in A position
   ii. but we have 100% when the position shifted to B, C, D, and E.

TABLE IV. CONSUMER'S HEIGHT TO DISTANCE TEST

No.	Height	Position	Total-Test	Result
1	Short	A	1	5,5%
2		B	18	100%
3		C	18	100%
4		D	18	100%
5		E	18	100%
6	Medium	A	1	5,5%
7		B	3	16,6%
8		C	18	100%
9		D	18	100%
10		E	18	100%
11	Tall	A	1	5,5%
12		B	1	5,5%
13		C	16	88,8%
14		D	18	100%
15		E	18	100%
5		E	18	100%

Table iv shows us that short consumers can interact with the application optimally at the position B, C, D, and E which has the distance 150cm to 300cm. Consumers with medium height suggested optimally use position C, D, and E which around 200cm to 300cm distance. While the tall consumer with over 180cm height can only optimally interact at the D position, and E which around 250cm to 300cm to the sensor. The detailed experimental scenario is shown in figure 8. Thus, we can conclude that taller consumers the higher the distance needed to optimally interact with the application.

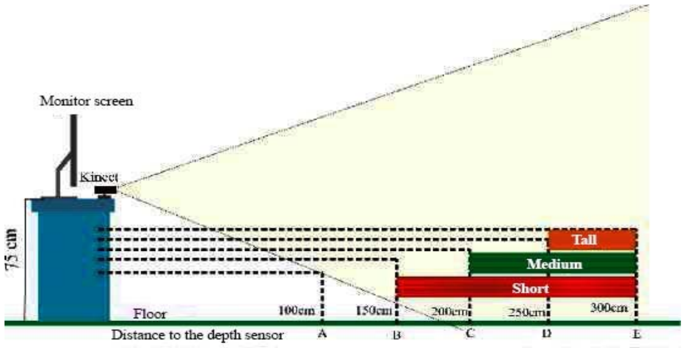

Fig. 8. Optimal consumer's position to interact

The functionality testing conducted to ensure that the application has all the required functionality that's specified within its functional requirements. Each and every functionality of the application is tested by verifying the output and comparing the actual results with the expected results. Our testing involves checking of Consumer Interface, APIs, database, mainline functions. The testing is done by manually involving the consumers in testing scenarios.

TABLE V. FUNCTIONALITY TEST

	Objective	Percentage of satisfied consumers
Basic Usability	Consumers can freely navigate through the application without any difficulties.	87,5%
Accessibility	Accessibility of the system for the consumer	82%
Error Conditions	Error Conditions / Error Handling	83%
The average percentage		84,12%

The UX measurement per-indicators has been prepared with detailed question of each indicator divided into 2 groups of statements. These two groups are positive statement (statement expected by the researcher and supporting the indicators in this study) and negative statements (statements which researchers do not expect).

TABLE VI. USER EXPERIENCE MEASUREMENT

Key	Indicator Name	Score per-Indicator (100 respondents)	Total Score
Adaptation Key	Attention	985	96%
	Importance	955	
	Arousal	940	
Quality	Impressed	995	97%

Key	Valence	970	
	Enjoy	945	

Each indicator is measured using 2 questions. Thus, the total of each respondent gets 12 questions. The results of user experience measurements that have been performed on 100 respondents are shown in table vi.

The total score that has been obtained divided by the maximal Likert scale expected to obtain will be the total percentage of user experience. The adaptation key performance indicators result showed 96% of respondents said that they were satisfied while the Quality key performance indicators showed 97% respondents were satisfied.

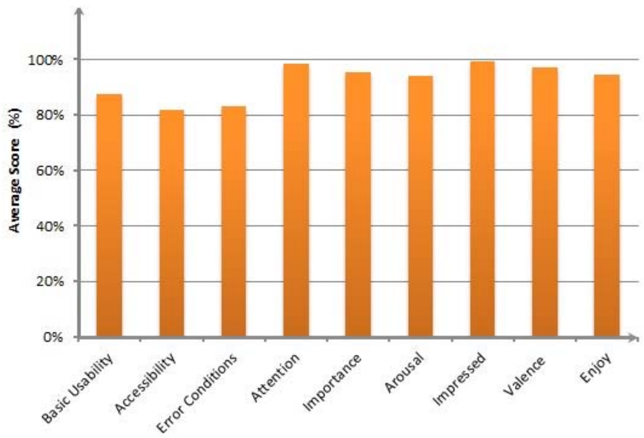

Fig. 9. Average score of user experience measurement

Figure 9 shows that from all the “measurement-indicator” test we have done, it shows acceptable results. The highest score of measurement was found on impression-indicators with 99.5%.

V. CONCLUSION AND DISCUSSION

A virtual dressing room for Madura batik dress has been successfully developed. The proposed system has a purpose to make dressing room specialized for Madura batik clothes supposed to create attention from customer and should contributes in improving sales performance and promote Madura’s heritages as also. The result virtual cloth based on tracking the gestures of the consumer with front pose only has been developed. 3D rigid transformations still require improvements to handle the back pose situation. In general, the system has provided a satisfactory user experience 96% and 97%. Beside UX measurement, we also conducted a functionality test which showing 84,12% positive result. Our virtual dressing room system may work optimally and fit for all consumers as our experimental testing show that the taller consumer the higher distance to the Kinect depth sensor needed. Efficient and fast computation methods needed to process numerous 3D models. So that, we don’t have to use high performing computer for implementing this virtual dressing room.

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