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# Implementation of Markerless Augmented Reality Method to Visualise Philosophy of Batik Based on Android

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## ABSTRACT

Indonesia has a variety of culture, tribes, customs, religion, and arts. One of the most popular cultural heritages in Indonesia is Batik. Each print or pattern has different meanings reflecting the culture of the area where the batik originates from. There are many ways to preserve batik; one of which is by giving information and understanding about the culture of batik through a technology called Augmented Reality (AR). In this study, the philosophy of batik patterns is visualised through AR application. Markerless's AR method is used so that the AR used to detect batik without using any markers. The application is implemented on android-based devices, either smartphones or tables, as they are very popular. Results of the visualisation are the image, name and philosophy of the batik detected. The application can detect at most around 50 cm and 30°C.

*Keywords:* Batik pattern, android, Markerless augmented reality method, philosophy

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## INTRODUCTION

Indonesia has many different tribes, culture, religion, and art. One of the most popular cultural heritages is batik. Batik is a fabric which has a unique pattern and processed in a certain way (Syahputra & Soesanti, 2016). Almost each area in Indonesia has batik with different patterns that have special philosophical meanings reflecting their culture.

The younger generation in Indonesia needs to preserve their culture; one of which is batik. One way of doing it is by understanding and teaching about batik and its philosophical meanings to the next generation using a technology namely augmented reality (AR) and android-based smartphones, which are very popular. Therefore, an AR application to visualise the information of the philosophy of batik patterns based on android using Markerless augmented reality is proposed, where the application detects the objects directly without any marker.

There are studies on applications to introduce batik patterns based on AR (Widiaty, Riza, Danuwijaya, Hurriyati, & Mubaroq, 2017), in which the application is able to detect batik as its reference. To detect the objects directly, the algorithm used in this study is ORB (Oriented FAST and Rotated BRIEF). Based on previous studies (Rublee, Rabaud, Konolige, & Bradski, 2011), ORB is proven to outperform SIFT (Scale Invariant Feature Transform) and SURF (Speed Up Robust Features). In matching feature, the algorithm used is hamming distance which measures the difference between two strings with the same length. The process of hamming distance is fast and efficient since it can be operated using XOR followed by a few instructions (Muhammad, 2015). To match key point, the study uses RANSAC which estimates the homography of picture perspective mapping.

## AUGMENTED REALITY AND ITS TECHNOLOGY

### Augmented Reality

Augmented Reality is a technology combining real world with virtual environment made by computers in real time (Azuma, 1997). It is actually a variation of virtual environment or popularly known as virtual reality.

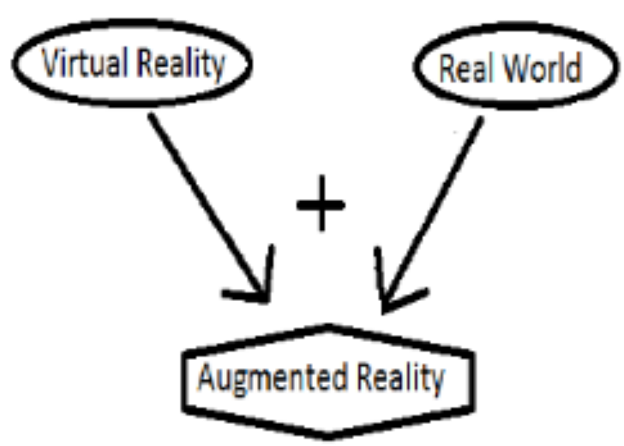



*Figure 1*. Augmented Reality as a combination of real world and virtual reality. From “A survey of augmented reality”, by Shoaib and Jaffry, 2015

Almost every AR system available nowadays focuses mainly on the annotation of the real world objects (Neri, García, Barón, & Crespo, 2013). One of the AR applications developed is in mechanical repair, in which AR is used to give explanations on parts of the car machines identified by the users. Thus, the users can identify certain parts of the machines where the AR system shows lines and texts by computers describing components from the machines as the following Figure 2 shows.

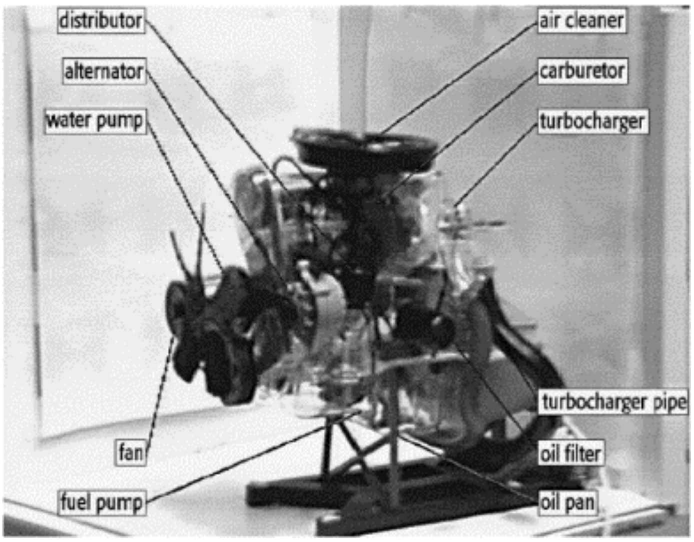



*Figure 2*. Annotation and visualisation on mechanics. From "A survey of augmented reality", by Azuma, 1997

## Markerless Augmented Reality

Markerless augR method to detect objects directly without any marker. There are two techniques.

1. Pose Tracking

   Pose Tracking can be used when the device has a camera and moving screen. This technique can be used by utilising Global Positioning System (GPS), digital compass, and sensor.

2. Pattern Matching

   Pattern Matching is actually almost similar to marker-based AR, yet it does not use marker. Instead, it uses common pictures. This technique can be used to recognise pictures, such as book covers, paintings, bus windows, human faces, and others.

3. Object Recognition

   Object Recognition is a way to recognise or identify an object. The common process of recognising objects and tracking usually uses a lot of algorithms based on features. The tracking based on features is a way to find a certain feature of a picture. After tracking, matching takes place to see whether two objects are similar to one another.

In feature-based tracking, there are several algorithms used (Du, Miao, & Cen, 2014), such as SURF (Speed Up Robust Features), SIFT (Scale Invariant Feature Transform), and BRISK (Binary Robust Invariant Scalable Key points). This study uses ORB which will be discussed in the next sub-chapter. The scheme of object recognition is described in Figure 3.

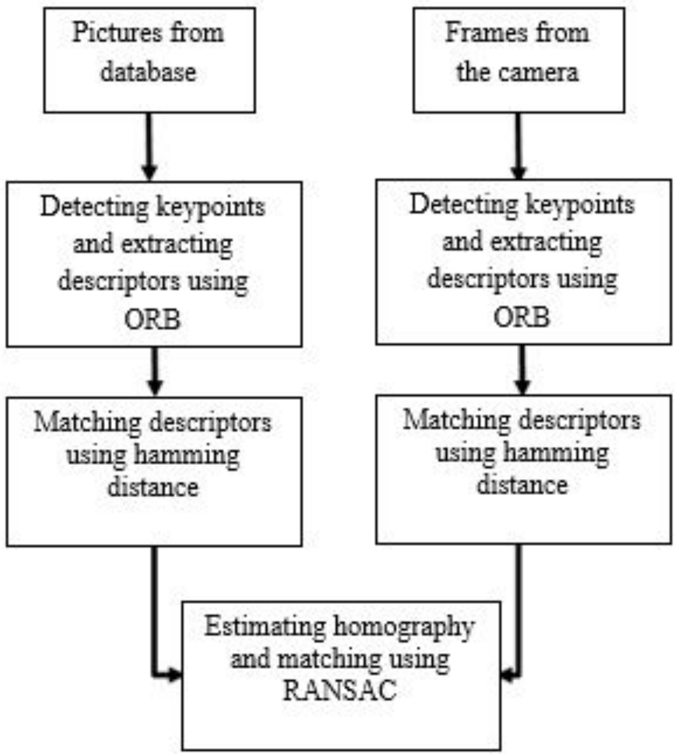



*Figure 3.* The scheme of object recognition

ORB (Oriented FAST and Rotated BRIEF) is a combination between oriented FAST feature point and rotated BRIEF description algorithms (Rublee et al., 2011). FAST algorithm is used to detect key points in pictures while BRIEF algorithm is used as a descriptor (Rublee et al., 2011).

FAST (Feature from Accelerated Segment test) is an algorithm to detect key points quickly. It is based on a parameter, namely threshold between the centre pixels and the other pixels. It does not have corner measurement. The measurement of Harrick corner is used to get the FAST key points. For the number of target of the key points, threshold is set quite low then done in accordance with Harris measure to get the highest number of key points. FAST also does not result if multi-scale feature, yet it uses picture scale pyramid and result it FAST feature in every level of pyramid.

An approach based on intensity centroid orientation uses simple yet effective measurement. The centroid intensity assumes that the corner intensity is corrector from the centre and that the vector that can be used to connect orientation is defined as follows.

$$m_{pq} = \sum_{xy} x^p y^q \, I(x,y)$$

Where $m_{pq}$ represents the order moment $(p+q)^{th}$ of a picture whose intensity change $I(x,y)$ as a function of x and y coordinates in the figure. The centroid is then obtained as follows.

$$C = (\frac{m_{10}}{m_{00}}, \frac{m_{01}}{m_{00}})$$

A vector is built from the centre to the centroid $\overrightarrow{OC}$ and the patch orientation becomes:

$$\theta = atan2(m_{01}, m_{10})$$

Where atan2 represents the quadrant version found from the arctan.

ORB also needs an additional component known as r-BRIEF. The descriptor of BRIEF is string bit description from various patches of pictures made from every set intensity of the binary test. For instance, a patch of a picture that is already softened is then identified as p and thus, the binary test and τ are defined as follows.

$$\tau(\mathrm{p}; \mathrm{x}, \mathrm{y}) := \begin{cases} 1 : \mathrm{p(x)} < \mathrm{p(y)} \\ 0 : \mathrm{p(x)} \geq \mathrm{p(y)} \end{cases}$$

Where p(x) is the intensity of p in an x point. The feature of *f* is defined as a vector test of the *n* binary test

$$f_n(\mathrm{p}) := \sum_{1 \leq \mathrm{i} \leq \mathrm{n}} 2^{\mathrm{i}-1} \tau(\mathrm{p}; \mathrm{x}_i \mathrm{y}_i)$$

The concept of hamming distance is basically measurement of two strings with the same length. It shows numbers between two binary strings. The process is fast and efficient since it can use machine instruction or XOR operation with a few numbers (Muhammad, 2015).

Table 1
*Example of hamming distance*

| String 1 | String 2 | Hamming Distance |
|---|---|---|
| karolin | kathrin | 3 |
| karolin | kerstin | 3 |
| 1011101 | 1001001 | 2 |
| 2173896 | 2233796 | 3 |

In this study, hamming distance is used to match the results of ORB descriptors. The descriptor with the shortest distance will be replaced with the right picture.

Homography is a transformational matrix used to project one picture over another based on match feature found by multiplying the pictures. The pictures will transform geometrically through translation, rotation, scaling, skew, shear, etc. The equation for homography is formulated as follows (Kriegman, 2007):

$$\begin{bmatrix} x_2 \\ y_2 \\ z_2 \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} & H_{13} \\ H_{21} & H_{22} & H_{23} \\ H_{31} & H_{32} & H_{33} \end{bmatrix} \begin{bmatrix} x_1 \\ y_1 \\ z_1 \end{bmatrix}$$

($x_2$,$y_2$,$z_2$) is the posisiton of pixels as the results of transformation, while H is a homographical matrix sized 3 x 3 and ($x_1$,$y_1$,$z_1$)) is the position of the pixel in the original pictures.

The algorithm of RANSAC (Random Sample And Consensus) was first introduced as a method to estimate a certain parameter contaminated by outlier (average deviation point) in a large number (Fischler & Bolles, 1981). Outliers are a feature with more deviant values compared with other features. In this study, RANSAC is used to estimate the homography. The steps are as follows:

1. Choosing four correspondences randomly and calculating the homography as explained before.
2. Calculating the distance of $d_\perp$ for every assumed correspondence.
3. Calculating the number of matching inliers in H with the number of correspondence where $d_\perp$<t.
4. Choosing H with the biggest inliers.
5. Re-estimating H from all the correspondences arranged based on inliers. Determining correspondent key points using H estimated to define the search location of the changed point position.

## OpenCV

OpenCV (Open Source Computer Vision) is a library computer vision open source written in C dan C++ (Bradski, Kaehler, & Pisarevsky, 2005). The algorithm in OpenCV can be used to detect and recognise faces, identify objects, clarify human movements in videos, search movements in cameras, detect moving objects, make 3D models of an object, result in 3D from stereo cameras, combine pictures to have high resolution, find similar pictures in the database, erase red eyes from pictures taken with flash, follow eye movements, recognise environment and build objects with augmented reality. In this study, the OpenCV is used as a tool and library in making android-based augmented reality which is the process of recognition. OpenCV used in this study is OpenCV for android that can be downloaded on http://opensource.org.

## Android

Android is an open source platform designed for mobile devices bought by Google Inc from Android Inc (Gargenta & Nakamura, 2014). The six frameworks of augmented reality developed from android are ARLab, ARToolKit, D'Fusion, Vuforia, catchoom and metaio (Marneanu, Ebner, & Roessler, 2014). There is also an OpenCV which provides a library for augmented reality. In this study, OpenCV is used as a medium to make the application.

## ARCHITECTURAL DESIGN OF AR

Figure 4 is the architectural design of AR proposed in this study.

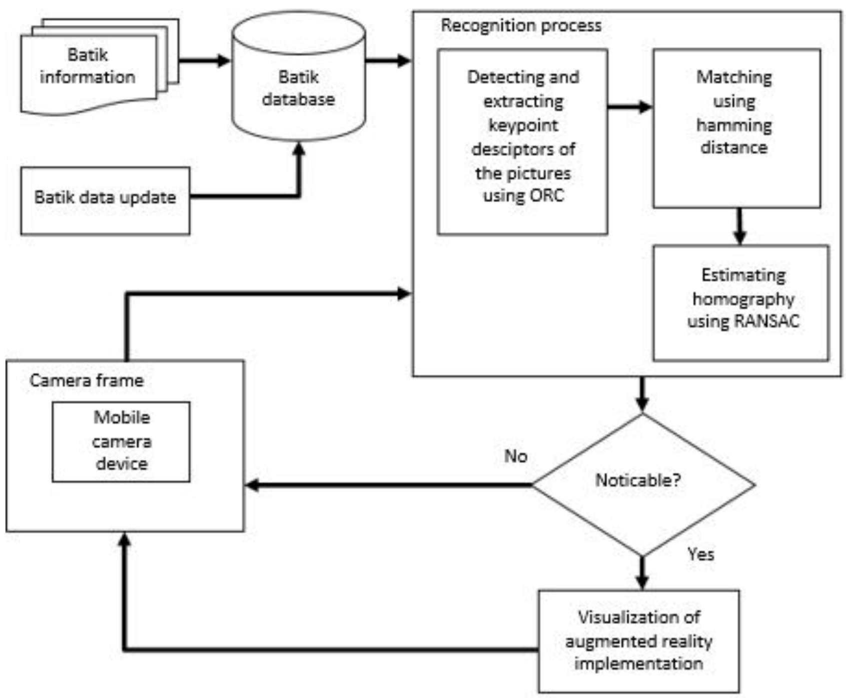



*Figure 4.* The architectural design of augmented reality

## Information about Batik

Data about batik information is inserted into database namely db_batik di sever whose URL is http://batik.16mb.com/index.php/. The data input into the server include names of batik, philosophy of batik, and pictures of batik. One type of batik may have one pattern and others may have more.

## Recognition Process

In recognition process, functions used are mostly those of OpenCV. Below is a series of recognition process.

1. Detecting and extracting picture key point descriptors using ORB.

   Before the pictures are processed to obtain key points, the pictures are transformed into grayscale. The results are a key point matrix from the detected pictures. The extraction leads to vector features. These steps are also done in the camera frame.

2. Matching using hamming distance

   Matching vector feature is done using hamming distance algorithm resulting in distance values. The minimum distance from the vector values is then calculated. After the minimum value is acquired, the vector values of the distance are selected. Only ones belonging to good match will be chosen if the distance values are smaller than the minimum distance values is tripled. The next step is obtaining key points of the good match on batik and frame from the camera based on the distance calculation.

3. Estimating homography using RANSAC

   After a good match of batik and frame of the camera are obtained, the next step is estimating homography using RANSAC by randomly taking at least four key point values. Homography is done if there is a picture or a frame with the same objects but with different perspectives. Meanwhile, RANSAC algorithm is used to match key points with batik pictures and frame of the camera.

## Visualisation of AR

Visualisation is used to perform AR on the device display so that users will understand batik and its philosophy easily. In this phase, there is additional information about the detected batik. In this application, the visualisation is texts and pictures about the batik detected. The information displayed is from the database and the pictures are captured when the batik is detected.

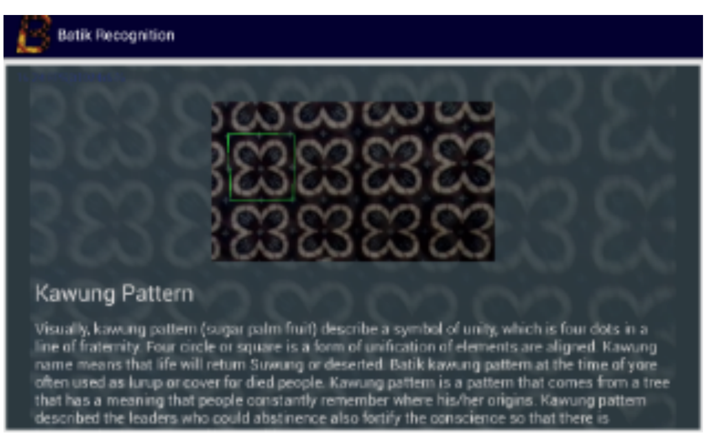



*Figure 5*. Visualisation of AR

## Update of Batik Data

In this phase, the data about batik in the database are updated. The process involves either adding or removing some information in the database.

# EXPERIMENTAL DESIGN

## Data Collection

The data about batik was obtained from a book and a respondent who was a lecturer at Faculty of Technology and Vocational Education, Universitas Pendidikan Indonesia through an interview about the philosophy of batik. Table 2 shows data about batik from the book and the interview.

Table 2
*Data about batik*

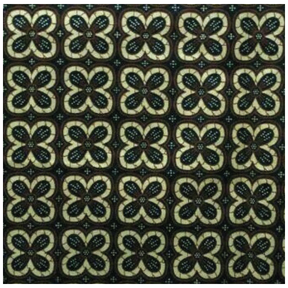
| No | Name | Description | Picture |
|---|---|---|---|
| 1 | Cirendeu Pattern | Cirendeu pattern is a batik from Cimahi City. The pattern represents culture of Cirendeu village people whose staple food is cassava. Characteristics of Cassava are :<br>a. It can be grown in the narrow land<br>The philosophy is we have to be visionaries.<br>b. Cassava is a versatile plant<br>The philosophy is whatever our circumstances, we must remain useful for others.<br>c. Simple food<br>The philosophy is living a simple life, far from being consumerism.<br>d. Cassava tubers are most sought-after even though it grows underground.<br>The philosophy is your goal come from the bottom if you have intelligence or ability. |  |
| 2 | Kawung Pattern | Kawung pattern is inspired by sugar palm fruit from palm tree trunks. All parts of the palm tree from the top (tip of the leaf) until the roots have benefits for humans. The symbol means humans must be useful to others. Visually, kawung pattern (sugar palm fruit) is a symbol of unity, which is four dots in a line of fraternity. Four circle or square is a form of unification of elements which are aligned.<br>Kawung name means that life will return to Suwung. The Batik kawung pattern at the time of yore is often used to cover the dead.<br>Kawung pattern is inspired by the tree which means people always remember their origins. Kawung pattern describes leaders who with abstinence can fortify their conscience so that there is harmony in the conduct of human life. |  |

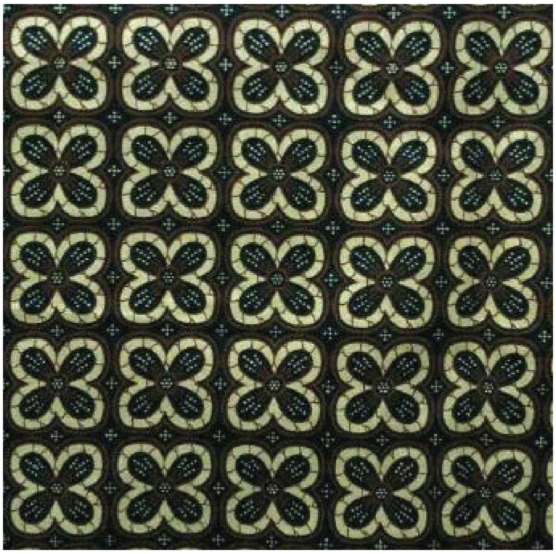
Table 2 *(continue)*

| No | Name | Description | Picture |
|---|---|---|---|
| 3 | SPBS (Sumedang Puseur Budaya Sunda) Pattern | SPBS pattern has two explanations. First, "DINA BUDAYA URANG NAPAK", that means Sumedang people have willpower and strong commitment to carry out the preservation and development of Sunda culture. Second, "TINA BUDAYA URANG NGAPAK ", that means Sumedang people will utilise Sunda cultural resource of theirs as effective media to realise Sumedanag vision to be prosperous, religious, and democratic (SUMEDANG SEHATI). The SPBS logo is inspired by Cangkok Wijaya Kusumah flower which shows that in order to achieve lofty ideas, wisdom is needed. a wisdom in will's structure of "Silih Asah" from domain "Resi" that is public figures in the province. Kujang means in order to achieve lofty ideas, = wisdom is needed and represented by Silih Asah" from domain "Rama" that is that is a public figure in the province. Manuk Julang represents that in order to achieve lofty ideas and realise success in life, struggle and sacrifice are essential. |  |
| 4 | Isola Park Pattern | Isola Park pattern represents the early history of the university. Visually, there are a Isola building, a banyan tree, and inscriptions of establishment dating back to 1954. Repetition of pattern is done to form rereng. The philosophy of this pattern represents the early history of the university. A solid Isola building represents a place to gain knowledge for people. A tip of banyan tree represents a will and a hope that always grows, a tip of banyan represented symmetrically to left and to right means a balance in various aspects of life. Inscriptions establishment PTPG 1954 means that we must inget kana purwadaksi and a past experience as the best teacher. A use of analogous colours means a harmony. |  |

## Scenarios

Experiment was done using batik materials with the size of 60 cm x 50 cm. The tested batik is shown in Table 3.

Table 3
*The tested batik*

| No | Name | Object |
|---|---|---|
| 1 | Cirendeu pattern |  |
| 2 | Kawung pattern |  |

Meanwhile, the device used was a tablet with the following specifications: 5-megapixel camera, 1024 x 576 camera resolution, Jelly Bean 4.2.2 operating system, A 60-cm ruler, A protractor. There were two conditions in the experiment: The measurement distance of detection of this experiment is ±10 cm, ±20 cm, ±30 cm, ±40 cm, and ±50 cm. This is done to find out how far the application can detect batik. The slope angle is this experiment is ±0 degree, ±15 degree, ±30 degree, and ±45 degree. This is also done to find out how far the application can detect batik in different positions.

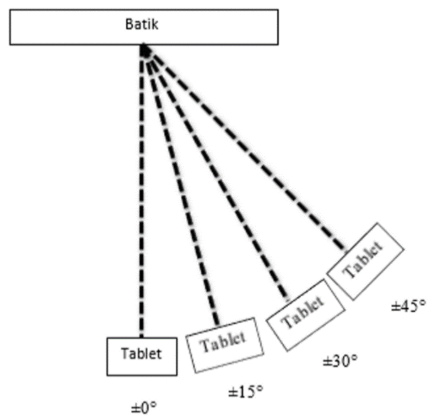



*Figure 6.* Angle position from above

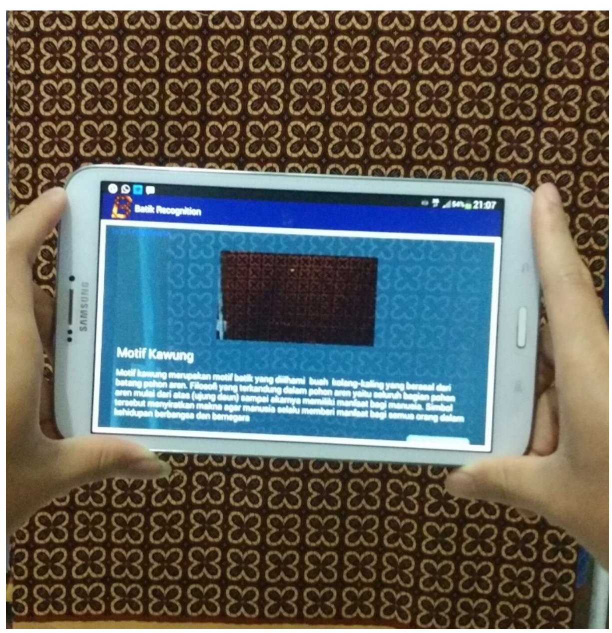



*Figure 7.* The experimental test

## RESULTS AND DISCUSSION

### Results

Table 4 contains the results of the experiment which record time, frame per second, and detection (whether it is detected or not).

Table 4
*Experimental results*

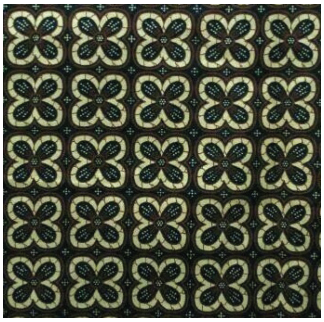
| No | Name | Object | Distance (cm) | Slope Angle (degree) | Time (second) | FPS | Detection |
|---|---|---|---|---|---|---|---|
| 1 | Kawung pattern |  | ±10 | ±0 | - | 3,58 | Undetected |
| | | | ±10 | ±15 | - | 3,58 | Undetected |
| | | | ±10 | ±30 | - | 3,58 | Undetected |
| | | | ±10 | ±45 | - | 3,58 | Undetected |
| | | | ±20 | ±0 | 5,8 | 3,58 | Detected |
| | | | ±20 | ±15 | 5,6 | 3,58 | Detected |
| | | | ±20 | ±30 | 4,4 | 3,58 | Detected |
| | | | ±20 | ±45 | - | 3,58 | Undetected |
| | | | ±30 | ±0 | 2 | 3,58 | Detected |
| | | | ±30 | ±15 | 3,3 | 3,58 | Detected |
| | | | ±30 | ±30 | 3 | 3,58 | Detected |
| | | | ±30 | ±45 | - | 3,58 | Undetected |
| | | | ±40 | ±0 | 2,1 | 3,58 | Detected |
| | | | ±40 | ±15 | 2,2 | 3,58 | Detected |
| | | | ±40 | ±30 | 1,6 | 3,58 | Detected |
| | | | ±40 | ±45 | - | 3,58 | Undetected |
| | | | ±50 | ±0 | 2,1 | 3,58 | Detected |
| | | | ±50 | ±15 | 2,9 | 3,58 | Detected |
| | | | ±50 | ±30 | 2,5 | 3,58 | Detected |
| | | | ±50 | ±45 | - | 3,58 | Undetected |
| 2 | Kawung pattern |  | ±10 | ±0 | 1 | 3,58 | Detected |
| | | | ±10 | ±15 | 5 | 3,58 | Detected |
| | | | ±10 | ±30 | 4,3 | 3,58 | Detected |
| | | | ±10 | ±45 | - | 3,58 | Undetected |
| | | | ±20 | ±0 | - | 3,58 | Undetected |
| | | | ±20 | ±15 | - | 3,58 | Undetected |
| | | | ±20 | ±30 | - | 3,58 | Undetected |
| | | | ±20 | ±45 | - | 3,58 | Undetected |
| | | | ±30 | ±0 | - | 3,58 | Undetected |
| | | | ±30 | ±15 | - | 3,58 | Undetected |
| | | | ±30 | ±30 | - | 3,58 | Undetected |
| | | | ±30 | ±45 | - | 3,58 | Undetected |
| | | | ±40 | ±0 | - | 3,58 | Undetected |
| | | | ±40 | ±15 | - | 3,58 | Undetected |
| | | | ±40 | ±30 | - | 3,58 | Undetected |
| | | | ±40 | ±45 | - | 3,58 | Undetected |
| | | | ±50 | ±0 | - | 3,58 | Undetected |
| | | | ±50 | ±15 | - | 3,58 | Undetected |

Table 4 *(continue)*

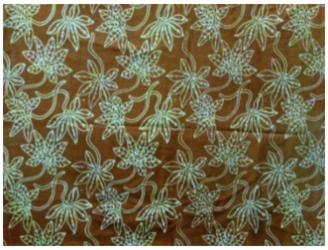
| No | Name | Object | Distance (cm) | Slope Angle (degree) | Time (second) | FPS | Detection |
|---|---|---|---|---|---|---|---|
| | | | ±50 | ±30 | - | 3,58 | Undetected |
| | | | ±50 | ±45 | - | 3,58 | Undetected |
| 3 | Motif Cirendeu |  | ±10 | ±0 | - | 3,58 | Undetected |
| | | | ±10 | ±15 | - | 3,58 | Undetected |
| | | | ±10 | ±30 | - | 3,58 | Undetected |
| | | | ±10 | ±45 | - | 3,58 | Undetected |
| | | | ±20 | ±0 | - | 3,58 | Undetected |
| | | | ±20 | ±15 | - | 3,58 | Undetected |
| | | | ±20 | ±30 | - | 3,58 | Undetected |
| | | | ±20 | ±45 | - | 3,58 | Undetected |
| | | | ±30 | ±0 | - | 3,58 | Undetected |
| | | | ±30 | ±15 | - | 3,58 | Undetected |
| | | | ±30 | ±30 | - | 3,58 | Undetected |
| | | | ±30 | ±45 | - | 3,58 | Undetected |
| | | | ±40 | ±0 | 5 | 3,58 | Detected |
| | | | ±40 | ±15 | 2,6 | 3,58 | Detected |
| | | | ±40 | ±30 | 5,4 | 3,58 | Detected |
| | | | ±40 | ±45 | - | 3,58 | Undetected |
| | | | ±50 | ±0 | 4,1 | 3,58 | Detected |
| | | | ±50 | ±15 | 6,9 | 3,58 | Detected |
| | | | ±50 | ±30 | 8,3 | 3,58 | Detected |
| | | | ±50 | ±45 | - | 3,58 | Undetected |
| 4 | Motif Cirendeu |  | ±10 | ±0 | - | 3,58 | Undetected |
| | | | ±10 | ±15 | - | 3,58 | Undetected |
| | | | ±10 | ±30 | - | 3,58 | Undetected |
| | | | ±10 | ±45 | - | 3,58 | Undetected |
| | | | ±20 | ±0 | 9,4 | 3,58 | Detected |
| | | | ±20 | ±15 | 7,4 | 3,58 | Detected |
| | | | ±20 | ±30 | 7,6 | 3,58 | Detected |
| | | | ±20 | ±45 | - | 3,58 | Undetected |
| | | | ±30 | ±0 | 8 | 3,58 | Detected |
| | | | ±30 | ±15 | 7,5 | 3,58 | Detected |
| | | | ±30 | ±30 | 8.8 | 3,58 | Detected |
| | | | ±30 | ±45 | - | 3,58 | Undetected |
| | | | ±40 | ±0 | - | 3,58 | Undetected |
| | | | ±40 | ±15 | - | 3,58 | Undetected |
| | | | ±40 | ±30 | - | 3,58 | Undetected |
| | | | ±40 | ±45 | - | 3,58 | Undetected |
| | | | ±50 | ±0 | - | 3,58 | Undetected |

Table 4 *(continue)*

| No | Name | Object | Distance (cm) | Slope Angle (degree) | Time (second) | FPS | Detection |
|---|---|---|---|---|---|---|---|
| | | | ±50 | ±15 | - | 3,58 | Undetected |
| | | | ±50 | ±30 | - | 3,58 | Undetected |
| | | | ±50 | ±45 | - | 3,58 | Undetected |
| 5 | Cirendeu pattern |  | ±10 | ±0 | - | 3,58 | Undetected |
| | | | ±10 | ±15 | - | 3,58 | Undetected |
| | | | ±10 | ±30 | - | 3,58 | Undetected |
| | | | ±10 | ±45 | - | 3,58 | Undetected |
| | | | ±20 | ±0 | 6,3 | 3,58 | Detected |
| | | | ±20 | ±15 | 5,7 | 3,58 | Detected |
| | | | ±20 | ±30 | 5 | 3,58 | Detected |
| | | | ±20 | ±45 | - | 3,58 | Undetected |
| | | | ±30 | ±0 | 7 | 3,58 | Detected |
| | | | ±30 | ±15 | 7,8 | 3,58 | Detected |
| | | | ±30 | ±30 | 8 | 3,58 | Detected |
| | | | ±30 | ±45 | - | 3,58 | Undetected |
| | | | ±40 | ±0 | - | 3,58 | Undetected |
| | | | ±40 | ±15 | - | 3,58 | Undetected |
| | | | ±40 | ±30 | - | 3,58 | Undetected |
| | | | ±40 | ±45 | - | 3,58 | Undetected |
| | | | ±50 | ±0 | - | 3,58 | Undetected |
| | | | ±50 | ±15 | - | 3,58 | Undetected |
| | | | ±50 | ±30 | - | 3,58 | Undetected |
| | | | ±50 | ±45 | - | 3,58 | Undetected |

The number of experiments conducted was 100. The number of detected and undetected experiments were 33 and 67 respectively.

The curation calculation in this experiment is as follows.

$$whole\ accuracy = \frac{The\ number\ of\ detected\ experiments}{The\ number\ of\ total\ experiments}\ x\ 100\%$$

Thus, $whole\ accuracy = \frac{33}{100}\ x\ 100\% \ = 33$

The average accuracy on the distance of ±10 cm from every slop angle is:

$\frac{3}{20}\ x\ 100\% \ = 15\%$

The average accuracy on the distance of ±20 cm from every slop angle is:

$$\frac{9}{20}\ x\ 100\% = 45\%$$

The average accuracy on the distance of ±30 cm from every slop angle is:

$$\frac{9}{20}\ x\ 100\% = 45\%$$

The average accuracy on the distance of ±40 cm from every slop angle is:

$$\frac{6}{20}\ x\ 100\% = 30\%$$

The average accuracy on the distance of ±50 cm from every slop angle is:

$$\frac{6}{20}\ x\ 100\% = 30\%$$

The average accuracy on the angle of ±0 degree on every distance is:

$$\frac{11}{20}\ x\ 100\% = 44\%$$

The average accuracy on the angle of ±15 degree on every distance is:

$$\frac{11}{20}\ x\ 100\% = 44\%$$

The average accuracy on the angle of ±30 degree on every distance is:

$$\frac{11}{20}\ x\ 100\% = 44\%$$

The average accuracy on the angle of ±45 degree on every distance is:

$$\frac{0}{20}\ x\ 100\% = 0\%$$

## DISCUSSION

A series of experiments with different distances and angles were conducted in this study. The FPS in the detection was 3.58 meaning that it is considered slow since the camera usually is at 15.78 in the normal condition. This is due to the fact that every frame has to be processed and matched with every picture in the database. The data shift process in Java with library used is also influential in the FPS work since the library used is JNI based on C++.

The experiment has 33% accuracy . The calculation of the accuracy is done in every distance ranging from 10 cm with the accuracy of 15%, 20% with 45% accuracy, 30 cm with 45% accuracy, 40 cm with 30% accuracy, and 50% with 30% accuracy. Not every object with slope angle of ±45 degree are detectable since homography is not able to handle the object perspectives at the that degree. The objects could only be detected at ±30 degree. At ±0 degree, the accuracy is 44%, at ±15 degree, the accuracy is 44%, and at ±30 degree, the accuracy is 44%.

The discussion of the experimental results of the study is listed below.

1. Object 1

   Object 1 detects all Kawung patterns. Experiments at ±10 cm could not detect the batik since the frame could not reveal the whole object picture. However, at ±20 cm, ±30 cm, ±40 cm, and ±50 cm, the object could be detected.

2. Object 2

   Object 2 detects Kawung pattern. Experiments at ±10 cm could be detected. Objects at ±20 cm, ±30 cm, ±40 cm, and ±50 cm could not be detected since the distance is too far.

3. Object 3

   Object 3 detects all Cireundeu patterns. Experiments at ±10 cm, ±20 cm, and 3±0 cm could not detect the batik due to the inability of the camera frame to capture all the objects. However, experiments at ±40 cm and ±50 cm could be detected.

4. Object 4

   Object 4 detect Cireundeu pattern. Experiments at ±10 cm could not detect the batik since the frame could not capture the whole picture. Experiments at ±40 cm and ±50 cm could not also detect it due to the same reason. Experiments at ±20 cm and ±30 cm are proven to be able to detect the batik.

5. Object 5

   Object 5 also detects Cireundeu patterns. Experiments at ±10 cm could not detect it since the frame could not capture the whole pattern. Experiments at ±40 cm and ±50 cm also failed due to the far distance. However, experiments at ±20 cm and ±30 cm are successful.

## CONCLUSION

Below is a summary of the implementation of augmented reality based on android to visualise the philosophy and patterns of batik:

1. The implementation involves ORB algorithm, hamming distance, homography, and RANSAC. ORB algorithm is used to detect and describe the picture key points. Hamming distance is used to match the results of ORB from the database and the camera frame. Homography is used to overcome if there is any picture and frame with the same object but different perspectives. RANSAC algorithm is used to math key points of the batik picture and the camera frame.
2. The results of the application using a mobile device could detect five patterns out of two batik objects with the accuracy of 33% out of 100 experiments. However, it had been proven that the FPS camera worked slowly due to the distance and angle of the detection. This affect the time length of the detection.

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