Mouse Control System using LED-Based Colour Detection

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Abstract — *This paper is encompassed of mouse functions using LED based on the colour detection. The colour that comes from the LED will be detected by the web camera and produced a movement of the cursor and operation of the mouse on a computer. The colour of the image converted into Hue, Saturation, and Value (HSV) colour space to facilitate the colour detection process. From the HSV data, colour thresholding process is performed to get the produced colour from the LEDs after they have turned on. The threshold colour can perform a cursor movement and mouse operation after setting up the mouse function with the colour in the system. The result obtained shows that the LED colour devices more easily detected in the dark with an appropriate distance. The mouse control system using LED based on colour detection are successfully developed, and the expansion of this study in the future will be able to improve the detection process and the stability of the system in controlling the cursor movement.*

Keywords — *Colour detection, colour thresholding, mouse control, LED device.*

I. Introduction

Human-computer interaction is an attractive research field nowadays. The mouse is one of the tools that allow users to interact with computers in various ways. A mouse control system can help users and people with disabilities to interact with computers for more engaging interaction. Mouse control based on object detection developed by some researchers using expensive hardware is unaffordable, thus most users reluctant to use that system. Also, colour detection using a coloured adhesive tape as a marker performed by a few of researchers also has a shortage when in the dark because colour detection cannot be carried out. Moreover, existing mouse is difficult to use for users with physical disabilities. Therefore, this colour-based mouse detection system will help users to use them at an affordable cost. In addition, the use of LEDs that replace the adhesive tape will aid in the colour detection process when in the dark. Mouse control using the colour detection allows users to interact with the computer in a more attractive way.

II. Mouse Cursor Control Technique

Previous studies have used different techniques and methods in implementing the mouse cursor control. Each technique has its advantages and disadvantages.

A. Eye Movement-Based Technique

Based on research in [1], the system that uses eye movements performs HCI can track the direction of the human eye to move the cursor on the computer screen. The user will move points to move the cursor while click operation can be executed by way of eye blinking. In this system, there are several techniques used, namely tracking Limbus, tracking eyewear, electrooculography and Saccade. The advantage of this system is that it does not require users to wear any device on the limbs and interaction will be more interesting and effective. The user just needs to sit in front of the computer screen, and just have to blink the eyes to perform the click operation. However, due to the fact that there are eyelids above and below the eye, the perfect shape of the eye is difficult to keep track of.

B. Colour Object Tracking

In the colour object tracking technique performed by [2], the user will use several distinctive bands on the fingers representing the cursor. The coloured tapes will be tracked using image rejection algorithms to detect the colours used. After colour detection, several processes will be performed to track the cursor and then run the cursor control process. Cursor coordinate will be determined via the centroid of the object after the centroid search process is performed. The cursor is accessible when the coordinates are determined through the mouse cursor tracking process. Click operation is based on simultaneous colour tracking, which other than the colour used as the cursor. The weakness in this system is the result of cursor movement depending on the brightness of the lighting.

C. Head Mounted Display Marker

One way to control the cursor movement for those who have a handicap is by using a head. The user only has to print the marker, then place it on the forehead or in the appropriate place. After that, the software should be installed on the computer and perform calibration procedures. This system will work when the mobile camera can detect the marker clearly. The Head-Mounted Display (HMD) marker system developed by [3], connecting the marker orientation to the movement of the mouse cursor and processing the image to make the marker as input through the mobile camera. HMD techniques are also widely applied in various fields. For example, HMD is used in medical research to see the patient's body structure more clearly during surgery [4]. In addition, [5] uses HMD markers in virtual reality game apps in cursor control using face tracking and features.

D. *Camera Depth Technique*

A study conducted by [6] uses a camera depth for the detection of hand movement gestures. Camera depth works by adding an additional dimension in depth maps and it allows the data to be captured in 3D. 3D motion signal recognition is divided into two parts, machine learning recognition and heuristics based recognition [7]. Machine learning recognition requires training while heuristics-based recognition does not require training to use it. Thus, this researcher chooses heuristic-based identification.

III. LED-BASED COLOUR DETECTION

Mouse control system using LED-based colour detection is developed by several processes using certain techniques. The techniques selected are based on the system architecture limitation to produce a better system. Following are the techniques and steps for colour detection:

A. *Image Reflection*

The image data obtained from the mobile camera is reflected vertically to ensure the movement of the on-screen output and the user is simultaneous. The process of reflecting the image is done according to 3 individual channels; red, green, and blue as shown in Fig. 1.

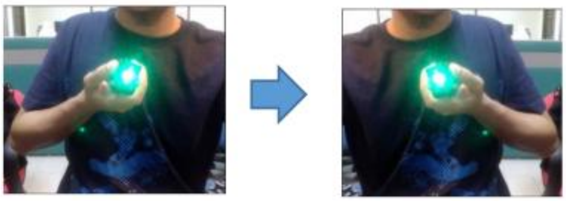

Fig. 1 Image reflection process

B. *Conversion of RGB to HSV*

The reflected image is then converted from RGB to HSV. Here are steps to convert RGB colour space to HSV:

Step 1: Find the maximum (M) and minimum (m) for R, G, B:

$$M = max\ (R, G, B)$$
$$m = min\ (R, G, B)$$

Step 2: Match brightness,V = M

Step 3: Calculate delta value (d) between M and m:

$$d = M - m$$

Step 4: If d = 0, then match S = 0 because H can't be defined.

Step 5: Calculate the value of S as a ratio of d and M.

$$S = d/M$$

Step 6: Calculations H depend on the values of M and m.

Fig. 2 shows the result of colour conversion from RGB to HSV.

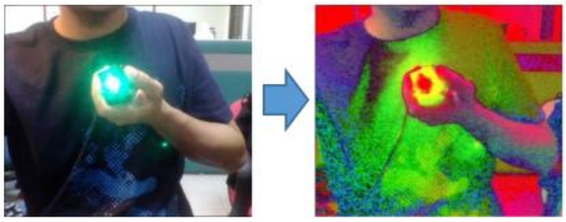

Fig. 2 RGB to HSV process

C. *Colour Thresholding*

Colour thresholding is used to obtain the target colour from LED in the system as shown in Fig. 3. Each LED colour has different HSV values, which has been obtained during the system development.

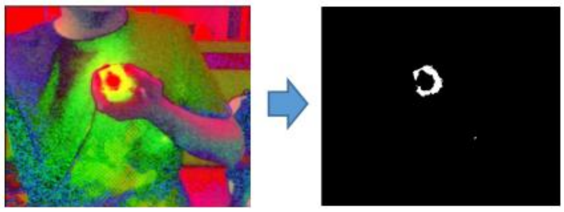

Fig. 3 Output from the thresholding process

D. *Noise Filtering*

The noise filter used is eroded and dilate to reduce the noise on the threshold image. The noise filtering results in Fig. 4 found that noise was reduced and the colour was smoother.

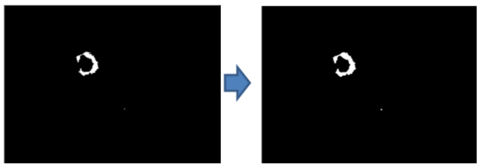

Fig. 4 Noise filtering output

E. *Colour-Based Mouse Function Settings*

The resulting colour of the LED device is set according to the operation of the mouse to be run as shown in Table 1.

TABLE I

MOUSE FUNCTION SETTINGS BASED ON COLOUR

LED colour	Mouse Function
Green	Cursor control and movement
Blue	Right click
Red	Left Click
Orange	Keyboard 'Enter' key

IV. EXPERIMENTAL RESULT

The experiments conducted are the test of distance between the camera and mobile devices and lighting test. Each test produced positive results as the LED colour detection was successfully executed in a state of the dark environment and convenient distance.

A. Lighting Test

The lighting test is conducted to identify optimum light values to obtain a high percentage of accuracy in the colour tracking process. The light detected from the LED will decrease if it is used in the bright condition. On the contrary, the resulting LED light colour is easier to detect in the dark because there is no other light disruption. Table 2 and 3 show the scale value of the lighting test.

TABLE III
LIGHTING TEST SCALE VALUE

Scale	Observation
1	Undetectable and many colour disorder
2	Detection is not clear and some colour disorder
3	Detection is clear and some colour disorder
4	Clear detection and less colour disorder
5	Very clear detection and no colour disorder

TABLE IIIII
LIGHTING TEST RESULT

Light (lux)	Colour			
	Red	Blue	Green	Orange
0	5	5	5	4
28	4	4	4	3
185	3	3	4	3

Based on Table 3, the best lighting conditions are in a dark state of 0 lux, whereas poor lighting conditions are in a clear state of 185 lux. This indicates the higher the value of lux, the more difficult the colour on the LED to be tracked besides various colour noises around the user. The orange colour is hard to detect due to the difficulty of obtaining accurate colour scale values. The colour scale value used is based on the colour output of the LED device.

B. Distance Test

The colour tracking process is tested at different distances between LED device and portable camera. Distance test is used to identify the appropriate distance to allow colours to be tracked more easily and accurately. Distance test is done in the dark to get good results. Table 4 shows the scale of the distance test.

TABLE IVV
DISTANCE TEST SCALE VALUE

Scale	Observation
1	Colour is undetectable
2	Colour is not clear
3	Colour is detected

TABLE V
DISTANCE TEST RESULT

Distance (cm)	Colour			
	Red	Blue	Green	Orange
69	3	3	3	3
92	3	2	3	1
133	3	1	3	1

Denotes in Table 5, the distance between the mobile camera and the LED device is important in obtaining good colour tracking results. The distance of 69 cm found that all mouse operations were successfully carried out and the colours of the LED device were successfully detected. The distance of 92 cm found that blue colour was not clearly detected and orange colour was undetected. The least efficient distance is at a distance of 133 cm which can only detect red and green colours.

V. CONCLUSION

As a result of the experiment, it is identified that long distance will require the user to make more movement when performing the operation of the cursor. When using the system, the user should be positioned nearby the mobile camera to enable the LED device's colours to be tracked more clearly. In addition, the luminous environment is an obstruction to this system. Therefore, the dark environment is recommended when using the system. The green colour is a much easier colour to be tracked followed by red and blue. Orange is the most difficult colour to detect because its colour scale can’t be determined accurately by the system.

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