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## Mouse Design Using Image Processing for Disabled

### Engelliler İçin Görüntü İşleme Kullanarak Mouse Tasarımı

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#### ABSTRACT

*This paper presents a method to control pointer with the help of camera for a person who is not able to control the pointer with hands. Physical problems result from brain paralysis are the most dominant obstacles for pointer control. This paper aims to control pointer with the help of human-computer interaction technologies instead of hands. The proposed design is similar to common pointer control. According to disability condition, people can choose the usage of the system because of the adjustability of the system. One can control the pointer by wearing a colored wristband or any item on body parts like arms, feet or any other moving part of the body. The designed system requires software, a camera, and a table lamp. The working principle of the system is inferring information from camera and transforming this information to pixels to control the pointer on the screen. In this paper, computer vision system was combined with Java class to control the pointer. When the camera gets the first snapshot from a real-time video, first, the software finds the location of the colored item on the screen then moves the pointer towards to location. In this real-time system, clicking is a problem because of the physical inabilities. In order to solve this problem, we use another colored item on the field vision of the camera. According to the location of the second object, the software decides about left or right clicks.*

**Keywords:** Pointer Control, Image Processing, Computer-Human Interaction

#### ÖZET

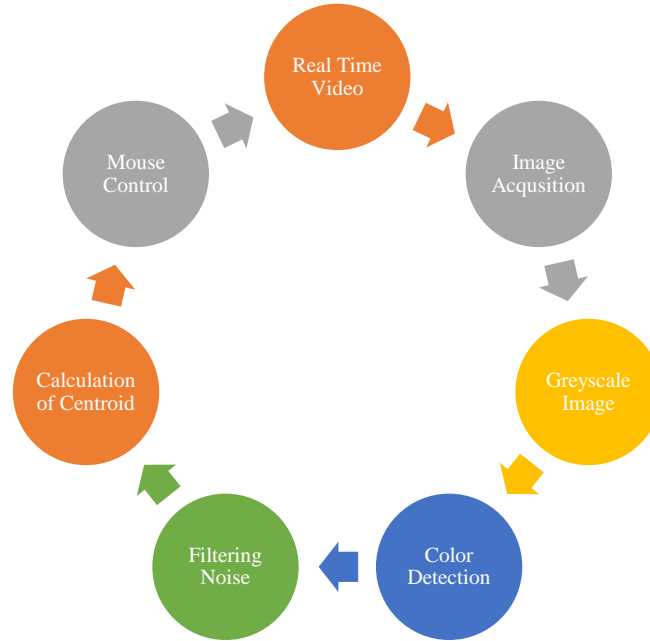
*Bu çalışmada elleri ile fareyi kontrol edemeyen engelli insanlar için kamera yardımlı bir fare tasarımı yapılmıştır. Elleri olmayan insanlar veya beyin felci gibi hastalıklara sahip olan insanlar fiziksel nedenlerden dolayı fareyi kullanamazlar. Bu çalışma sayesinde bilgisayar insan etkileşimi sağlanarak fare kontrolü sağlanmıştır. Bu tasarımın kullanım şekli geleneksel fare kullanım şeklinden çok farklı değildir. Engellilik durumuna göre sistemin kullanım şekli değiştirilebilir. Engelli kişi eline koluna veya ayağına yani vücudunun oynayan herhangi bir kısmına renkli bir bileklik giyerek fareyi kontrol edebilir. Bu tasarım bir kamera ve masa lambasından meydana gelmektedir. Sistemin asıl amacı kameradan bilgi almak ve bu bilgileri fare kontrolü yapmak için piksellere dönüştürmektir. Java ve görüntü işleme işlemleri beraber kullanılarak bu tasarım elde edilmiştir. Kamera ilk görüntüyü aldığı anda sistem renkli objenin konumunu hesaplar ve fareye ilk konumunu verir. Bu gerçek zamanlı sistemde tıklama büyük bir sorundur. Bu durumu çözmek için kameranın görüntü alanında farklı renkte farklı bir obje kullanılmalıdır. Bu ikinci objenin konumuna göre yazılım sağ yada sol tıklamanın yapılacağına karar verir.*

**Anahtar Kelimeler:** Fare Kontrolü, Görüntü İşleme, Bilgisayar-İnsan Etkileşimi

## 1. INTRODUCTION

In this paper, object tracking system was designed and a software is developed to control the pointer for disabled people. Physical problems like lack of hands or brain paralysis problems are the most dominant obstacles for pointer control. People with disabilities are faced with some difficulties according to their disability conditions while using mouse and keyboard in brief the computers. They also need others in their education and internet usage. Moreover, these people have limited number of the field to work because of the inability for using computers. When disabled people cannot use computers effectively, this has a negative effect on themselves and business sector. Nowadays, computer-human interaction has an important place in human life from education to business sector. The proposed design is similar to common pointer control. According to disability condition, people can choose the usage of the system because of the adjustability of the system. One can control the pointer by wearing a colored wristband or any item on body parts like arms, feet or any other moving part of the body. The designed system consists of a webcam and a table lamp. First, the system gathers necessary information via the camera and transform this information to pixels to controlling the pointer on the screen. In this real-time system, clicking is a problem because of the physical inabilities. In order to solve this problem, we use another colored item on the field vision of the camera. According to the location of the second object, the software decides about left or right clicks. The first step is image acquisition from a real-time video after that converting snapshot image to grayscale image. Defining the object according to its color. Filtering the noises and small pixels

from the image. Finding the object from real-time video. Calculating coordinates of the centroid of the object. In this paper, object detection managed by using color detection algorithm. Color detection was used because of its simple structure. Images are created by pixels. Every pixel has created by red, green, blue colors and its possible to get any color by determining the RGB values. The system works in 7 different processes. Flowchart of the system is shown in Figure 1. (Manpreet, 2014; Gevers and friends.,1997; Mahmoud A and friends.,2014; Dee and friends.,2008; Celik and friends., 2017; Goel and friends., 2017).



**Figure 1.** Flow Chart of System

## 2. OBJECT & COLOR DETECTION

Object detection can be applied in terms of shapes and color in the simplest. In this paper, color-based object detection was used and then object shapes were found. Color provides powerful information for object recognition. Object Detection is related to objective and subjective dimensions. The most important objectivity parameters are shape, color, texture, size and scale and subjectivity parameters are perception and cognition of the image. The importance of color for image processing is quite high. Every image is created by an array of  $M \times N$  pixels with  $M$  rows and  $N$  columns of pixels. These pixels include a certain value for RGB colors. By changing these values for red, green, blue (RGB) we can get almost any color. RGB is one of the most suitable for multicolored object recognition when all imaging conditions are controlled. Figure 2 shows blue color wristband to control the pointer. (Manpreet, 2014; Gevers and friends.,1997; Mahmoud A and friends.,2014; Celik and friends.,2017; Goel and friends., 2017).



**Figure 2.** Blue Color Wristband

Red, green and blue color and their saturation and hue were formulated from (1,6) below. The basic objective is to implement color based object detection algorithm to track object successfully. Let RGB is normalized color RGB (red, green, blue) and I is the intensity, H is hue and S is saturation; (Gevers and friends., 1997; Celik and friends.,2017).

$$I (R, G, B) = R + G + B \quad (1)$$

$$r (R, G, B) = \frac{R}{R + G + B} \quad (2)$$

$$g (R, G, B) = \frac{G}{R + G + B} \quad (3)$$

$$b (R, G, B) = \frac{B}{R + G + B} \quad (4)$$

H hue can be calculated as;

$$H(R, G, B) = \arctan\left(\frac{\sqrt{3}(G - B)}{(R - G) + (R - B)}\right) \quad (5)$$

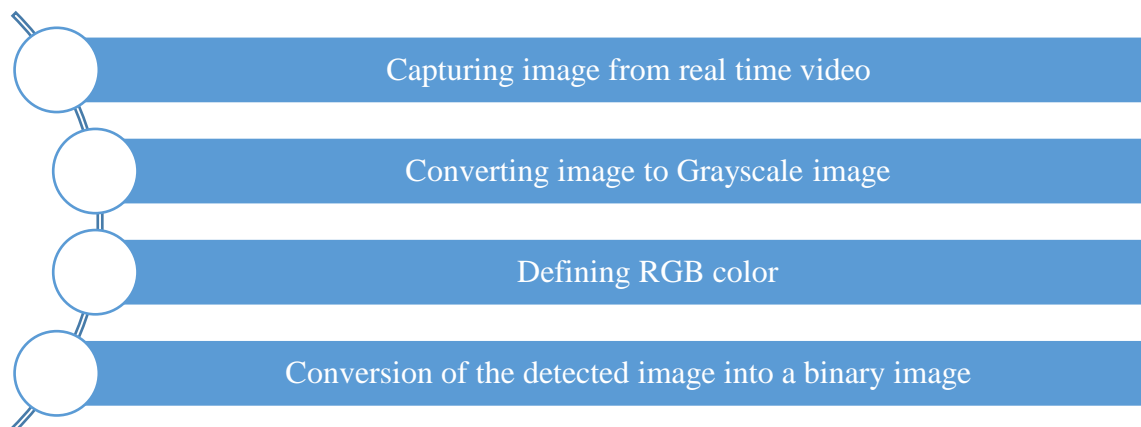
and saturation S measuring the relative white content of a color can be calculated ;

$$S(R, G, B) = 1 - \frac{\min(R, G, B)}{R + G + B} \quad (6)$$

By using the formula, we can estimate all colors features from the original R, G, B values from the corresponding red, green, and blue images provided by the camera. In Table 1, some of the basic color codes were stated and specific colors can be determined according to this RGB codes. (Gevers and friends., 1997; Celik and friends.,2017; Goel and friends., 2017).

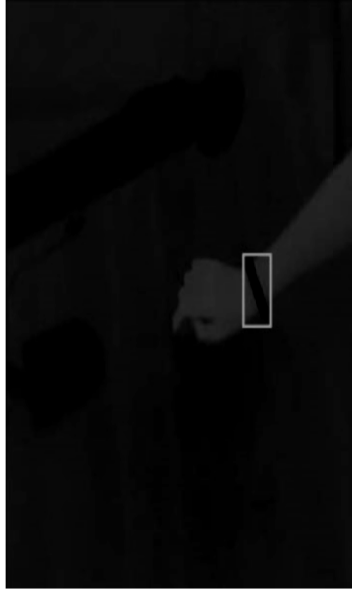
**Table 1.** RGB Color Table

Color	Hex Code	Decimal Code
Black	#000000	(0,0,0)
White	#FFFFFF	(255,255,255)
Red	#FF0000	(255,0,0)
Green	#00FF00	(0,255,0)
Blue	#0000FF	(0,0,255)
Yellow	#FFFF00	(255,255,0)
Silver	#C0C0C0	(192,192,192)
Maroon	#800000	(128,0,0)

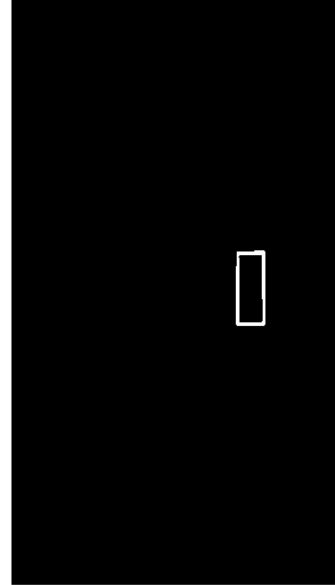


**Figure 3.** Flow Chart of Detecting Color

Converting the grayscale image to binary scale images was done by using “im2bw” function. This function replaces all pixels in the input image with luminance greater than level with the value 1 (white) and replaces all other pixels with the value 0 (black). Specify level in the range [0,1]. This range is relative to the signal levels possible for the image's class. Figure 4 shows the image after grey scale process but it is clear that to infer the color from image this process is not enough by itself. That's why ‘im2bw’ function was used to convert image from grayscale to binary image. (Lulu and friends., 2015).



**Figure 4.** Grey Scale Image of Original Image



**Figure 5.** Binary Image

To understand the basics of camera analysis, one must know how a computer perceives an image. An image consists of a lot of pixels. Each pixel corresponds to a code. The summation of these codes gives an entire image. After the analyzation of these codes, these codes can be used for the definition of colors and these defined colors are used for pixel labeling which are used to recognize colors in the picture. (Trang and friends., 2013; Manpreet, 2014; Gevers and friends., 1997; Mahmoud A and friends., 2014; Celik and friends., 2017; Goel and friends., 2017).

### 3. MAPPING & LOCALIZATION AND POINTER TRACKING

In this part of the project, we calculate the coordinate of the object on the x and y-axes. Camera resolution is an important factor for calculating the coordinates of the objects. Objects can be detected easier in high-resolution images than low ones. Before mapping section, objects must be recognized on the screen. This process is not something trivial because outside reasons such as too much light or lack of light in the environment or more than one object with the same color affect the process. In this paper, I used 1280x720 camera so the screen is divided to x and y-axis. X axis has 1280 and y-axis has 720 pixels. Whole pixels inside the tracking window. Calculation formulas of x and y axis of the object is stated in the equations (7-10) (Trang and friends.,2013; Manpreet, 2014; Gevers and friends.,1997; Mahmoud A and friends.,2014; Celik and friends., 2017).

Compute the zero moment

$$M_{00} \sum_x \sum_y I(x, y) \quad (7)$$

First moment values of x, y;

$$M_{10} \sum_x \sum_y xI(x, y) \quad (8)$$

$$M_{01} \sum_x \sum_y yI(x, y) \quad (9)$$

Localization values;

$$X_c = \frac{M_{10}}{M_{00}}, Y_c = \frac{M_{01}}{M_{00}}. \quad (10)$$

(Trang and friends.,2013; Gevers and friends., 1997; Celik and friends.,2017).

Bounding box and centroid of the object was found with the help of code. As long as the colored object is present on the camera, the pointer will be present. When the object moves to the right in real-time, the object moves to the left on the screen because of mirror effect. As we know, when we raise our right hand in front of the camera, we see that our left hand is raised. This condition can be fixed in the software by multiplying coordinate values with the minus. By taking into consideration this idea, when we move the object in the right direction, the pointer moves to left. In Table 2, 4 edge coordinates of the bounding box of the object were stated. These values change with movements of the object.

**Table 2.** Bounding Box Edge Coordinates of Object

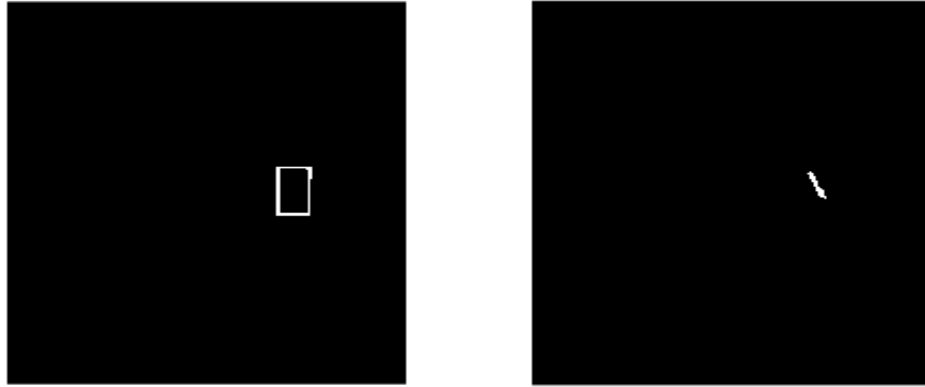
Edge1	Edge2	Edge3	Edge4
485,5	413,5	64	123

As we can see in Figure 6, the object is present on the camera and the first coordinate of the pointer is 474.5/517 on the 1280x720 screen.

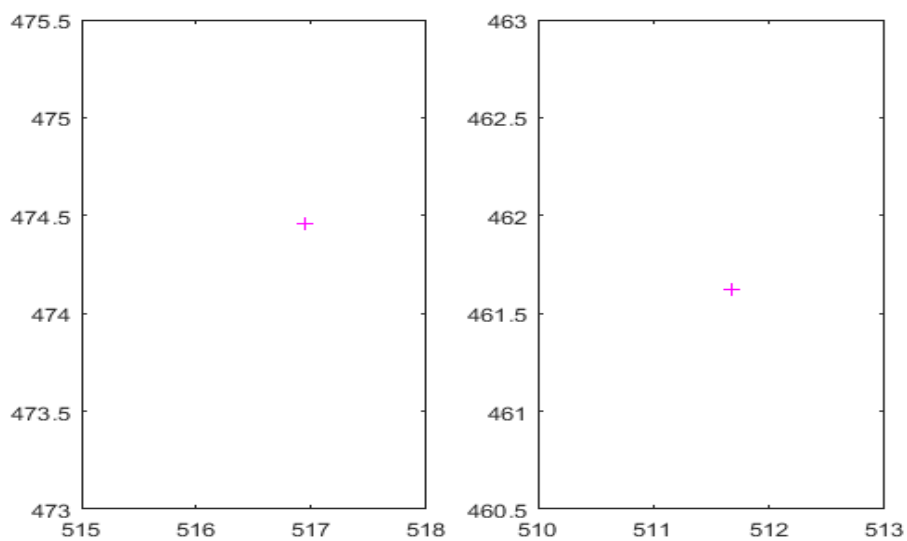


**Figure 6.** Calculated Pointer Coordinates on 1280x720 Resolution

Pointer tracking is being done with java robot class. This class includes pointer tracking, left and right clicking. Clicking task is based on simultaneous detection of red and blue colors. The pointer is controlled with blue and right clicking is controlled with red colors, left clicking is controlled with green colors. Usage of clicking is not as easy as it seems at the beginning but after some practice, one can control easily. When there are 2 present objects on the screen, it is now possible to click right or left according to second object color.



**Figure 7.** Two Objects Present



**Figure 8.** Coordinates of Present Two Objects

As it is stated above, first clicking approach needs another colored item. Figure 8 shows two different objects and their coordinates. This approach is more complicated than the second approach stated below. Moreover, this approach is more difficult for disabled because it requires 2 different colors so items and more moving part of the body. That's why second approach is more suggested because it requires only one colored item other than the pointer.

**Table 3.** Centroid Coordinates of Objects

Object Number	X axis	Y axis
1	516,9501	474,4554
2	511.6831	461.6185

Another approach for right or left clicking can be improved according to the place of the second object in X-axis. If the second object is in the right side of the first object, right click is on, if the second object is in the left side of the first object left click is on. According to this approach in Figure 8 system make left click for pointer because 512 is in the left side of 517 on the plane. Moreover, scrolling option can be improved according to Y axis values. According to this approach Figure 8 makes down rolling because 465 is lower than 474.5.

#### 4. CONCLUSION

This paper presents a method for controlling Mouse with the help of image processing and color detection algorithms for a person who cannot control the pointer with hands. This system works in real time and helps people to control the pointer, left and right clicks and scrolling button. Clicking problem was fixed by stating 2 different approaches. The first approach is about using 2 different colors other than blue. The second approach is the position of the second object. One can use a keyboard with the help of screen keyboard for Windows. The system is adjustable for several situations according to disabilities. Due to the fact that system is not stable, further works can be improved by adding stabilization algorithms and different approaches according to physical problems. For one who doesn't have hands can use this system with a foot or any other moving part of the body. After some practice of this system, disabled can educate themselves without any help. This application has wide applications areas like biomedical instrumentation, augmented reality, computer gaming and prosthetics. It is believed that this application will serve for society and the recuperation of people with disabilities and it will contribute the economy by increasing the number of computer literate.

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