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參展科別 電腦科學與資訊工程

作品名稱 **Utilizing Computer Vision And Machine Learning Algorithms To Control Smart Systems Helping Physically Disabled People.**

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關鍵詞 **Computer Vision、Python**

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1- Introduction

1.1- Background Information

About 15% of the world's population lives with some form of disability, of whom 2-4% experience significant difficulties in functioning. The global disability prevalence is higher than previous WHO estimates, which date from the 1970s and suggested a figure of around 10%. This global estimate for disability is on the rise due to population ageing and the rapid spread of chronic diseases, as well as improvements in the methodologies used to measure disability. This research deals specifically with the physically disabled and often people with physical disabilities feel frustrated because they cannot do activities such as: playing sports and doing exercise. Having a physical disability also changes the way a person lives their life. They may find their life changes and activities they had previously included as part of their daily routine such as brushing their teeth, washing and doing household chores suddenly become a huge effort and many people require another person's help to carry out these activities. Also, they suffer from three basic challenges like; education, economic and, communication. Firstly, Education: The results of the investigation revealed that the physically handicapped. They face a lot of problems while studying they can't learn as the normal ones and they needs someone to help in learning. Secondly, Economic: they can't work and achieve income to help in his practical life. And finally Communication: they can't communicate with others because of his disability.

1.2- Rationale

According to WHO, there are about 15% of world population are suffering from disability, who are challenging to unemployment, difficulties of interacting with others and education. In this study, the researcher aims to help physically disabled people to use a computer without using hand so, they have a chance to work online as freelancer, educate online, communicates with the outside world.

1.3- Research problem

Previous research in this field couldn't fully control the computer. They only help physically handicapped people in gaming. However, they can't control the computer's cursor. And there is research that they can use their voices to control the computer, but there are problems in the language because it depends on the accuracy of the sound and when the voice is high can't achieve accurate measurements.

1.4- Variable & Keywords

Computer Vision: is an interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do. Python: is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales. Opencv: is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel,   it was later supported by Willow Garage then Itseez (which was later acquired by Intel). The library is cross-platform and free for use under the open-source BSD license. Numpy: is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays. The ancestor of NumPy, Numeric, was originally created by Jim Hugunin with contributions from several other developers. In 2005, Travis Oliphant created NumPy by incorporating features of the competing Numarray into Numeric, with extensive modifications. NumPy is open-source software and has many contributors. Pyautogui: it is library in python is responsible for making GUI (Graphic User Interface). RaspberryPi: is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries. Raspberry Pi Trading is responsible for developing the technology while the Foundation is an educational charity to promote the teaching of basic computer science in schools and in developing countries.

1.5- Aims of Study

In this study the aim is to improve the daily life routine of the physically disabled people as it helps them in using the computer in any field they need. It will also solve their educational, economic and communicative problems in a country that will help them learn through computer use. Moreover, Egyptian education now depends on e-learning and helps it to work online and profit. Through marketing and free lancer and also helps him to communicate with others through social networking sites and finally our project helps the disabled to live in an easier way.

2-Methodology

2.1 Design of study:

It is essentially a program which applies image processing, retrieves necessary data and implements it to the mouse interface of the computer according to predefined notions.

The code is written by Python programming language. In this research the cross platform image processing module OpenCV was used to implement the mouse actions using Python specific library PyAutoGUI.

The video is captured by the webcam then processed and only the three coloured finger tips are extracted. Their centers are calculated using method of moments and depending upon their relative positions it is decided that what action is to be performed.

To allow for a broader and more direct use of the IMouse device in scientific research, we have implemented a software Toolkit in OpenCV which interfaces with the

color tracker controller .The OpenCV Toolkit used in nine parts in the code:

cv2.videoCapture() 2) cv2.cvtColor() 3) cv2.inRange() 4) cv2.imshow() 5) cv2.findContours() 6) cv2.CHAIN_APPROX_NONE 7) cv2.RETR_TREE 8) cv2.destoryAllWindows() 9) cv2.COLOR_BGR2HSV. There are another two modules: First, is numpy that which responsible for numerical value in programming code as 1) np.array(), second, pyautogui module that gives commands to pointer to move or click as 1) pyautogui.click(button = 'right') 2) pyautogui.click(button = 'left') 3)pyautogui.moveTo(cursor[0],cursor[1]).

2.2 Instruments software and hardware:

The instrument used to make this project is Python idle3 was used to compile this code, python programming language was added to it 4 programming libraries:

1. OpenCV: to make image processing as background filtering and color detection.

2. Pyautogui: to make a gui of program, give commands to computer's pointer to move and click.

3. Numpy: to make computer understand numerical value in programming code.

4. Time: cause there are commands will be execute according to time.

to make a programming code of this project as a software .

Raspberry Pi 3 B+ was also used to be a CPU of the portable prototype, LCD screen 5 inch to be a monitor, webcam 1.3 megapixel as a graphical input hardware.

2.3 Feature of the system:

the eye mouse controller is a color tracing device that allows moderately free head movement it returns a real time estimate of the 3 colors position on the screen as well as the 3D position of the the three colors with respect to the screen center. The actual technique exploited by the device for color tracking is not declared by the manufacturer. These color trackers are based on colors centers that known by method of moments. The position of center of color (which move jointly with the 3D color region) is computed with respect to the position of point x(x1, x2) and y(y1, y2) on circle.
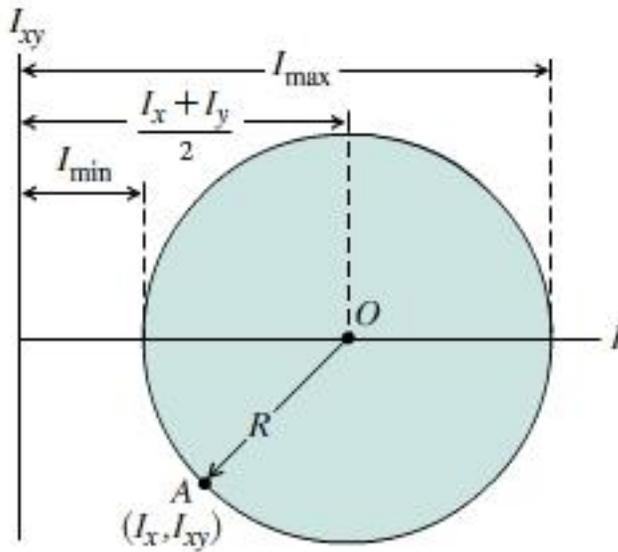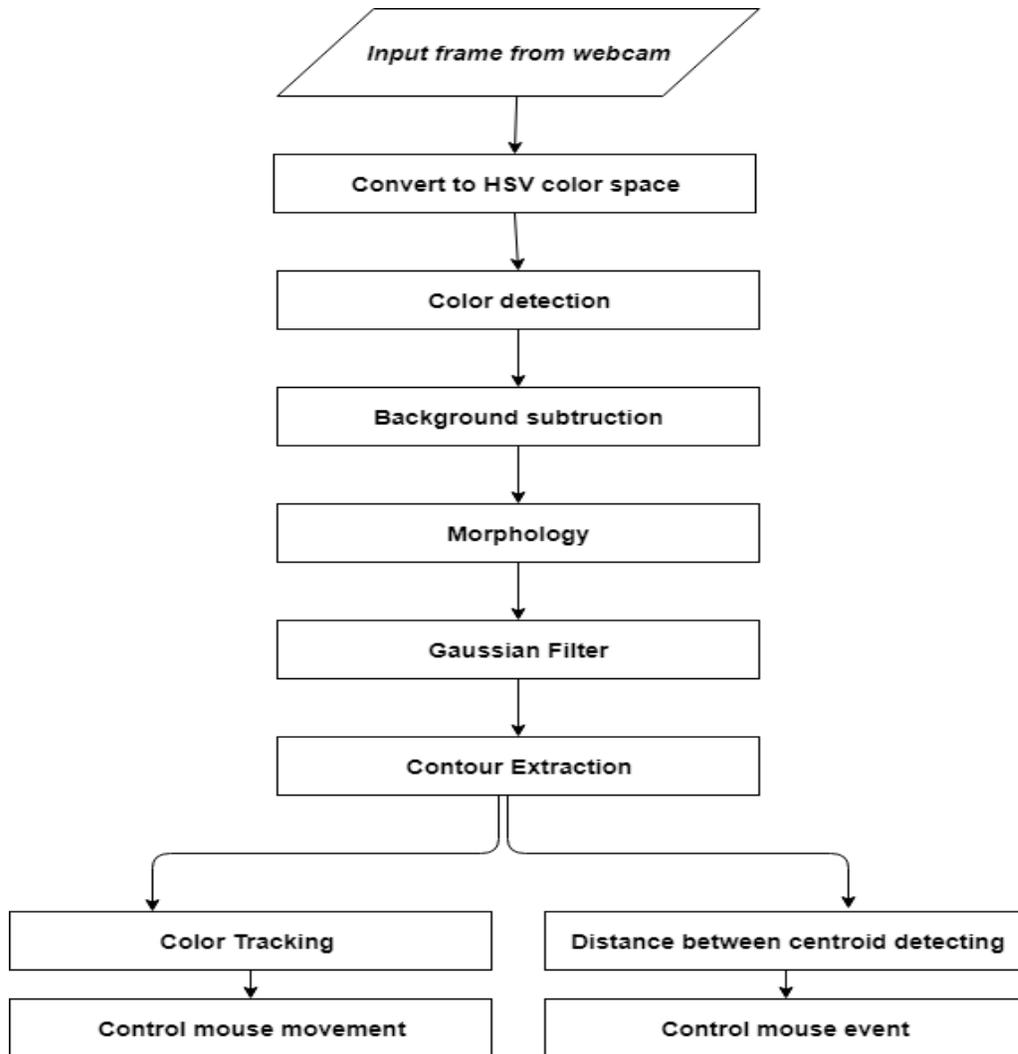

These application can be employed to perform a calibration of the color data

and to gather the color data in real-time. The IMouse SDK released python setup, 4

modules (opencv, time, PyAutoGUI, numpy) necessary to access the color tracking data

and mouse movement system and mouse movement. In order to validate the IMouse for

scientific research, we propose and perform a series of procedures to provide a quantitative

evaluation of the spatial and temporal characteristics of the device.

2.4 procedures:

In this section the strategies and methods used in the design and development of the vision based on IMouse system will be explained. The algorithm for the entire system is shown in Figure below

(1)

```
┌─────────────────────────────────┐
│   Input frame from webcam       /
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Convert to HSV color space    │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Color detection               │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Background subtruction        │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Morphology                    │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Gaussian Filter               │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Contour Extraction            │
└─────────────────────────────────┘
         │              │
         ▼              ▼
┌──────────────────┐  ┌────────────────────────────────────┐
│  Color Tracking  │  │ Distance between centroid detecting│
└──────────────────┘  └────────────────────────────────────┘
         │              │
         ▼              ▼
┌────────────────────────┐  ┌──────────────────────┐
│ Control mouse movement │  │  Control mouse event │
└────────────────────────┘  └──────────────────────┘
```

Figure(1): This is algorithm of IMouse program.

This section is separated into the following subsections:

Capture video from webcam.

  Tracking colors remove noise.

Finding contours it mask relevant to that color range.

Cursor Control.

5

cv2.VideoCaputre()

Capture video from webcam:

The researchers need to capture a video stream by a webcam. OpenCV provides a simple interface to this. To create a videocapture object it is argument either the device index or the name of a video file if you want execute tasks on video but in this case the researchers used device index Normally one camera will be connected. So simply pass 0. After that, you can capture frame-by-frame then the color channel will be changes from BGR to HSV as it is more closely align with the way human vision perceives color-making attributes by (cv2.cvtColor()) by give to arguments frame and cv2.COLOR_BGR2HSV and store it in HSV variable . But at the end, the frames will be shown by (cv2.imshow()) function to show frames by entering two argument the name of window that will show frame (in my case) "frame" HSV variable. cv2.destoryAllWindows() when user click ESC.

cv2.inRange()

Tracking colors remove noise:

Ranges of color were inputs when using (np.array()) is a high-performance multidimensional array object that is a powerful data structure for efficient computation of arrays and matrices. 3 color range was declare like that (np.array([lower color],[upper color]))

Depending on ranges that entered one by one using the)cv2.inRange()) function which find the region of color that compatible with ranges of color in code and filter color region out by giving 3 attributes HSV frame, upper color ranges, lower color ranges . To resolute noise in the video stream, two step moriphism Erosion, delation. After that, The noise filtered image referred to as mask in the program is then sent for locating the centers.

cv2.findContours()

Finding contours it mask relevant to that color range:

By using cv2.findContours function it has 3 arguments

first argument is source image or frames.

second is contour retrieval mode (cv2.RETR_TREE).

third is contour approximation method (cv2.CHAIN_APPROX_NONE) It removes all redundant points and compresses the contour, thereby saving memory.

Areas filter was used to filter any color region its area bigger than area range that was entered at code.then, used method of moment to detect center of color region.

setCursorPosition function:

To reduce noise of movement captured by webcam and vibration in centers. This function compare the new center with the previous position of the cursor that takes as parameters center of yellow region (yc) and the previous cursor position (pyp) . If difference is less than 5 pixels, it is usually due to noise. If difference is more than 5 pixels is considered as voluntary movement.

chooseAction function:

3 centers are calculates, to decide what action need to be performed depend on relative position the researchers used chooseAction function that take 3 parameters (center of red region, center of blue region, center of yellow position)

Then array was made by using numpy module np.array has on it 'move' , 'false' as a value. If distance between center of yellow region and center of red region less than 40 mm for 0.3 sec the left click will occur. If distance between center of blue region and center of red region less than 40 mm for 0.3 sec the right click will occur.

PerformAction function:

Depending on output of the chooseAction the performAction start to execute it's command

pyautogui.click(button = 'right')

pyautogui.click(button = 'left')

pyautogui.moveTo(cursor[0],cursor[1])

While(True):

Finally, infinite loop was made to call all function (perfomAction, chooseAction, setCursorPosition, cv2.cvtColor, cv2.inRange, cv2..imshow, cv2.destroyAllWindows). loop break when user click ESC equal 27 at ascii code.

2.5 Data analysis:

After collecting data, the researcher started to analyze the information gathered and find answers to the research question proposed. Graphical tools, such as charts, are used here to represent the collected data.
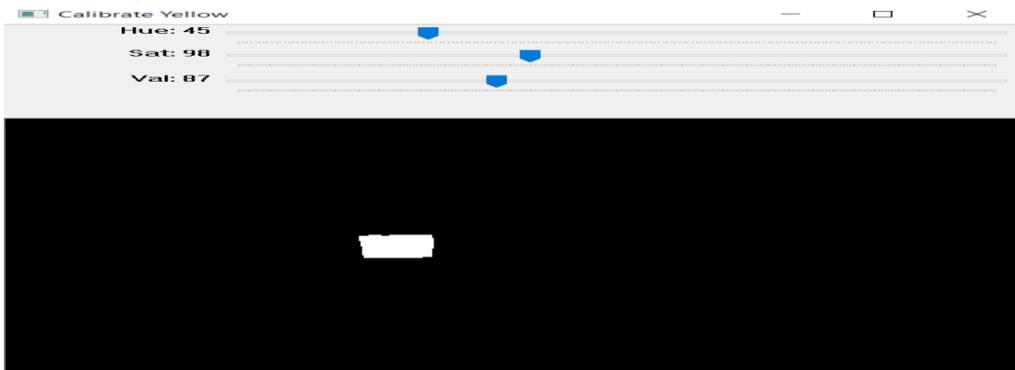
1)

Fig. (1): The ranges of yellow color that takes as stander is Hue = 45, Sat = 98, Val = 87. A distinction was made between yellow and   other colors.
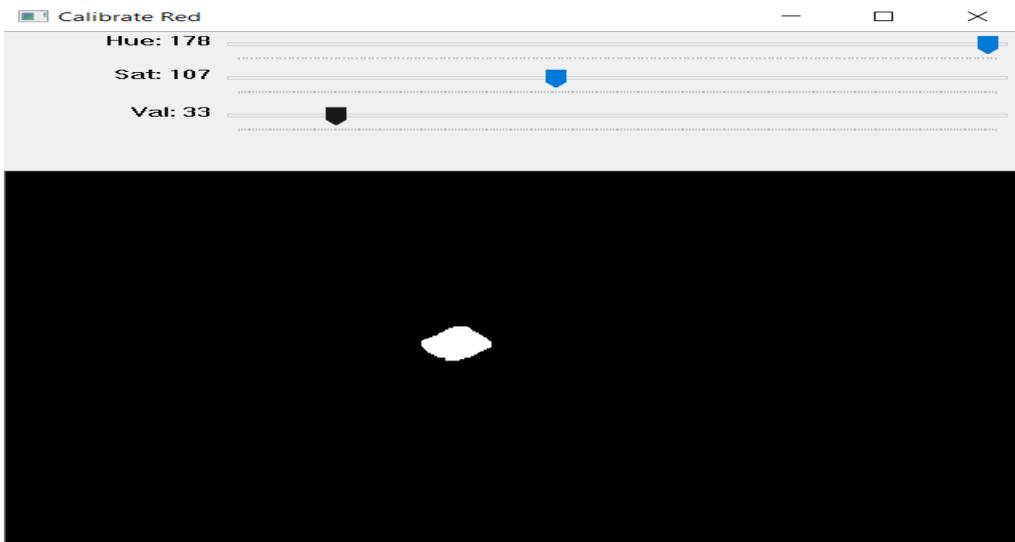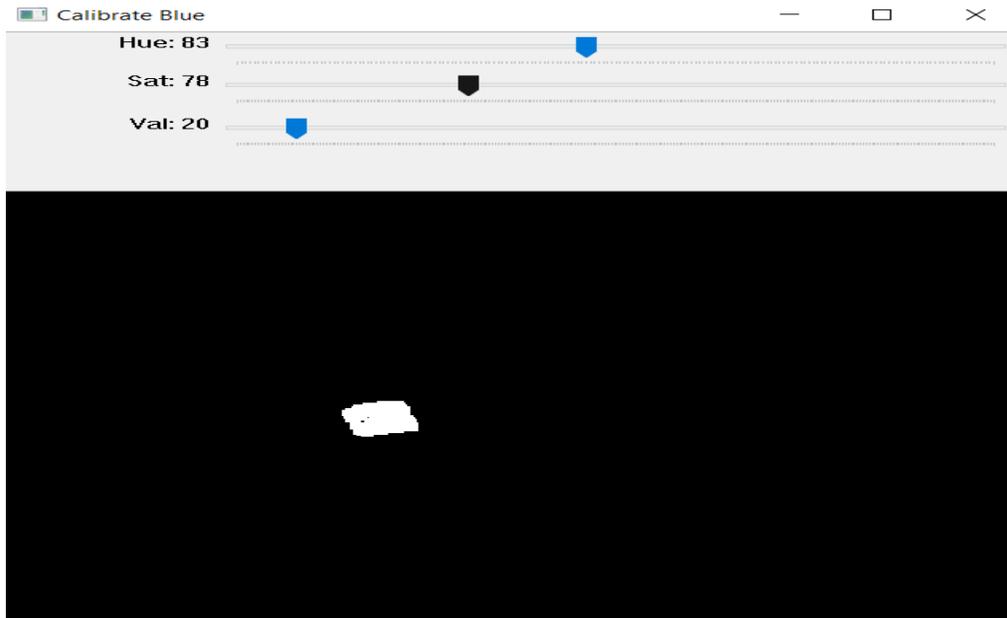
2)

Fig. (2) : The ranges of red color that takes as stander is Hue = 178, Sat = 107, Val = 33. A distinction was made between yellow and other colors.

3)

Fig. (3) : The ranges of blue color that takes as stander is Hue = 83, Sat = 78, Val = 20. A distinction was made between yellow and other colors.

This is how it works:
First the program work when user open computer system, inaddition this icon of program if user want to open it manually.

IMouse.exe

Now, let see how it tracks our palm and detects color on mask.
Image

This detect distance between red color and blue color to make right click:

Image

This detect distance between yellow color and yellow color to make left click:

Image

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3-Conclusion

With the help of observations that we have, we can conclude that the results should be depend upon:

cv2.findContours : This is the function used to find contours while converting the BGR image to the HSV image.

Background of the pictures should be plain to get accurate analysis of color detection.

The ranges of color change when degree of light.

Python with OpenCV is faster than matlab.

Center of any mass was known by method of moments.

For maintaining the performance, the database should contain the template images of small dimension.

We observe the following output by implementing algorithm:

Here, what we do is, the user just open his computer IMouse program will automatically. that we required to run it for instance- OpenCV, Camera, pyautogui. Now, we are ready to do just sit back and control without using any conventinal method. By,moving head in plain background, we can get following output.

__ACTION__	__ACTION PERFORMED__
Move head up	Cursor moves up
Move head down	Curosr moves down
Move head left	Cusror moves left
Move head right	Cursor moves right
Move tongue towards left	Click on the left click
Move tongue toward right	Click on the right click

Table: IMouse-Action table

SOFTWARE	HARDWARE
Python idle	**Rasspberry pi**
OpenCV module	**Rasspberry pi Camera 8 megapixel**
PYautoGUI module	**LCD 5 inch (HDMI)**
Numpy module	
Time module	

4-Discussion:

4.1 Summary of main finding:

By implementing this project the researchers receive valuable information as

python is fast, open source and best programming language in artificial intelligence also there is a OpenCV module can be add to python to perform image processing inaddition, IMouse code could be implemented at linux , windows and mac operating systems moreover, knowing the method of moments to know the center of regular circle.

4.2 Practical implication:

Computer program was made by researchers written by python programming language with 4 modules and experienced by 15 participants average of their age is 23 years old, ratio of boys:girl is 2:1. The participants invited were from our surrounding environment, they were chosen by individual piloting, all of them are physically and mentally well, except two participant who were disabled. The researcher applied the test on the participants using the prototype to analyze distinct readings with different tongue movement that were done by the participant to measure the calibration and accuracy of the program detection. Their is almost no risk assessment on the participants as they are only allowed to use their tongue to click on plastic parts.

4.3   Technical specifications :

Few technical specifications have been provided by the manufacturer. The operating distance refers to the minimum and maximum distances between a 3d color region on the mask and the webcam at which color tracking can be performed while maintaining robust tracking. The IMouse operating distance is specified at 200-850 mm. The IMouse allows for free head movements while a color is detected.

Thus, the allowable horizontal and vertical head movements change as a function of the distance of the user from the screen. For example, at a distance of 700mm users may move their head 240mm leftwards or rightwards and 195mm upwards or downwards. The maximum recommended screen size is 24 inches. Considering a user positioned at the far limit of the operating distance (800 mm). The working range of the program in degrees of

visual angle is $[-18\degree, 18\degree]$ on the x-axis, and $[-10.5\degree, 10.5\degree]$ on the y-axis. The device will likely provide gaze estimates at wider gaze angles, to the detriment however of accuracy and precision, particularly in the corners of the monitor. The sampling rate of the device is the number of data samples per second collected for each eye.

4.4 Future Suggestions

In the upcoming researches, the inventors may want to study matlab programming language deeply instead of python and opencv to execute color detection with using differentiate factor (area in our case). In-addition, do survey to be able to analyze more the range of characters and environment that resulted with the personality that each participant had. Also increasing the number of handicap people because, they may have another point of views in such a topic which will be reflected positively on making the results more varied.

5-Literature review :

[1] In November 2014 Richard R. Ragland made a study about an application   that relates in general to methods and systems for tracking movements of a human using a digital camera, and more particularly to determining location and relative motion of a human head based on anatomical features not directly visible in an image. But in this study, Richard R. Ragland could not relate tracking movements of a human with movement of pointer of computer.

[2] Mr. Deepak K. Ray, Mayank Soni, Prabhav Johri, Abhishek Gupta in june 2018 discussed in their paper ways of hand Gesture recognition using Python. The goal for this study was to develop a new type of Human Computer Interaction system that subdues the problems that users have been facing with the current system. The project is implemented on a Linux system but could be implemented on a windows system by downloading some modules for python. The algorithm applied is resistant to change in background image as it is not based on background image subtraction and is not programmed for a specific hand type; the algorithm used can process different hand types, recognizes no of fingers, and can carry out tasks as per requirement. As it is stated within this paper, the main goals were reached. The application is capable of the gesture recognition in real-time. There are some limitations as they could not execute this algorithm in colors they executed it on hand so they did not solve our problem**,** which they still have to be overcome in future.

[3] Vaishali Gaikwad, Rishiraj Singh, Parthil Thaker, Gaurav Sawardekar in November 2018 studied Hand Gesture Controlled Robots, where the motion of a robot is controlled by the gestures of the hand. Another interesting project based on a similar principle is an Arduino based Hand Gesture Control of your computer or laptop. Human Machine Interface or HMI is a system comprising of hardware and software that helps in communication and exchange of information between the user (human operator) and the machine. The LED Indicators, Switches, Touch Screens and LCD Displays are normally used as a part of HMI devices. Another way to communicate with machines like Robots or Computers is with the help of Hand Gestures. Instead of using a keyboard, mouse or joystick, we can use our hand gestures to control certain functions of a computer like play/pause a video, move left/right in a photo slide show, scroll up/down in a web page and many more.In this project, In this project the researchers implemented a simple Arduino based hand gesture control where you to determine the position of our hand and control a media player (VLC) based on the position. They could not execute this algorithm in colors they executed it on hand so they did not solve our problem, which they still have limitations.

[4] In January 2014 Kengo Ohnishi, Richard F Weir & Todd A Kuiken investigated various neural machine interfaces for voluntary control of externally powered upper-limb prostheses. Epidemiology of upper limb amputation, as well as prescription and follow-up studies of externally powered upper-limb prostheses are discussed. The use of electromyographic interfaces and peripheral nerve interfaces for prosthetic control, as well as brain machine interfaces suitable for prosthetic control, are examined in detail along with available clinical results. In addition, studies on interfaces using muscle acoustic and mechanical properties and the problem of interfacing sensory information to the nervous system are discussed. There are some limitation because the mind sends out unwanted signals to trigger the robot, this unwanted signals obstruct controlling machines.

[5] C. Harding, A. Griffiths, H. Yu from 5 to 17 April 2007 . This research aimed to undestand that MATLAB is a software simulator which is good for simulating the mathematical modeling and feedback control, while OPNET is a software tool which is good for simulating the network communication behavior. However, currently simulating the communication behavior of a wireless ad hoc network within MATLAB is difficult, where complex queuing models in OPNET are also difficult to create and manipulate. In this paper, we have created an interface between MATLAB and OPNET to allow MATLAB to use its strong mathematical functionality and OPNET to use its ability to manipulate network simulations.

6-Reference

[1]https://www.researchgate.net/publication/275637528_Accuracy_and_Precision_of_the_Tobii_X2-30_Eye-tracking_under_Non_Ideal_Conditions

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[3]http://www.ijfrcsce.org/download/browse/Volume_4/June_18_Volume_4_Issue_6/153 0176523_28-06-2018.pdf

[4] https://www.hackster.io/WolfxPac/colour-detection-using-opencv-python-8cbbe0

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7-Acknoledgment

We are thankful to "Hazem python" course which first introduced us to know image processing algorithms.We are also thankful for the Alexandria faculty Engineering for giving us this opportunity .This project was possible due to warsha field. Special Thanks:-

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Dr.Ayman Hamed (Doctor in Computer Engineering Department)He helped us in doing design of mask.

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In this project, the authors apply the image processing technology to detect the user's head motivation to control the curser of a computer mouse. The topic of this project is very practical. The idea has been implemented. However, this idea is not a new one. There are many works or products providing the same applications. It will be better if the authors can compare these works and identify the main critical issue. Then the authors can focus on the critical issue.