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VIRTUAL MOUSE USING DEEP LEARNING

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Abstract—**The technique of establishing a process of interaction between human and computer is evolving since the invention of computer technology. The mouse is an excellent invention in HCI (Human-Computer Interaction) technology. Though wireless or Bluetooth mouse technology is invented still, that technology is not completely device free.A Bluetooth mouse has the requirement of battery power and connecting dongle. Presence of extra devices in a mouse increases the difficulty to use it. The proposed mouse system is beyond this limitation.This project proposes a novel camera vision-based cursor control system, using hand gestures captured from a webcam through a color detection technique. The system will allow the user to navigate the computer cursor using their fingers and left click and dragging will be performed using different hand gestures.Primarily, a user can perform left clicks, right clicks, and double clicks, scrolling up or down using their hand in different gestures. The proposed system uses nothing more than a low-resolution webcam that acts as a sensor and it is able to track the users hand bearing color caps in two dimensions. The system will be implemented using the python and OpenCV. The hand gesture is the most effortless and natural way of communication. The output of the camera will be displayed on the monitor. Shape and position information about the gesture will be gathered using detection of color.**

INTRODUCTION

Computer Mouse:

A computer mouse is a handheld hardware input device that controls a cursor in a GUI (graphical user interface) and can move and select text, icons, files, and folders on your computer.

For desktop computers, the mouse is placed on a flat surface (e.g., mouse pad or desk) in front of your computer. The picture is an example of a Logitech desktop computer mouse with two primary buttons and a wheel.

Virtual Mouse:

Virtual-Mouse is an application, which can replace your Computer Mouse with normal keystrokes on your keyboard! It allows you to assign any key or combination of keys to move around your mouse cursor and to execute various mouse occurrences like Double Clicking etc. Virtual-Mouse can be used both alone or together with your present mouse. Virtual-Mouse also can help you to eliminate arm and wrist pain caused by your mouse. If you are a Network Administrator or a computer supplier you can find many advantages in using the Virtual-Mouse instead of a computer mouse for each.In today's technological era, many technologies are evolvingday by day. One such promising concept is Human- MachineInterface. For example, in a wired mouse there is noprovision to extend limit. In wireless mouse, one should haveBluetooth hardware installed in the computer and Bluetoothdongle attached. For the Virtual mouse, mostly uses web camera works withthe help of different image processing techniques in whichpointer has been used for the objectrecognition andtracking. Left and the right click events of the mouse havebeen achieved by detecting the number of pointers on the images.

Domain Explanation- Artificial Intelligence:

Artificial intelligence is the ability of machines to perform certain tasks, which need the intelligence showcased by humans and animals. This definition is often ascribed to Marvin Minsky and John McCarthy from the 1950s, who were also known as the fathers of the field.

Artificial intelligence allows machines to understand and achieve specific goals. AI includes machine learning via deep learning. The former refers to machines automatically learning from existing data without being assisted by human beings. Deep learning allows the machine to absorb huge amounts of unstructured data such as text, images, and audio. Any AI system must be able to have some of the following characteristics: Observation, analytical ability, problem solving, learning, etc.

Machines Recognize Gestures:

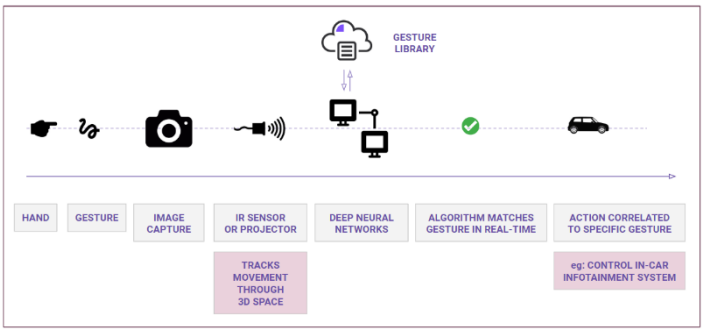
A gesture is specifically classified by any physical movement, large or small, that can be interpreted by a motion sensor — anything from the pointing of a finger to a jumping high kick, a nod of the head, or even a pinch or wave of the hand. A camera system feeds captured image data into the primary sensing device. This devicetypically calculates the depth of field and tracks the movement of the hand (or other body part

through 3D space. Deep Learning algorithms, based on layered neural networks are then trained to identify and correlate meaningful gestures from a comprehensive pre-built library of 'gestures. Each gesture or movement is then matched in real-time to an intended action specific to the end-user's application. Once the gesture has been interpreted and matched from the library, the system executes the desired set of actions.

The most efficient and expressive way of human communication is through hand gesture, which is a universally accepted language. It is pretty much expressive such that the dumb and deaf people could understand it. In this work, real-time hand gesture system is proposed. Experimental setup of the system uses fixed position low-cost web camera high-definition recording feature mounted on the top of monitor of computer or a fixed camera on a laptop, which captures snapshot using Red Green Blue [RGB] color space from fixed distance. This work is divided into four stages such as image preprocessing, region extraction, feature extraction, feature matching. Recognition and the interpretation of sign language is one of the major issues for the communication with dump and deaf people.

In this project an effective hand gesture segmentation technique has been proposed based on the preprocessing, background subtraction and edge detection techniques. Pre-processing is defined as procedure of formulating data for another process. The main objective of the preprocessing process is to transform the data into a form that can be more effectively and effortlessly processed. In the proposed work, the pre-processing techniques are created on the basis of different types of combinations from the subsequent hand gesture image processing operations such as capturing image, removing noise, background subtraction, and edge detection and these image processing methods are discussed is as follows.

Initially, the hand gesture images are captured from the vision-based camera, The hand gestures can be observed with the different kind of interfaces like "data gloves" that accurately records every abduction angle and digits and position sensors for wrists and optical orientation or electromagnetic, requiring the user to wear trackers or gloves. Habitually, the glove-based interfaces even need the user to be hitched to the computer, all minimizing time to user comfort and interface, conversely, vision-based interfaces offer unencumbered interaction with human.



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PROBLEM DESCRIPTION

Gesture recognition might be a futuristic way to the computers to understand human gesture (Body Language). It will build a greater interaction between human & computer machines rather than primitive text-based interaction.

To track fingertips as a movable object, and to utilize it for mouse functions, the camera should be positioned in a way so that it can see the user's hands in the right positions. This can be used in space-saving situations, for those patients who don't have control over their limbs and for other similar cases. It's a virtual mouse instead of a physical mouse which will work only based on webcam captured frames & tracking colored fingertips.

LITRATURE SURVEY

1.**Mouse on a Ring: A Mouse Action Scheme Based on IMU and Multi-Level Decision Algorithm**

Author: Yuliang Zhao; Xianshou Ren; Chao Lian; Kunyu Han; Liming Xin; Wen J. L,Year:2021

Overview:The traditional mouse has been used as a main tool for human-computer interaction for more than 50 years. However, it has become unable to cater to people's need for mobile officing and all-weather use due to its reliance on the support of a two-dimensional plane, poor portability, wearisomeness, and other problems. In this paper, we propose a portable ring-type wireless mouse scheme based on IMU sensors and a multi-level decision algorithm. The user only needs to operate in the air with a smart ring worn on the middle finger of their right hand to realize the interactive function of a mouse. The smart ring first captures changes in the finger's attitude angle to reflect how the cursor position changes. And, it captures the rapid rotation of the user's palm to the left and right to achieve mouse clicking. In addition, a multi-level decision algorithm is developed to improve the response speed and recognition accuracy of the virtual mouse. The experimental results show that the virtual mouse has a target selection accuracy of over 96%, which proves its practicability in real-world applications. This virtual mouse is expected to be used as a portable and reliable tool for multi-scenario human-computer interaction applications in the future.

2.**Gesture Recognition Based Virtual Mouse and Keyboard**

Author:Sugnik Roy Chowdhury; Sumit Pathak; M.D. AntoPraveena,Year:2020

Overview:Nowadays computer vision has reached its pinnacle, where a computer can identify its owner using a simple program of image processing. In this stage of development, people are using this vision in many aspects of day-to-day life, like Face Recognition, Color detection, Automatic car, etc. In this project, computer vision is used in creating an Optical mouse and keyboard using hand gestures. The camera of the computer will read the image of different gestures performed by a person's hand and according to the movement of the gestures the Mouse or the cursor of the

computer will move, even perform right and left clicks using different gestures. Similarly, the keyboard functions may be used with some different gestures, like using one finger gesture for alphabet select and four-figure gesture to swipe left and right. It will act as a virtual mouse and keyboard with no wire or external devices. The only hardware aspect of the project is a web-cam and the coding is done on python using Anaconda platform. Here the Convex hull defects are first generated and then using the defect calculations an algorithm is generated and mapping the mouse and keyboard functions with the defects. Mapping a couple of them with the mouse and keyboard, the computer will understand the gesture shown by the user and act accordingly.

3.Modifying Texture Perception With Pseudo-Haptic Feedback for a Projected Virtual Hand Interface

Author: Yushi Sato; TakefumiHiraki; Naruki Tanabe; HarukaMatsukura; Daisuke Iwai; Kosuke Sato,Year:2020

Overview: Human body augmentation makes it possible to obtain new abilities that we cannot achieve with our actual bodies. A projected virtual hand interface is a promising approach for body augmentation because it can extend a user's reach in daily life without the need to wear a device. Although users can manipulate a projected virtual hand as if it were their own hand and can interact with distant objects through it, they cannot feel the sensation of touch when the projected virtual hand is overlaid on a real object. In this paper, we propose a novel pseudo-haptic feedback framework to provide users with the tactile texture of objects without the use of haptic devices. We designed three types of visual effects that produce unevenness, slipperiness, and softness. The experimental results indicate that the proposed visual effects can lead users to feel the intended tactile sensation. Furthermore, the visual effects provide users with tactile sensations with three to five levels of intensity without producing a strange feeling.

4.Application and Designing of Wireless Mouse using Object Tracking

Author:Rahul Kumar; Rajat Gupta; MohdSaquib Faraz,Year:2019

Overview:Paper aim towards building a system that can eliminate the need of mouse, touchpads and other touch devices like smartphones to control all of them. Controlling the functions of devices include the positioning of the cursor and clicking at the desired position to perform a specific task. All other features like scrolling, double-click, zooming, multiple touches, etc. fall in these categories that can be added to this system on an extension. The positioning of the cursor can be done using object tracking in computer vision. The ability to click can be provided with the help of sensors. Sensors are the good choice as some of them generate voltage signal whenever they experience a change in their respecting sensing medium. Arduino can further detect this voltage signal in order to assist the program for clicking purpose. Such a system can prove very useful in complex medical surgery, defence mission, and can enhance the growing experience of Virtual Reality games if used for entertainment purpose.

5.BMK Stick: IMU-Based Motion Recognition Air Mouse and Five-Multikey Keyboard

Author: WonHoSeo; Younggeun Choi,Year:2018

Overview:BMK stick, a Bluetooth mouse with a keyboard is a joystick-type input device based on an inertial measurement unit (IMU) sensor that recognizes human hand movements along with the combinations of five buttons and enables users to input text with one hand. It is designed as an input device for computers and virtual environments. The BMK stick has two modes, mouse mode (mode 0) and keyboard mode (mode 1), which can be set by pushing a button. In mode 0, the IMU sensor extracts the value of the user's hand motion with the 3D Euler angle. The extracted values are then converted into two-dimensional Cartesian coordinates through a built-in algorithm in the microcontroller unit (MCU). The converted value is mapped onto the computer screen to control the mouse pointer. In mode 1, text can be entered with with one hand using a five-button combination by using an AEIOU key-map provided by a commercial text-entry device, TAP. Two experiments were conducted to evaluate the performance of the BMK stick. In the first experiment, the mouse pointing performance was compared with three existing commercial ones. In the second experiment, the text-entry rate was evaluated in words per minute (WPM) compared with the two existing commercial one-handed keyboard input devices. The result shows that our proposed device in the first experiment performed better than the other commercial products. In the second experiment, even though some experimenters had some difficulties in manipulating our device, it produced more WPM than the commercial ones**.**

6.Virtual Mouse Control by Webcam for the Disabled

Author: ReyhanSeherBaştuğ;BartuYeşilkaya;MazlumUnay; Aydın Akan,Year: 2018

Overview: Image processing, with the development of technology, has a very wide field of usage. The health sector is also one of these uses. Much progress has been recorded on image processing and eye tracking. In both processes have software application. Image processing, a subdivision of the signal processor, can consist of an image or video-like visual objects as input and output as an image or various parameters of it. Also, eye tracking is a kind of image processing process. In general terms, eye tracking refers to eye movements, image processing or image processing through the input and the recorded data as software. This project was developed for people who are inadequate in terms of use of mouse with hands. In this thesis study, a real-time view can be obtained with the help of color, eye movement is perceived to be followed and processed, and then to monitor these eye movements using the MATLAB® program for mouse control by using a webcam. Separately a virtual menu is created by adding warning buttons that indicate the basic needs of the person to be easy to use.

7.Mechanics of pseudo-haptics with computer mouse

Author: Ashok Kumar; RavaliGourishetti; M Manivannan,Year: 2017

Overview:The haptic illusion-based force feedback, known as pseudo-haptics, is used to simulate haptic explorations, such as stiffness, without using a force feedback device. There are many computers mouse based pseudo-haptics work reported in the literature. However, none has explored the mechanics of the pseudo haptics. The objective of this paper is to derive an analytical relation between the displacement of the mouse to that of a virtual spring

assuming equal work done in both cases (mouse and virtual spring displacement) and experimentally validate their relation. A psychophysical experiment was conducted on eight subjects to discriminate the stiffness of two virtual springs using 2 Alternative Force Choice (AFC) discrimination task, Constant Stimuli method to measure Just Noticeable Difference (JND) for pseudo-stiffness. The mean pseudo-stiffness JND and average Weber fraction were calculated to be 14% and 9.54% respectively. The resulting JND and the Weber fraction from the experiment were comparable to that of the psychophysical parameters in the literature. Currently, this study simulates the haptic illusion for 1 DOF, however, it can be extended to 6 DOF.

SYSTEM ANALYSIS

Existing System:

A Real-Time Hand Gesture Recognition System Using Motion History Image" based on adaptive skin color model & motion history image (MHI). In their work they used an adaptive skin color model and a motion history image-based hand moving direction detection method. The prime limitation of the paper is a problem with working for more complicated hand gestures recognition.

A Human-Machine Interaction Technique: Hand Gesture Recognition Based on Hidden Markov Models with Trajectory of Hand Motion"that is basically learning based interaction between human & machine. Their work is very accurate but it worked only in high configuration computers.

Real Time Static and Dynamic Hand Gesture Recognition" in which design, develop and study a practical gesture recognition that can be used in a variety of human-computer interaction applications framework for real-time. But it was unable to work at a complex background and was computable only under good light.

Mouse Control using a Web Camera based on Color Detection" titled paper where the methodology is Hand gestures were acquired using a camera based on color detection technique. The limitations of their work are the operating background has to be light and no bright coloured objects are present. It works well on certain computers of high configuration.

novel finger and hand pose estimation technique for real-time hand gesture recognition" based on directly extract fingers from salient hand edges. Considering the hand geometrical characteristics, the hand posture is segmented and described based on the finger positions, palm centre location and wrist position. But this method is only compatible with high configuration computer machines.

Proposed System:

Using the current system even-though there are a number of quick access methods available for the hand and mouse gesture for the laptops, using our project we could make use of the laptop or web-cam and by recognizing the hand gesture we could control mouse and perform basic operations like mouse pointer controlling, select and deselect using left click, and a quick access feature for file transfer between the systems connected via network LAN cable.

The project done is a "Zero Cost" hand recognition system for laptops, which uses simple algorithms to determine the hand, hand movements and by assigning an action for each movement. But we have mainly concentrated on the mouse pointing and clicking actions along with an action for the file transfer between connected systems by hand action and the movements. The system we are implementing which is been written in python code be much more responsive and is easily implemented since python is a simple language and is platform independent with a flexibility and is portable which is desirable in creating a program which is focused in such an aim for creating a Virtual Mouse and Hand Recognition system. The system be much more extendable by defining actions for the hand movement for doing a specific action. It could be further modified to any further extent by implementing such actions for the set of hand gestures, the scope is restricted by your imagination.

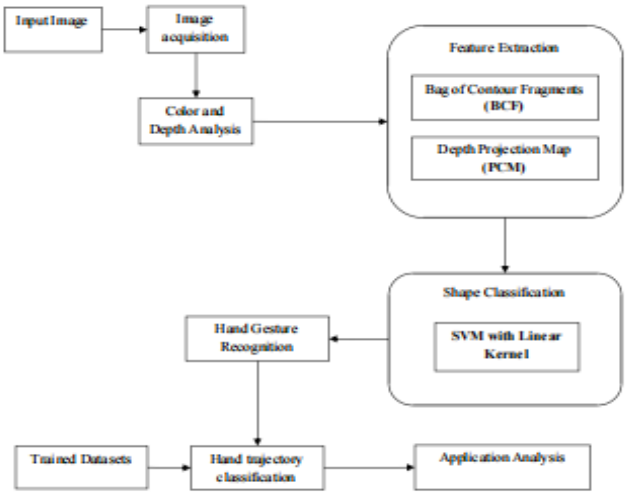


Image Acquisition

1.Camera:The runtime operations are managed by the webcam of the connected laptop or desktop. To capture a video, we need to create a Video Capture object. Its argument can be either the device index or the name of a video file. Device index is just the number to specify which camera.Since we only use a single camera we pass it as '0'.

We can add additional camera to the system and pass it as 1,2 and so on. After that, you can capture frame-by-frame. But at the end, don't forget to release the capture. We could also apply color detection techniques to any image by doing simple modifications in the code.

2.Capturing:The infinite loop is used so that the web camera captures the frames in every instance and is open during the entire course of the program. We capture the live feed stream, frame by frame. Then we process each captured frame which is in RGB (default) color space to HSV color space. There are more than 150 color-space conversion methods available in OpenCV. But we will look into only two which are most widely used ones, BGR to Gray and BGR to HSV.

3.Flipping of images:When the camera captures an image, it is inverted. Thismeans that if we move the color pointer towards the left, theimage of the pointer moves towards the right and vice-versa.It's similar to an image obtained when we stand in front of amirror (Left is detected as right and right is detected as left).To avoid this problem, we need to vertically flip the image.The image captured is an RGB image and flipping actionscannot be directly performed on it. So the individual colorchannels of the image are separated and then they are flippedindividually. After flipping the red, blue and green coloredchannels individually, they are concatenated and a flippedRGB image is obtained.

4.Conversion of Flipped Image into Gray scale Image:

As compared to a colored image, computational complexity isreduced in a gray scale image. Thus, the flipped image isconverted into a gray scale image. All the necessaryoperations were performed after converting the image intogray scale.

Color Detection:This is the most important step in the whole process. The red,green and blue color object is detected by subtracting theflipped color suppressed channel from the flipped Gray-ScaleImage. This creates an image which contains the detectedobject as a patch of grey surrounded by black space.

Conversion of gray scale Image into Binary scaleImage:The grey region of the image obtained after subtraction needsto be converted to a binary image for finding the region of thedetected object. A grayscale image consists of a matrixcontaining the values of each pixel. The pixel values laybetween the ranges 0 to 255 where 0 represents pure blackand 255 represents pure white color.

5.Foreground Segmentation:

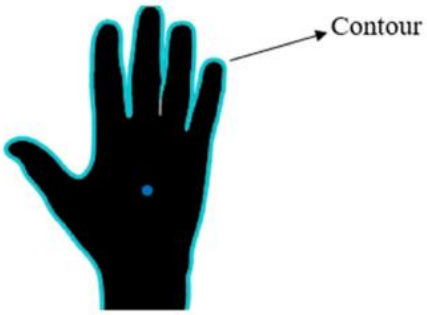
BLOB Analysis: Blob Analysis is a fundamentaltechnique of machine vision based on analysis ofconsistent image regions. As such it is a tool of choice forapplications in which the objects being inspected areclearly discernible from the background.

HSV Model: SKIN COLOR DETECTION HSL standsfor hue, saturation, and lightness, and is often also calledHLS. HSV stands for hue, saturation, and value, and isalso often called HSB (B for brightness). A third model,common in computer vision applications, is HSI, for hue,saturation, and intensity.

Detecting Background: After giving the feedfrom camera. 1st thing to do is to remove the background.We use running average over a sequence of images to getthe average image which will be the background too.

BackgroundSubtraction: Backgroundsubtraction involves calculating a reference image,subtracting each new frame from this image andthresholding the result which results is a binarysegmentation of the image which highlights regions ofnon-stationary objects.

Contour Extraction: Contour extraction isperformed using Open CV"s inbuilt edge extractionfunction. It uses a canny filter. You can tweak parametersto get better edge detection.



Convex Hull and Defects: Convex hull pointsare most likely to be on the fingers as they are theextremities and hence this fact can be used to detect no offingers. We are finding the deepest point of deviation onthe contour.

6.Fingertip Detection:After extracting the hand contour, the K-cosine Corner Detection algorithm computes thefingertip points using the coordinates of the detected hand contour. This is a well-knownalgorithm used for detecting the shapes of certain objects and also in fingertip detection.

contour points of Pi. ai denotes the angle between ai (K) and bi (K) for a given pixel Pi. The angle ais defined as a threshold value to distinguish the fingertips and the finger valleys. Forthis project, the final k is set to 20, and angle a is set to 45 degrees, which are suitable formost situations.

From the cosine values of ai, obtained by the K-cosine algorithm, if the point value of ai issmaller or equal to the threshold value, it is defined as the fingertip. The number of fingertipsdetected is the number of fingers. To real-time

fingertip tracking, the detection of frame-byframe is used for tracking.

A. Mouse Movements:At first, calculation of the center of two detected color objects which is done by the coordinates of the center of the detected rectangle. To create a line between two coordinates, the built-in OpenCV function is used and to detect midpoint equation given below is used:
This midpoint is the tracker for the mouse pointer and the mouse pointer will track this midpoint. In this system, the coordinates from camera captured frames resolution is converted to screen resolution. A predefined location for the mouse is set, so that when the mouse pointer reaches that position, the mouse started to work and this may be called open gesture. This allows the user to control the mouse pointer.

B. **Mouse Clicking:**The proposed system uses close gestures for clicking events. When the rectangle bounding boxes come closer to another rectangle, bounding box is created with the edge of the tracking bounding boxes. When the newly created bounding box becomes 20% of its creation time size then the system performs left button click and it can be clicked. By holding this position more than 5 seconds, the user can perform a Double click. And for the right button click again the open gesture is used. To perform the right button, click, the single finger is good enough. The system will detect one fingertip color cap then it performs a right button click.

C. **Mouse Scrolling**:To scroll with this system, user needs to use the open gesture movement with three fingers with color caps. If the users use their three fingers together & changes its position to downwards, it will perform scrolling down. Similarly, if itsposition is changed to upwards, it will perform scrolling up. When three fingers move up or down the color caps gets a new position and new coordinates. By the time all three-color caps get new coordinates, it performs scrolls. If their y coordinate values decrease, it will perform scrolling down and if the values increase, it will perform scrolling up.

Virtual-mouse performance analysis

In this experiment, ten subjects made various rapid gestures to evaluate the detection accuracy.The dataset was recorded with various size of monitor resolution to prove that our model ismore compatible with real application, instead of using a fit resolution as presented in [1, 17,19, 25, 31]. There are four computer resolutions as follows: 1280 × 1024 with 200 cases,followed by 1600 × 1200 100 cases, 1680 × 1050 200 cases and finally 1900 × 1200 100 cases.We assume that X is the number of fingertips shown on the right hand. Each single-personperforms gestures with normal light condition. Each gesture from 1 to 5—mouse movement(X = 1), left-click (X = 2), right-click (X = 3 || X = 4), and no action (X = 5 || X = 0)—wasperformed ten times by the ten participants, resulting in 600 gestures, with manually labeledground truth. All participants were right-handed, since we focused on right-hand movement forsimplicity and accurate detection.

SYSTEM TESTING

1.Unit Testing:Unit testing is a software testing method by which individual units of source code are put under various tests to determine whether they are fit for use (Source). It determines and ascertains the quality of your code.Generally, when the development process is complete, the developer codes criteria, or the results that are known to be potentially practical and useful, into the test script to verify a particular unit's correctness. During test case execution, various frameworks log tests that fail any criterion and report them in a summary.

2 .Integration Testing: Integration testing exercises two or more parts of an application at once, including the interactions between the parts, to determine if they function as intended. This type of testing identifies defects in the interfaces between disparate parts of a codebase as they invoke each other and pass data between themselves.

3.Module testing:Module testing is defined as a software testing type, which checks individual subprograms, subroutines, classes, or procedures in a program. Instead of testing whole software program at once, module testing recommends testing the smaller building blocks of the program.
Module testing is largely a white box oriented. The objective of doing Module, testing is not to demonstrate proper functioning of the module but to demonstrate the presence of an error in the module.

CONCLUSION

This project presented a new virtual-mouse method using RGB-D images and fingertip detection. The user's fingertip movement interacted with the computer in front of a camera with nomouse device, gloves, or markers. The approach demonstrated not only highly accurate gestureestimates, but also practical applications.The proposed method overcomes the limitations of most current virtual-mouse systems. Ithas many advantages, e.g., working well in changing light levels or with complex backgrounds, accurate fingertip tracking at a longer distance, and fingertip tracking of multiplepeople. The experimental results indicated that this approach is a promising technique forfingertip-gesture-based interfaces in real time.

FUTURE ENHACEMENT

This projecct still suffers from several limitations that are mainly inherited from MicrosoftKinect. Therefore, our next work aims to overcome those limitations and improve the fingertiptracking algorithm. We also intend to expand our system to handle more gestures and interactwith other smart environments. Finally, it is possible to enrich skeletal tracking by usingmachine learning algorithms such as OpenPose-based multi-person 2D pose detection,including body, hand, and facial keypoints.

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