Computer Vision
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Project Report:

Computer Vision based mouse using color and motion detection

Submitted by: Group 2

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Table of Content

1. Introduction

The Computer Vision-Based Mouse is a technology that allows us to monitor our computer's cursor without the use of any physical device, including a mouse. To monitor mouse movement, left-click, and right-click, our project primarily relies on image processing, object detection, and marker motion tracking. We'll basically be holding a coloured object in our hands. Our palm's motion has been captured on the camera which acts as a sensor. The coloured objects are tracked, and the mouse cursor is influenced by their movement. In our work, we used three different colours to represent three different mouse behaviours.;

1. **Red** color for **mouse cursor movement**
2. **Green** color for **left click**

3. **Blue** color for **right-click**

To make it work, we'll simply use the appropriate colours inside the camera's viewing area. Colored items should be put in the Region Of Interest (ROI). The computer cursor moves or shows its click events according to colour movements, and the video produced by the camera is detected and analysed using image processing. Python GUI - PyAutoGUI is used for Mouse handling activities.

2. Motivation

We chose this project because we wanted to learn more about how people communicate with consumer electronics. This elevates the user experience to new heights. The use of gesture control technology would reduce our reliance on outdated peripheral devices, lowering the system's overall complexity. Initially, this technology was thought to be useful in the gaming industry. Initially, this technology was considered for use in the field of gaming (virtual reality gaming), but the application of gesture control technology to other electronics such as computers, televisions, and other devices for everyday tasks such as scrolling, picking, and clicking will be more diverse.

Just using simple input devices like the mouse and keyboard limits the user's imagination and capabilities. We want to increase the number of ways people can communicate with their computers. We want to make it easier for everyone to communicate more naturally by allowing them to control tasks with simple hand movements. Hand movements can be recognised in real time, allowing for rapid human-computer interaction. A computer vision-based gui can use hand movements to guide the cursor. In contrast to a conventional mouse, video-based hand tracking and gesture recognition is a powerful tool since it can offer a more intuitive interface to the computer.

This project is an application of the concepts described above, and it may be beneficial to bedridden patients or handicapped individuals with reduced range of motion who are unable to get out of bed and sit at a desk for an extended period of time in order to operate a device. Individuals could now conveniently operate a PC's interface using a simple motion and gesture captured by a video capture system connected to a computer from any place in their home by using the software. Many who have trouble using traditional input devices will benefit from this form of human-computer interaction.

Our main goal in doing this project was to take the results of it and transform them into a physical system inspired by Leap Motion. It's a hand motion recognition system that can be used to manipulate a machine remotely. In a nutshell, it creates a virtual screen that allows us to communicate with the machine. As a result, we chose to create an initial software implementation of the device in the form of a virtual mouse, with plans to expand to virtual gaming controllers and other fields in the future.

3. Work Done

3.1 Image processing

1. **Image Acquisition:** The web-cam detects an image (or a video frame) that is acquired as a digital representation of the visual characteristics of the physical world. The information needed to create an image is detected and captured using an image sensor or a webcam.

2. **Image Processing:** The signals in the acquired images are screened to eliminate any unwanted frequencies or noise. Images are padded and converted into a different space if necessary to prepare them for review.
3. **Image Analysis:** To obtain useful information from the processed image, it is analysed. Many important image properties are involved in this process, including pattern recognition, colour recognition, object recognition, feature extraction, motion detection, and image segmentation.
4. **Decision Making:** High-dimensional data derived from all of the preceding steps is used to generate useful numerical data, which contributes to decision-making.

3.2 Video Capture

1. **Capture video:** The coloured object that is shown to the webcamera is the input. The video frame is read by the camera. The webcam serves as a tracker, assisting in the detection and monitoring of the target.

2. **Read Frame from the video:** The function ,cam.read(), reads frames from video, where cam is the output of the captured video. The picture that we get is inverted after the frames are obtained by the OpenCV function. The feature allows you to easily flip the picture vertically. 2.flip cv (0).

3. **ROI Definition and Grid Generation:** We need to create a Region of Interest (ROI) and a grid after acquiring the image, applying image smoothing, and removing the noise. The grid will aid in the conversion of the marker's location to cursor movement. The ROI is where we'll do all of the mouse work and where our sensor will detect the marker. The ROI has been placed in the upper left corner of the screen. The grid is 3x3 inches in size, and the outline is red in colour.
   cv2.cvtColor(image, cv2.COLOR_BGR2HSV)

4. **Marker Identification :**
    a. Contours for colored object
    b. Contours with maximum Area
    c. Features of contour with maximum Area

5. **Marker Motion Tracker:** Once the markers in each frame are identified, the motion is tracked in different frames by locating the centroid of the markers in the Region of interest(ROI). We have made use of centroid location relative to the grid. Contour features are useful to find the contour around the markers on the palm. After getting the centroid of the marker, we got the location of the centroid in the grid that we have created. It can fall in any of the 9 regions.

3.3 Result and Evaluation

1. **Edge Detection:** The object's edge is detected using the canny edge detection algorithm, a very efficient edge detection algorithm.

2. **Object Tracking**: For the cursor movement, we chose red-colored pieces. The requisite HSV range for the red colour has been set.

3. **Mouse cursor movement and click-events:** We used PyAutoGUI to shift the cursor based on the position of the marker in the grid and to click is based on the colour of the object (green for left click, blue for right click). PyAutoGUI's mouse functions, like any other image, use the x and y coordinates of the pixels on the screen. As a result, the screen resolution, which defines how many pixels wide and tall our screen is, is an important parameter.

4. Application

The proposed machine design would fundamentally alter how people interact with computers. This project did away with the need for a mouse or some other physical device to monitor the cursor. The implementation of our proposed work using object detection, marker motion tracking, and PyAutoGUI was successful, and the movement of the mouse and click events was achieved with high precision. This resulted in improved Human-Computer Interaction (HCL). There are several benefits to the proposed work. Patients who are unable to control their limbs can benefit from this technology. They can use any coloured item that they have at their disposal. It can also be used in Augmented Reality and Computer Graphics.The main goal is to eliminate the use of any physical device and rely solely on the webcam that comes standard with the laptop. There are no extra expenses.

Other uses for the technology include:

- **Medical Applications –** Gesture-recognition robots may be used in hospitals or homes to detect and treat life-threatening conditions. With the help of touchless interfaces they can access information while maintaining total sterility.
- **Alternative computer interfaces –** By combining gesture recognition, speech recognition, facial recognition, lip movement recognition, and eye tracking, a perceptual user interface (PUI) can be developed, which is a totally new way to communicate with computers that will increase functionality and productivity by great strides.
- **Entertainment applications –** Most video games today are played either on game consoles, arcade units or PCs, and all require a combination of input devices. When immersed in realistic video games, gesture recognition provides a means of expressiveness. Some notable technologies, such as Microsoft Kinect, Sony PSP, and Nintendo DS and Wii, recognise gestures. Unfortunately, only dynamic movements like waving and fist-shaking have so far been recognised.
- **Automation systems –** Gesture recognition can be used in residences, workplaces, transportation equipment, and more to significantly improve usability

and minimise the resources required to build primary or secondary input systems such as remote controls, car entertainment systems with buttons, and similar.

- **An easier life for the disabled –** Gesture recognition technology can eliminate a lot of manual labor and make life much easier for those who aren't as fortunate. Being able to control home devices and appliances for people with physical handicaps and/or elderly users with impaired mobility would bring all lives on equal footing. It can be used as communication between deaf-mute people.
- **Exploring big data -** 3D interaction, rather than restricted conventional 2D approaches, is better for exploring huge complex data volumes and manipulating high-quality images by intuitive behaviour.

5. Conclusion

Hand gesture recognition systems attracted a great deal of attention during the last couple of years due to its manifold applications and therefore the ability to interact with machines efficiently through human computer interaction. In recent years tons of research has been conducted in gesture recognition. The goal of this project was to develop a Gesture recognition system.

The system has the potential of being a viable replacement for the computer mouse, however because of the constraints encountered, it cannot completely replace the computer mouse. The major constraint of the system is that it must be operated within a well lit room. This is exactly why the system cannot completely replace the computer mouse, as it is very common for computers to be used in outdoor environments with poor lighting conditions.

Further, we would want to work towards decreasing the response time of the software for cursor movement so that it can completely be used to replace the conventional mouse. We also look forward to designing a hardware implementation for the same

in order to improve accuracy and increase the functionality to various domains such as a gaming controller or as a general purpose computer controller.

5.1 Future Prospects

Hand Gesture Recognition is advancing at a breakneck pace for innovative goods and services, with major companies such as Microsoft, Samsung, and Sony developing technologies based on the hand gesture paradigm, which includes devices such as laptops, handheld devices, professional lighting, and LED lights. Entertainment, Artificial Intelligence, Education, and the Medical and Automation fields are among the verticals where Gesture technology is and will be evident. With further research and development in the field of gesture recognition, the use and adoption of this technology will become more cost efficient and less expensive.