

HCI Project Report:

Controlling Mouse Cursor Using Hand Gesture

Mohammed Ibrahim Shawon ,Md.Tahsinur Rahman, Mahreen Tabassum, Nusrat Jahan Ekra,

Part 1 - Understanding the Problem

Overview:

A virtual mouse is a type of computer software that allows a user to control a cursor on a computer screen in the same way that a physical mouse controls the cursor on a physical desktop computer. This can be useful for users who do not have access to a physical mouse, or for users who prefer using a virtual mouse over a physical one. A virtual mouse typically uses the keyboard, touchpad, or trackpad on a computer or mobile device to control the cursor, and they often have customizable settings and features to allow users to tailor their experience to their specific needs and preferences.

Characteristics of the users:

Some potential users of the virtual mouse may include individuals who do not have access to a physical mouse, such as those who are using a touchscreen device or a laptop without a built-in trackpad or touchpad. Other users may prefer using a virtual mouse over a physical one for reasons such as convenience, customization, or preference. Additionally, a virtual mouse can be useful for individuals with disabilities that make it difficult or impossible to use a physical mouse.

Existing system Analysis:

A physical mouse is a type of computer input device that allows users to control the cursor on a computer screen by moving the mouse across a flat surface. They typically have two buttons for left and right clicks, and a scroll wheel for scrolling through documents or web pages. A physical mouse is widely used because they are relatively inexpensive, easy to use, and widely available. One of the main strengths of a physical mouse is its simplicity and ease of use. They are intuitive to operate, and most users can quickly learn how to use them effectively. Physical mouse are also widely compatible with different types of computers and operating systems, and they typically do not require any special drivers or software to work. Additionally, a physical mouse is relatively durable and can withstand regular use without malfunctioning. However, the physical mouse also has some limitations and deficiencies. One of the main drawbacks of a physical mouse is that they require a flat surface to operate properly, which can be inconvenient in some settings. They can also be uncomfortable to use for extended periods of time, and they can cause hand and wrist strain if used improperly. Additionally, a physical mouse can be difficult or impossible to use for individuals with certain disabilities, such as those who have limited mobility or fine motor control. Overall, the physical mouse is a reliable and widely used input device, but they have some limitations and drawbacks that can be addressed by alternative technologies such as the virtual mouse.

Usability Criteria:

A virtual mouse can be used in many different settings and situations in daily life. For example, they can be used on personal computers, laptops, or tablets to control the cursor and perform tasks such as clicking, dragging, and scrolling. A virtual mouse can also be useful for individuals who do not have access to a physical mouse, such as those using a touchscreen device or a laptop without a built-in trackpad or touchpad. Additionally, a virtual mouse may be useful in settings such as schools or offices where multiple users need to share a single computer.

Part 2 - Design Alternatives

Project Description:

There are several requirements that may be difficult to realize with virtual mouse. One of the main challenges is achieving the same level of precision and accuracy as a physical mouse. Virtual mouse typically use a touchpad, trackpad, or keyboard to control the cursor, which can be less precise than moving a physical mouse across a flat surface. This can make it difficult to perform tasks that require precise cursor control, such as drawing, photo editing, or gaming. Another challenge with virtual mouse is providing a comfortable and ergonomic user experience. Physical mouse are designed to fit comfortably in the hand and allow for natural movement, whereas virtual mouse may require users to use their fingers or thumbs to control the cursor, which can be uncomfortable or fatiguing. Additionally, virtual mouse may not provide the same level of tactile feedback as physical mouse, which can make it difficult for users to determine when a click has been registered or how much force to use when scrolling. Finally, virtual mouse may not be as widely compatible with different types of computers and operating systems as physical mouse. Some virtual mouse may require special drivers or software to work, and they may not work with all types of computers or operating systems. This can make it difficult for users to use virtual mouse on different devices or in different settings.

Project Requirements:

There are several tradeoffs that designers and developers of the virtual mouse should consider before creating a virtual mouse. One of the main tradeoffs is between precision and ease of use. The virtual mouse that is highly precise may be more difficult to use and require more training or practice to master, whereas the virtual mouse that is easy to use may be less precise and may not be suitable for tasks that require high levels of precision. Another tradeoff to consider is compatibility and customization. The virtual mouse that is designed to be compatible with a wide range of computers and operating systems may have fewer customization options and may not be able to take advantage of the latest technologies, whereas a virtual mouse that is highly customizable may be less compatible and may only work with certain types of computers or operating systems. Finally, designers and developers of the virtual mouse should consider the tradeoff between cost and performance. The virtual mouse that is highly advanced and feature-rich may be more expensive and may not be affordable for all users, whereas a virtual mouse that is less expensive may have fewer features and may not provide the same level of performance.

Design Space:

The tasks that will be easiest to support with a virtual mouse are those that do not require high levels of precision or accuracy. For example, tasks such as browsing the internet, reading documents, or watching videos can be easily performed with a virtual mouse. The virtual mouse can also be effective for tasks that do not require frequent clicking or scrolling, such as typing or editing text. On the other hand, tasks that require high levels of precision or accuracy may be more difficult to perform with a virtual mouse. This can include tasks such as drawing, photo editing, or gaming, which may require precise cursor control and quick reactions. The virtual mouse may also be less effective for tasks that require frequent clicking or scrolling, such as working with large spreadsheets or long documents. Overall, the easiest tasks to support with a virtual mouse are those that do not require high levels of precision or frequent clicking and scrolling, whereas tasks that require these abilities may be more difficult to perform with a virtual mouse.

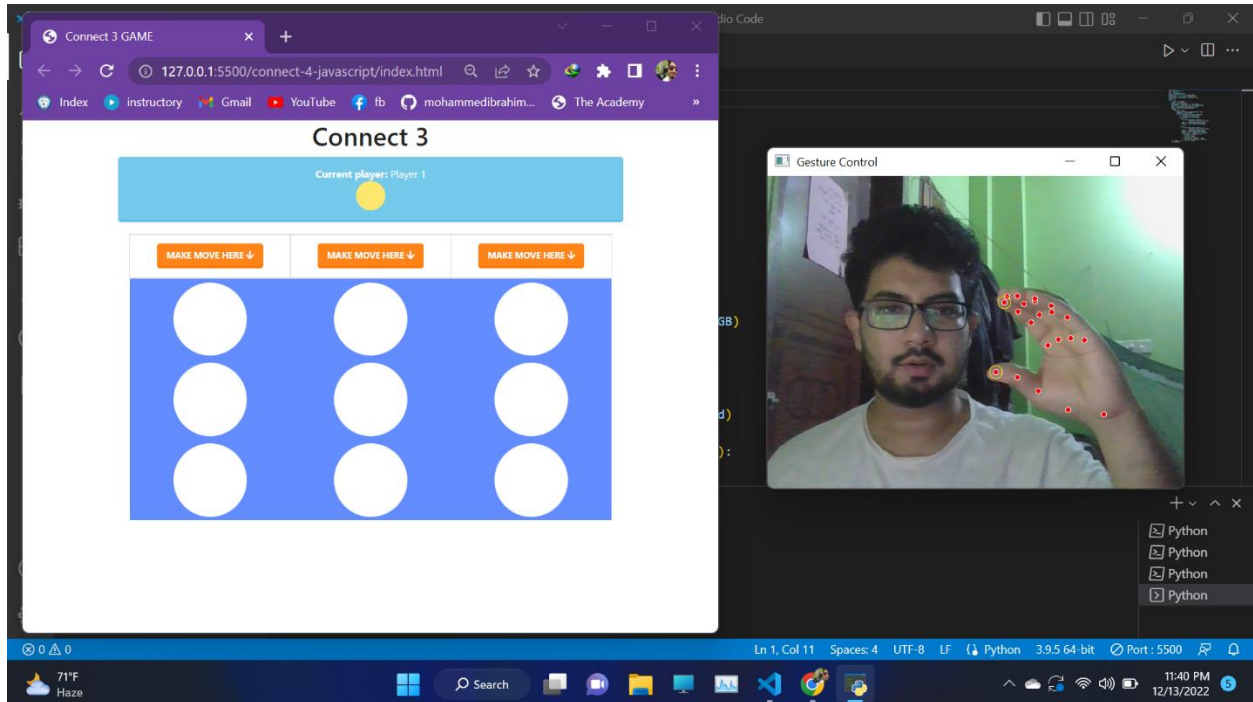
Part 3 - System Prototype and Evaluation Plan

Prototype Description:

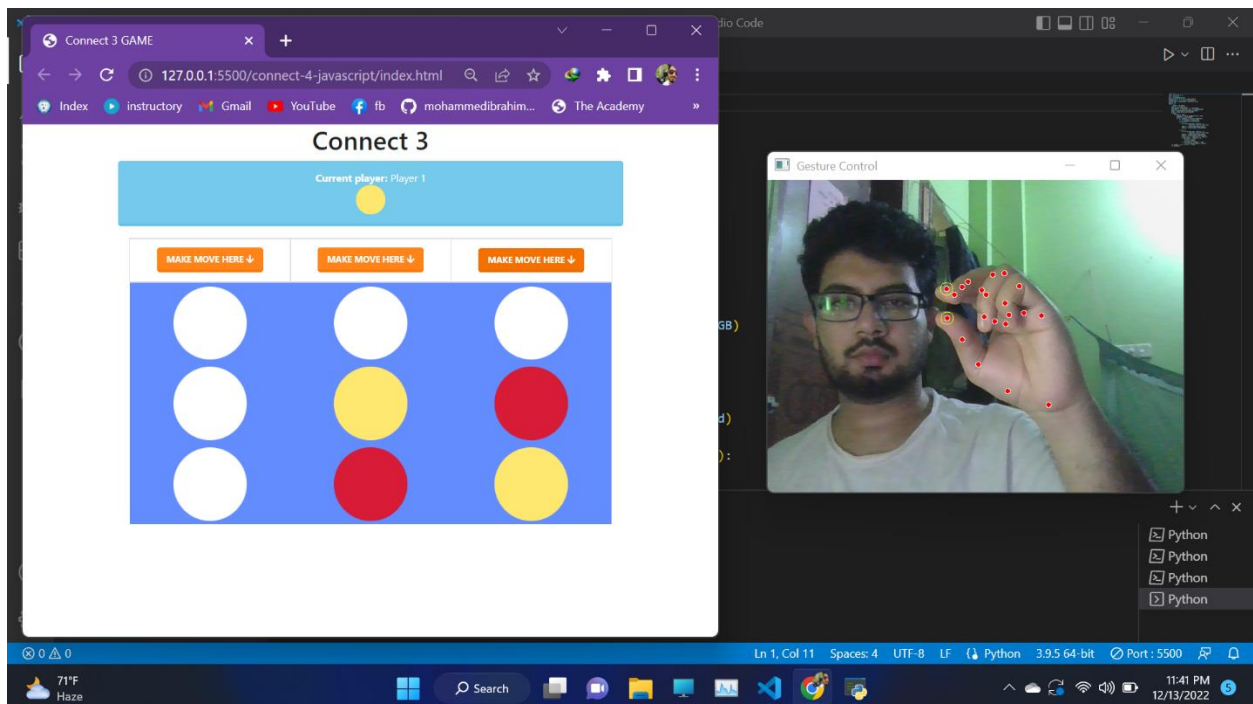
The focus of the system that we have designed is to control our screens without any direct contact with the mouse, touchpad, or keyboard. For that, we have built a prototype of the system where we have used our laptop camera to capture the motion. The system works in the following way:

1. Bring the hand in front of the camera so that it can detect the hand.

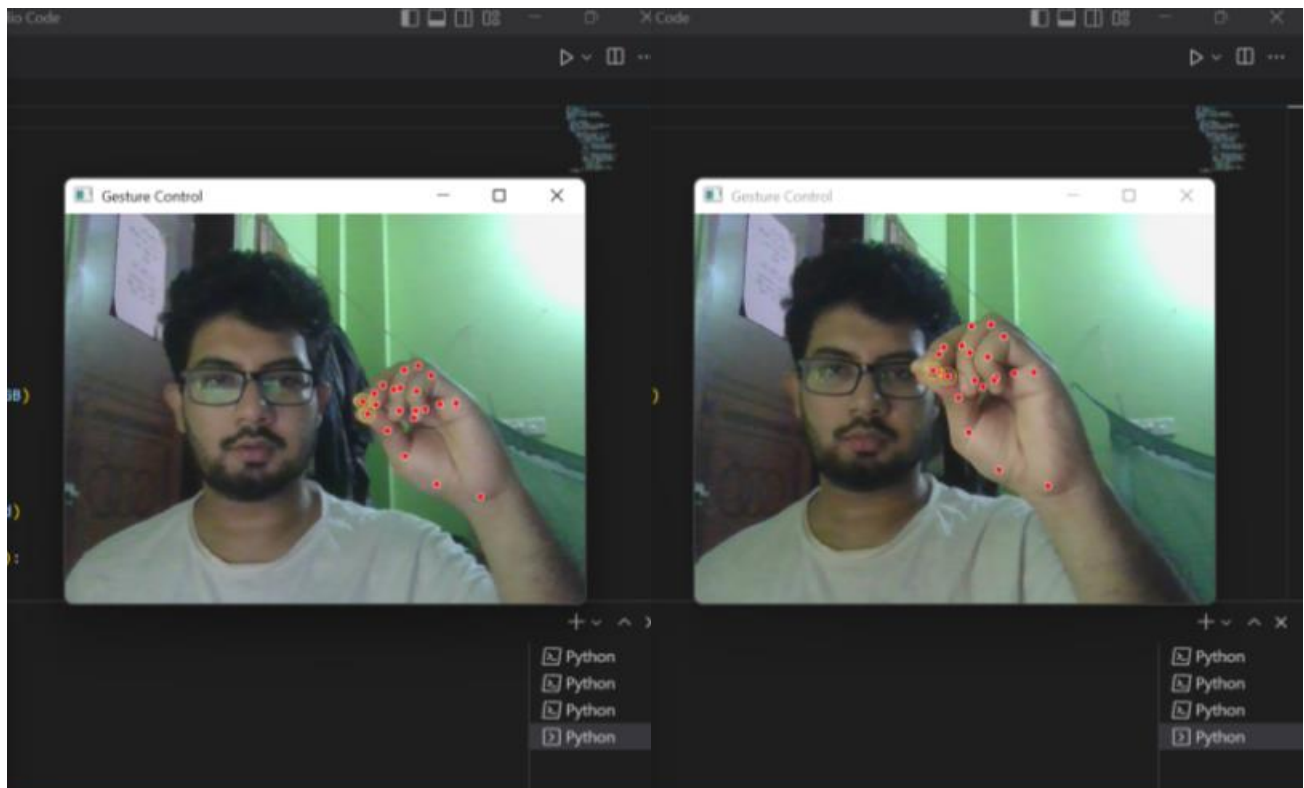
2. The camera is positioned in such a way that it recognizes the moment of fingertips and performs the operations of a mouse.
3. The camera detects hand gestures patterns instead of physical a mouse.
4. Once the hand is detected we must bring the thumb and the index finger very close.
5. The cursor will then be at our grasp.
6. Now if we move our hand then the cursor will also move.
7. To click we need to join our thumb and index finger.



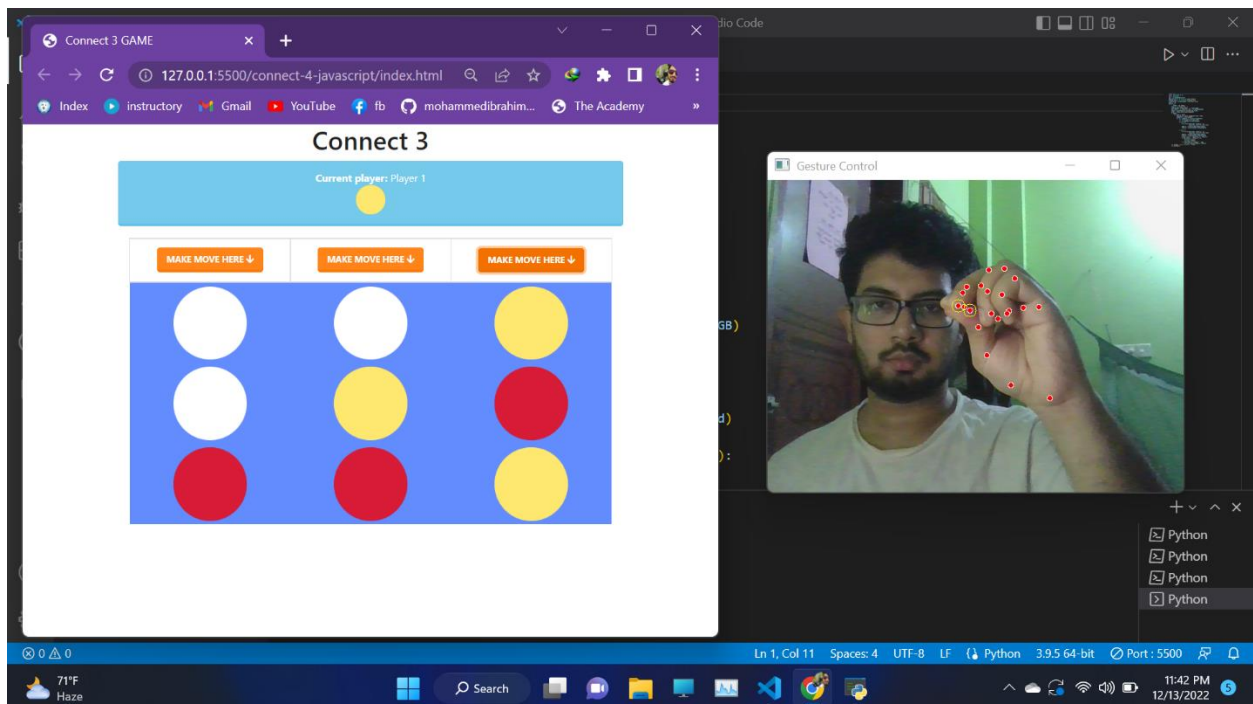
Here we can see that the system has detected the hand and the hand position is marked with red dots. The system is ready to be controlled by gesture.



Here we can see that we have to bring our thumb and index finger very close to each other in such a way as if we are holding the cursor with these two fingers.



If we move our fingers, then the cursor also moves. Moving the cursor becomes very easy with this system.



We can also click anywhere by joining the thumb and index finger. We just have to place the cursor in our desired position by moving our hand and then clip two fingers together.

User Perspective:

Here we will demonstrate a scenario where the user will play Connect-3 using our system.

The above snaps show that the user is playing Connect-3 using hand gestures. The steps are described below:

- Point the cursor over the row you want to place your piece
- Left click to drop your piece.
- To left click, snap your thumb and index finger together.
- To win the game the user can connect 3 pieces vertically, horizontally, or diagonally.

This system will help the user in interactive gaming. Users can have the full experience of any game with help of this system. Though a disadvantage of this is that people with no limbs cannot use this system. Although traditional mouse or touchpad also doesn't provide the facility to limbless people either, if further work is done on the system and the system is updated in such a way that it can understand the motion of the head then we can overcome the problem successfully.

This system requires a machine with high powered GPU and a camera with good resolution. But it is too expensive for us to have right now. So, we have developed this prototype based on a laptop and webcam. The prototype is slower than the original system as the resolution of the webcam is not very well, and the GPU takes a lot of time to process. But it is okay for a prototype as it is enough to explain the System.

Part 4 – Evaluation

Gesture Controlled Virtual Mouse makes human-computer interaction simple by making use of Hand Gestures and Voice Commands. The computer requires almost no direct contact. All i/o operations can be virtually controlled by using static and dynamic hand gestures along with a voice assistant. This project makes use of state-of-art Machine Learning and Computer Vision algorithms to recognize hand gestures and voice commands, which works smoothly without any additional hardware requirements. It leverages models such as CNN implemented by MediaPipe running on top of pybind11. It consists of two modules: One which works directly on hands by making use of MediaPipe Hand detection, and the other which makes use of Gloves of any uniform color. Currently, it works on the Windows platform. We have evaluated the system based on the following features:

Hand detection: After testing, we have seen that our system can detect hands successfully almost every time.

Gesture and Click Recognition: Gesture and click recognition can be a bit lengthy but it works perfectly.

Conclusion:

A new technique has been proposed to increase the adaptability and response time of the system. We have developed a system to control the mouse cursor and implement its function using a real time camera. Implementation of all the mouse tasks such as left and right clicking, and scrolling up & down, starting the applications using the gestures like notepad, paint, command prompt etc. This system is developed in such a way that the user, new to the system will just have to install the set up and not run the whole project. In this system, an object tracking based virtual mouse application has been developed and implemented using a webcam.

Reference:

- <https://www.sciencedirect.com/science/article/pii/S2351978918304438>
- <https://www.sciencedirect.com/science/article/pii/S2212017316001389>
- Bankar RT, Salankar SS. Head gesture recognition system using gesture cam. Fifth International Conference on Communication Systems and Network Technologies, Gwalior, MP, India, 2015, p.535-538.