IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 11, Issue 12, December 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 11, Issue 12, December 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1112025 |

Gesture Based Human-Computer Interaction Applications

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ABSTRACT: Interaction with computers is one of the major challenges faced by older and disabled persons in today's digitised society. In recent years, hand gesture recognition has become one of the most natural human machine interfaces in software development, particularly when it comes to encouraging flexible and friendly interactions between humans and computers. It's possible to apply it in a number of areas, like Sign Language and Human Computer Interface (HCI). Using the fundamental concepts of finger segmentation and hand detection, you can build a gesture recognition system in different platforms. The main goal of the developed gesture based systems are recognize individual humans gestures, and take them into account for regulating functions of devices but lacks accuracy.

KEYWORDS: Human-computer interaction, hand gesture recognition.

I. INTRODUCTION

Gesture-based applications refer to software programs or interfaces that allow users to interact with devices or systems using physical movements or gestures instead of traditional input methods like keyboards or mice. These applications leverage the capabilities of sensors such as cameras, accelerometer, and depth sensors to interpret and respond to specific gestures made by users. This form of interaction can be found in various types of devices, including smartphones, tablets, computers, and even specialized hardware like motion-sensing gaming consoles. It aims to make human-computer interaction more intuitive and natural. Users can control and navigate through the application by making gestures similar to real-world actions. These applications rely on sensors such as cameras or depth sensors to capture and interpret gestures. Advanced algorithms are used for gesture recognition, allowing the system to identify specific movements and associate them with predefined actions.Gesture-based interfaces enhance the overall user experience by providing a more immersive and engaging interaction. This is particularly evident in applications related to gaming, virtual reality, augmented reality, and touch-less controls.

With the development technologies in the areas of augmented reality and devices that we use in our daily life, these devices are becoming compact in the form of Bluetooth or wireless technologies. Hand gestures are the most efficient means of communicating with a human computer interface, HCI. Only a few of the input devices you can use to communicate with your computer, such as keyboards, mouses and joysticks, provide an easier means of communication. One of the most important problems for computer vision is that it must recognize hand gestures. Given the variability of position, orientation, location and size, it may be difficult to identify an arm. It's the identification of

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the hand that's the first thing. In addition, a video camera is used to recognize the user's hand when viewed in real time. However, it may be possible to experience difficulty in brightness, noise, resolution and contrast during this capture. In recent years, rapid advancements in human-computer interaction have sparked a growing interest in gesture-based control systems. Many reasearchers has developed various methods to control the mouse functions but all of them had one or another limitations in the means of accuracy, position etc. The challenging part in these systems is background images or videos which is recorded or captured during taking the inputs i.e. hand gesture by the user, also sometime lightning effect the quality of the input taken which creates the problem in recognizing the gestures.

II. LITERATURE REVIEW

There are some related works carried out on virtual hand gesture detection by using different techniques, but they are not much accurate in performing functions. The low accuracy is because of the use of gloves for detection, and in some cases, the recognition is not so accurate because of the failure of detection of color tips. Some efforts have been made for camera-based detection of the hand gesture interface.

In 1990, Quam introduced an early hardware-based system; in this system, the user should wear a DataGlove. The proposed system by Quam although gives results of higher accuracy, but it is difficult to perform some of the gesture controls using the system[1]. Dung-Hua Liou, ChenChiung Hsieh, and David Lee in 2010 proposed a study on "A Real-Time Hand Gesture Recognition System Using Motion History Image." the main limitation of this model is more complicated hand gestures. Its main drawback is the difficulty of handling more complex hand gestures[2]. Monika B. Gandhi, Sneha U. Dudhane, and Ashwini M. Patil in 2013 proposed a study on "Cursor Control System Using Hand Gesture Recognition." In this work, the limitation is stored frames are needed to be processed for hand segmentation and skin pixel detection[3].

In 2013, Angel, Neethu. P.S proposed a paper named "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 [4]. In 2014, Abhik Banerjee & Abhirup Ghosh proposed "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 colored objects are present. It works well on certain computers of high configuration [5].Vinay Kr. Pasi, Saurabh Singh, and Pooja Kumari in 2016 proposed "Cursor Control using Hand Gestures" in the IJCA Journal. The system proposes the different bands to perform different functions of the mouse. The limitation is it depends on various colors to perform mouse functions[6].

In 2016, Yimin Zhou, Guolai Jiang & Yaorong Lin published "A 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 center location and wrist position. But this method is only compatible with high configuration computer machines [7]. A. Haria, A. Subramanian, N. Asokkumar, S. Poddar, and J. S. Nayak proposed a robust marker- less hand gesture recognition system which can efficiently track both static and dynamic hand gestures. Our system translates the detected gesture into actions such as opening websites and launching applications like VLC Player and PowerPoint[8]. Chaithanya C, Lisho Thomas, Naveen Wilson, and Abhilash SS in 2018 proposed "Virtual Mouse Using Hand Gesture" where the model detection is based on colors. But, only few mouse functions are performed[9].

H. Shibly, S. Kumar Dey, M. A. Islam, and S. Iftekhar Showrav in 2019 proposed the technique a virtual mouse system based on HCI using computer vision and hand gestures. Gestures captured with a built-in camera or webcam and processed with color segmentation & detection technique. The user will be allowed to control some of the computer cursor functions with their hands which bear colored caps on fingertips. Primarily, a user can perform left clicks, right clicks, and double clicks, scrolling up or down using their hand in different gestures [10]. In order to implement the relative virtual mouse, the proposed technique detects relative movements of a user's head within an image and converts them into relative movements of the mouse. This algorithm uses a hand gesture recognition system along with inputs from a webcam to identify motion in images. This can easily replace the traditional mouse system that has been in use for decades[11]. Reddy et al. proposed a virtual mouse control using finger tip identification and hand gesture recognition. This study consists of two methods for tracking the fingers, one is by using colored caps and other is by hand gesture detection. This includes three main steps that are finger detection using color identification,

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hand gesture tracking and implementation on on-screen cursor. In this study, hand gesture tracking is generated through the detection of the contour and formation of a convex hull around it. Features of hands are extracted with the area ratio of contour and hull formed. Detailed tests are performed to check this algorithm in real world scenarios [12].

D.-S. Tran, N.-H. Ho, H.-J Yang, S.-H. Kim, and G. S. Lee proposed a novel virtual-mouse method using RGB-D images and fingertip detection. The hand region of interest and the center of the palm are first extracted using in-depth skeleton-joint information images from a Microsoft Kinect Sensor version 2, and then converted into a binary image[13]. Shir Ley Chooi created a model that can identify and determine the handwritten character from the EMNIST by applying machine learning technique for handwritten character recognition[14]. Based on the detected human hand, the proposed system moves the pointer in the direction of the hand to control the mouse pointer. Controlling simple mouse functions such as left-clicking, Using a real-time digital camera, cursor motion can be managed, instead of pressing buttons manually or converting mouse positions on a physical computer [15].

III. BACKGROUND KNOWLEDGE

A. COMPUTER VISION

Gesture recognition uses computer vision techniques to analyze and interpret hand movements. This can be done through techniques such as image segmentation, feature extraction, and pattern recognition. Depth sensing technology such as the Microsoft Kinect or depth sensing camera can be used to capture handheld 3D information. This additional in-depth information helps identify accurate gestures.

B. SENSOR TECHNOLOGY

Infrared sensors can be used to detect the presence and movement of hands. These sensors are especially useful in low-light situations. High quality cameras such as RGB cameras or depth cameras are also used to capture hand movements. RGB cameras capture color information, while depth-enhancement cameras provide additional color information.

C. FEATURE EXTRACTION

Identifying points on the hand, such as the tips of the fingers or the middle of the fingers, is important for identifying gestures. OpenPose is an example of a library that can be used to display points. Motion analysis can help to understand hand-driven dynamics including speed and direction.

D. MACHINE LEARNING

Machine Learning is a branch of Artificial Intelligence that empowers computers to learn and improve performance without explicit programming. It revolves around creating algorithms that enable systems to recognize patterns and make predictions based on data. It has applications across various industries including healthcare,finance, marketing and more. For gesture recognition ML is an important aspect to train machine learning models such as a neural network, using the extracted features and gesture data. Machine learning models for gesture recognition should be trained on data with various gesture patterns using voice and light manipulations This data should be modified to account for different lighting conditions, hand size and orientations is accountable for the work. TensorFlow and PyTorch are popular libraries for implementing such models using machine learning models to accurately classify gestures.

E. CONVOLUTIONAL NEURAL NETWORK (CNN)

It is a type of deep neural network specifically designed to process structured web data, such as images and videos. CNNs have proven to be highly effective in various computer vision tasks such as image segmentation, object recognition and face recognition. Their characteristic is the ability to automatically and adaptively learn features of spatial structure from input data. CNNs have played an important role in improving computer vision tasks and have become the standard framework for many image-related processing systems.

F. IMAGE PROCESSING TECHNIQUE

Image processing refers to the process of manipulating and analyzing visual information in images to extract useful information or enhance features. It uses a variety of techniques and procedures to enhance the quality of digital images, extract information, or prepare them for further analysis. Image processing is an important part of computer vision, pattern recognition, and applications in a variety of industries. Hand gesture recognition often involves a series of image processing techniques such as image acquisition, color space conversion, segmentation and many more to extract relevant information from images or video frames

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IV. DISCUSSIONS

In the implemetation of hand gesture recognition systems for funtion control and alphabet recogniton, various techniques were used and all of them had one or another deficiency. The techniques used as of now and its limitations found after the study are as follows:

METHODS	DEFICIENCY
Color detection technique	The major limitations of this technique were, the background has to be light for detection, it has to depend on various colors to perform functions, only few of the functions were performed, lacks efficiency in complex and rough background, and low accuracy.
Computer vision technique	Stored frames has to be processed for image processing techniques, only limited features could be performed.
Machine learning technique	Low accuracy

V. CONCLUSION

In conclusion, various implements were done to detect the hand gestures to control various mouse operations with different accuracies and positions. Most of them lacked accuracy and worked only under specific lighting criterias. But our project aims at developing a system to control the volume and brightness of a device as well as a system to recognize the alphabets with a much better accuracy in detection. These doesn't require any specific gloves or color bands and can be operated in our real life on personal computers with a very low cost camera to detect the hand gestures. As technology continues to advance, the widespread adoption of gesture based interfaces holds promise for shaping more natural and interactive interactions between humans and computers.

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ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

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