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HAND MOTION BASED COMPUTER ACTIVITY CONTROL

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Abstract: Human-computer communication (HCI) has been one of the major advancements in the development of technology as a new means of communication between humans and computers in today's world. Several new interactive methods, such as Sign and speech recognition, visual analysis, virtual reality, touch-free writing, brain activity have come out in recent years to achieve this goal. We need an alternative means to control computers and the technology needs to be robust so that it can be scaled on bigger boundaries. So, the proposed algorithm develops an alternative input means which can be useful in real time applications to control the daily computer activities like controlling media player, web browser, file manager, PowerPoint presentations and also for playing games through different gesture commands using a simple web camera. The main aim is to study and analyze the use of gesture recognition techniques for embedded systems by proposing a new model based on neural networks such as 2D and 3D CNNs able to perform gesture control using a simple web camera without any additional expensive hardware.

Index Terms **- Alternative input, computer control, neural network gesture control; computer vision.**

I. INTRODUCTION

The basic aim of human computer interaction is to enhance the process of interaction between computer and the user. Hand gesture recognition system received massive attention in the recent few years because of its applications and the ability to interact with machines systematically through human computer interaction. Gesture is one of the most vivid and dramatic ways of communication between humans and computers. Hence, there has been an extended interest to produce easy-to-use interfaces by directly utilizing the natural communication and management skills of humans. Gesture-based interactions have evolved and science & technology have played a big role in furthering its development with the advancement of machine learning techniques and the increased accessibility to computing power, Artificial Neural Networks (ANNs) have achieved state-of-the-art results in image categorization and, most recently, in video categorizations. The probability of gesture recognition from a video source enables a more natural non-contact human-machine interaction, immersion when interacting in virtual reality environments. However, the methodology utilized in video classifications are usually computationally big-budget, being restraining to conventional hardware.
For the computer to first recognize the gesture it needs to identify the approach. Generally, there are two approaches for a computer to recognize gestures i.e., vision based and non-vision-based approach.

A) Non-Vision Based Approach:
The non-vision-based approach deals with techniques involving the use of additional devices, which should be detected by the user. Wearable equipment, positioned on the arms and/or hands of finger movement with a pair of wired gloves which sends signals to the computer regarding the exact position and movement of hand hands in air. Through devices capable of estimating position and movement, such as accelerometers and gyroscopes, infrared sensors, these devices can map the positioning of the user's and extract the information of its movement.

B) Vision Based Approach:
In general vision-based techniques are further more natural as they require no hand devices. Vision-based techniques, uses cameras, which captures the user's movement, without the need for it to be using additional equipment. This uses the more traditional way of capturing RGB frames images. Though this method is challenging as computation techniques and algorithms are required to separate the gesture from different complex backgrounds, the skin color and other things that appear in the image. Thus, Vision based techniques are considered less intrusive by the user, allowing for wider use.

Theoretically they can be also classified into two types of hand gestures i.e., static and dynamic gestures. Static hand gestures can be described as the gestures where the position and direction of the hand in free space does not alter for the required time. If there are any adjustments within the given time, the gestures are called dynamic gestures. Dynamic hand gestures include gestures like zooming in with two figures while static hand gestures comprise of showing the palm of the hand like "stop" sign. These goals can be achieved by proposing a new model which could handle complex computation tasks and can detect dynamic gestures easily by using simple web cameras to trigger basic computer applications such as playing a song, web browsing, giving presentations, playing games or for using different applications with ease of interactions.

II. LITERATURE REVIEW

Sarita K. (2020) [1] uses an approach that successfully trial the working of hand motion sensing system using sensors i.e., Ultrasonic sensors and finger contact sensors and implementing it to Arduino kits in wireless mode using radio frequency. This method presents one of the interpretations among various others, for operating a computer using hand motions. It is one of the simplest ways of interface between human beings and computers. It is a cost effective and resourceful model which is only based on Arduino UNO ARDUINO and python programming with wired ultrasonic sensor. In this technique ultrasonic sensors are used to sense hand motion gesture or of position of arm and conferring to situation action is accomplished on computer. It was observed that the performance of the system improved as the data set for training was improved. The python IDE allows a continuous incorporation with which it can be matched with most of the electronic devices, can be used for wide kinds of applications from medical care to leisure, exact sensing of various gestures etc.

Sung Ho C. (2021) [2] reviewed a number of the studies associated with Hand Gesture Recognition applications using radars. Presently, the researchers depend closely on commercially available radars made with the aid of using tech corporations such as Novelda and Texas Instrument. With those structures being on chips, interest has been shifted to develop the gesture detection and recognition algorithms. In current years, interest is transferring from signal-processing-based HGR algorithms to deep-learning-based algorithms. Although radar sensors provide numerous benefits over the other HGR sensors (i.e., wearable sensors and cameras), the adoption of radar-based HGR in our day by day lives are nonetheless lagging in the back of those competing technologies. This labeled the radars used for HGR as pulsed and continuous-wave radars, and both the hardware and the algorithmic information of every category is supplied in detail. Towards the end, advanced gadgets and applications based on gesture-recognition through radar are discussed.

Benjamin C. Bedregal (2006) [3] proposed a fuzzy rule-based technique for the popularity of hand gestures non inheritable from a knowledge glove, with associated application to the popularity of some sample hand gestures of LIBRAS, the Brazilian language. The strategy uses the set of angles of finger joints for the classification of hand configurations, and classifications of segments of hand gestures for recognizing gestures. The selection of gestures relies on the construction of monotonic gesture segments, sequences of hand configurations within which the variations of the angles of the finger joints have identical signs (non-increasing or non-decreasing). every gesture is characterised by its list of monotonic segments. The set of all lists of segments of a given set of gestures verify a group of finite automata, that area unit able to acknowledge each such gesture.

Abdelkader Bellbarbi (2014) [4] have explored the method of Recognition of hand gestures, and they have tried to present a method for the same based on the detection of colour markers. The main colours of the markers used are Red, Blue, Yellow and Green. These markers are attached on both the hands and then the various gestures are tried such as Zoom, Move, Draw and Write on Virtual Keyboard. This enforced system provides a lot of versatile, natural and intuitive interaction prospects, associated additionally offers an economic and sensible means of interaction.

Ayushi B. (2020) [5] presents a method based on determining distance by the sensor and therefore a particular function is executed. Some recognition means of the gestures are projected and then actions are recognized utilizing sensors. In order to control pc utilizing ultrasonic sensors, this technique named Leap motion is executed which facilitates us to control certain functions on our computer/Laptop by simply gesturing our hand in front of it. in view of this work, we will place two Ultrasonic sensors in addition to our monitor and will state the distance between the monitor and our hand utilizing Arduino, established this importance of distance we will execute certain actions. To complete actions on our computer we use the Python PyAutoGui library. The commands from Arduino are shipped to the computer through the sequential port. This data will be then read by python which is running on the computer and founded on the read data an operation will be performed. The incoming time-domain signals are buffered, and Fourier transform is used on them. The Arduino maybe connected to the PC/Laptop for powering the module and again for serial communication. The result concerning this operation is magnitude vectors that are spread equally over the spectral width. After each FFT vector is computed, it is further treated to decide the bandwidth of the signals, speed of gestures and motion discovery. The detected motions are then reformed to pc commands. This object presents one of the effortless approaches of interaction between human and computer. It is an economical model which is only founded on Arduino UNO and ultrasonic sensors. The python IDE acknowledges a coherent integration with Arduino UNO in order to obtain diverse processing and regulating methods for establishing new gesture control solutions.

Rytis M. (2021) [6] presents a featherweight model based on YOLO (You Only Look Once) v3 and DarkNet-53 convolutional neural networks for gesture recognition outside additional pre-processing, image refining, and augmentation of images. The proposed model achieved perfect precision even in a complicated situations, and it successfully recognized gestures even in low resolution picture mode. The projected model was assessed on a labelled dataset of aid gestures in both Pascal VOC and YOLO plan. They attained better results by eliciting features from the aid and recognized hand gestures of our proposed YOLOv3 based model accompanying accuracy, precision, recall. Further, the trained model can be used for real-time detection, both for changeless hand images and dynamic gestures written on a video. The developed hand gesture recognition system detects both real-time objects

and gestures from video frames accompanying an exactness of 97.68%. Despite the preciseness obtained there is still space for enhancement in the following model, as right now the model proposed detects motionless gestures. However, the model maybe enhanced for detecting multiple gestures and maybe enhanced by detecting in addition to one gesture at a opportunity. The proposed plan can be used for developing assisted living schemes, which are used for human–computer interaction both by athletic and impaired community. Additionally, we compared the efficiency and execution of the YOLOv3 model with various systems and our proposed method attained better results by extracting features from the hand and recognized hand gestures accompanying the preciseness, accuracy, recall, and F-1 score of 97.68, 94.88, 98.66, and 96.70%, respectively.

Min C. (2004) [7] provides a gesture recognition system for visualisation navigation. Scientists are inquisitive about growing interactive settings for exploring big data units in intuitive surroundings with input consisting of registered 3-d data. A geometric approach the use of Bezier curves is used for the trajectory evaluation and classification of gestures. The hand gesture speed is included into the algorithm to allow accurate recognition from trajectories with variations in hand pace. The method is strong and reliable: accurate hand identity rate is 99.9% (from 1641 frames), modes of hand movements are accurate 95.6% of the time, recognition rate (given the right mode) is 97.9%. An application to gesture-controlled visualization of 3-D bioinformatics data is likewise presented. Visual data exploration has tremendous abilities for revealing properties and abnormalities in large records units. This paper described a gesture recognition device for visualisation navigation. Scientists are interested in growing interactive settings for exploring big records units in intuitive surroundings. A geometric (rather than statistical) version is prompted by the nature of the utility (representation of visualization operations) and its requirements (robustness and simplicity). Since the method is geometry-based, the complete trajectory is recorded and may be used to apprehend gestures with the aid of using the hand pace. Variations withinside the hand speed inside a gesture as well as between gestures are normalized with the aid of using parameterizing the points alongside the trajectory to a Bezier curve description with respect to the hand speed at every frame. An application to gesture-controlled visualization of 3-D bioin-formatics data is likewise presented. Future work includes defining a bigger set of gestures based at the basic moves already analyzed, the use of gesture pace for type, and creating real hand models for detection of smaller, greater subtle gestures.

Anupam A (2011) [8] designs a system for gestural interplay between an end user and a computer in dynamic environment. The gesture recognition system makes use of image processing strategies for detection, segmentation, monitoring and popularity of hand gestures for changing it to a significant command. The interface being proposed right here may be substantially applied towards one-of-a-kind applications like photo browser, video games etc. A ubiquitous computing provides advanced dynamic environments in which people need to make diverse forms of interface for interaction with media and information with none bodily restrictions. a successful 3-d consumer interface must be natural, intuitive, effective sufficient and clean to analyse allowing customers to perform the necessitated tasks. The present contact-based devices like accelerometers, facts glove sensors/actuators and different input gadgets used to capture the consumer motion and manipulate the selection, manipulation and actions of objects in digital scenes. The use of those gadgets is hindered by quantity elements together with awkwardness, unintuitive, rigidity, and liable to distortion from the bodily environment. These gadgets have price that's prohibitive for his or her common use by the overall consumer. The number one goal of the existing device is to apply a natural tool free interface that acknowledges the hand gestures as commands. This paper develops a hand gesture recognition device for interacting with one-of-a-kind applications like image browser; video games etc. and presents a fruitful answer in the direction of a consumer-friendly interface among human and computer. The gesture vocabulary designed may be similarly prolonged for controlling one-of-a-kind programs like game control etc. As the device presents the flexibility to the users and especially physically challenged customers to define the gesture in line with their feasibility and simplicity of use.

Zhou R. (2013) [9] focuses on constructing a sturdy part-based hand gesture recognition machine using Kinect sensor. These days developed depth sensors, the Kinect sensor, have supplied new possibilities for human-pc interaction (HCI). Although excellent development has been made with the aid of leveraging the Kinect sensor, e.g., in human body tracking, face recognition and human motion recognition, robust hand gesture recognition remains an open problem. Compared to the entire human body, the hand is a smaller object with extra complex articulations and more easily affected by segmentation errors. It is for this reason a totally challenging problem to recognize hand gestures. To deal with the noisy hand shapes received from the Kinect sensor, on this paper, we provided a sturdy component-based hand gesture recognition machine the use of the Kinect sensor. It uses a novel distance metric, Finger-Earth Mover's Distance (FEMD) for dissimilarity measure, which represents the hand form as a signature with every finger component as a cluster and penalizes the empty finger-holes. Extensive experiments on a challenging 10-gesture dataset validate that our component-based hand gesture recognition system is correct and efficient. Taking each accuracy and performance into consideration, they use thresholding decomposition for finger detection in our actual time demo device. One predominant contribution of this paper is the gap metric based on component-primarily based totally representation. The proposed FEMD distance metric is based on a component-primarily based totally representation which represents a hand form as a signature with every finger component as a cluster. Such a illustration enables the computation on the global features, for this reason it's miles robust to nearby distortions. It shows that with hand gesture reputation technique we will mimic the communications among human, and contain hand gesture as a natural and intuitive manner to engage with machines. Consequently, we will benefit our everyday life in lots of aspects inclusive of providing aids for the listening to impaired, and keeping absolute sterility in fitness care environments using touchless interfaces through gestures.

Yanan X (2017) [10] in this paper, presents a method to obtain a series of features which are depended upon convex defect detection, Using the feature of close relationship of convex defect and fingertips. Hand gesture recognition objectives to pick out the that means that signer need to express based at the gestures made. With human hand as the enter tool of pc, the communication among human and system will not want special medium, however customers can certainly outline a series of suitable gestures to govern surrounding machines. Compared with different enter forms of human-pc interaction, hand gesture has better traits of natural, easy however with wealthy expression and direct. This approach is easy, efficient and free from gesture route and function. Due to the limitation of complex records gloves and function tracker needed, the hand gesture reputation gadget based on sensors in costly and hard to be popularized, whilst vision primarily based totally hand gesture recognition is easy and smooth to perform without

counting on complicated gadgets or interfaces, it's been turning into a tough interdisciplinary research and warm subject matter withinside the discipline of human-pc interaction. This paper brought a sequence of fingertip associated capabilities primarily based totally on convex illness detection, so that you can be defined in subsequent chapter. This paper focuses on the study of function extraction primarily based totally on convex illness for the recognition of static hand gesture. The proposed capabilities include the tightness of gesture contour to its convex hull, namely, convexity, and the relative role of fingertips.

Table 1. Literature review comparison

SR.NO	TITLE	AUTHORS	TECHNIQUES INVOLVED	ADVANTAGES	DISADVANTAGES
1	Hand Gesture Detection using Arduino and Python for screen control.	Sarita K. Gavale, Yogesh S. Jadhav	The Technique involves a hardware part consisting of Arduino Microcontroller, the ultrasonic sensors HC-SR04 and a pc, or device such as laptop, while the software used is Arduino IDE and Python 3.8.2 IDE with GUI module configured.	Not influenced by the colour or transparency of objects. Can be implemented in dark environments. Not particularly affected by dust, dirt, or high-moisture environments.	Low robustness as there are various markers on the body. Computational complexity and calibration difficulties. Unmanageable and cumbrous device with loads of cables. Band needs to be in contact with the human body for the operation to be possible.
2	Hand Gestures Recognition Using Radar Sensors for Human-Computer-Interaction: A Review.	Sung Ho Cho, Sarfaraz Ahmed, Karam Dad Kallu, Shahzad Ahmed	It involves use of Pulsed radar, such as Ultra-Wideband Impulse-Radar (UWB-IR), It starts by transmitting short duration pulses, whereas continuous-wave radar, like Frequency Modulated Continuous Wave (FMCW) radar, does the work of transmitting and receiving a continuous wave of data.	RADAR can penetrate mediums; the signals used by RADAR technology are not limited or hindered. can penetrate insulators. The signals start by penetrating the materials and capturing the necessary data required. Have the capability of measuring the velocity of an object in an action. Do not require a medium of transportation. Can target several objects simultaneously.	Operates in a contained and controlled environment. Line of sight is usually needed between hand and the sensors. At one location, recognition potential is often limited to a limited number of users and their hands.
3	Fuzzy Rule-Based Hand Gesture Recognition.	Benjamín C. Bedregal, Antônio C. R. Costa and Graçaliz P. Dimuro	A fuzzy rule-based method for the recognition of hand gestures acquired from a data glove, with an application to the recognition of some sample hand gestures of LIBRAS, the Brazilian Sign Language.	A strong system where no precise inputs are required. These systems are equipped to handle various types of inputs which include vague, distorted or imprecise data. In case the feedback sensor stops working, it can be reprogrammed according to the situation.	One of the main issues of the Fuzzy rule-based system is that rules need to be defined and expressed for detection and increasing the number of rules results in more computation. Also changes made in program function for gesture recognition can require changes in rules or it might affect the other parameters which gives multi parameter

					optimization problems.
4	Hand Gesture Interaction Using Colour-Based Method for Tabletop Interfaces.	Abdelkader BELLARBI, Samir BENBELKACEM, Nadia ZENATI-HENDA, Mahmoud BELHOCINE	This technique involves use of four types of coloured markers.	Convenient for image acquisition and displaying. Based on human colour perception. Robust before non-uniform illumination.	Variation of illumination conditions where any change in the lighting condition affects badly on the extracted colour. Background problem refers to the complex background where there are other objects in the scene with the glove because of this it would produce a misclassification problem.
5	Arduino Based Hand Gesture Control of Computer.	Ayushi Bhawal, Debaparna Dasgupta, Arka Ghosh, Koyena Mitra	The Technique involves a hardware part consisting of Arduino Microcontroller, the ultrasonic sensors HC-SR04 and a pc, or device such as laptop, while the software used is Arduino IDE and Python 3.8.2 IDLE with GUI module installed.	The result is not influenced by colour or transparency of objects. Can be used in dark environments. This technique is not easily influenced by factors such as dust, dirt, or high-moisture environments.	Low robustness as there are various markers on the body. Computational complexity and calibration difficulties. Unmanageable and cumbrous device with loads of cables. Band needs to be in contact with the human body for the operation to be possible.
6	Real-Time Hand Gesture Recognition Based on Deep Learning YOLOv3 Model.	Abdullah Mujahid, Mazhar Javed Awan, Awais Yasin, Mazin Abed Mohammed, Robertas Damaševicius, Rytis Maskeliunas, Karrar Hameed Abdulkareem	Technique comprises of YOLO (You Only Look Once) i.e., v3 and DarkNet-53 CNN model for the purpose of gesture recognition.	It has very high precision in a dark and complicated surrounding, and it can precisely detect gestures even in low-resolution picture mode.	Requires large amount of time for data processing and high computational capabilities are required for training the dataset.
7	Gesture recognition using Bezier curves for visualization. navigation from registered 3-D data.	Min C. Shin, Leonid V. Tsap, Dmitry B Goldgof	It uses a geometric method called Bezier curves for the trajectory analysis and classification of gestures. The hand gesture speed is recorded and passed into the algorithm to calculate correct gesture from trajectories of the given sample with variations in hand speed.	The method has high accuracy rate and has correct hand identification rate up to 95.6%. Tracks the overall body during detection so various other forms of gestures can be implemented.	Alterations due to minor movement or noise around the hand area leads to incorrect detection of gesture. Requires up to three cameras for gesture detection and they need to be calibrated with their relative positions, the focal length and resolution.
8	Real Time Gesture Recognition System for Interaction in Dynamic Environment.	Siddharth S. Rautaray, Anupam Agrawal	It uses Classifier for detecting and locating hand gestures. Cam-Shift Technique is used for tracking of hands by	It doesn't require any external device for classification of hand gestures. The system performs well in	Due to only computational processing of image frames, the accuracy of the system decreases. It gets difficult to recognize

			shifting the region of interest with average shift in object i.e., hands.	environment with little noise.	gesture in darker environment with low light.
9	Robust Part-Based Hand Gesture Recognition Using Kinect Sensor.	Zhou Ren, Junsong Yuan, Jingjing Meng, Zhengyou Zhang	Uses kinetic and depth sensor to identify complex articulate hand gestures.	Due to its versatility, size and optimum cost it can be used throughout the day. Kinect sensor helps in reducing the effect of shadows and multiple source illumination that might affect the gesture detection capabilities.	The depth sensor has range limitation so with an increment, at an amount of 1cm the detection accuracy decreases. Also, the sensor has limited 58-degree field of view.
10	Hand Gesture Recognition Based on Convex Defect Detection.	Yanan Xu1, Dong-Won Park and GouChol Pok	Extracting sequence of features of an image using convex defect and figure tips.	Gesture detection has better traits as gestures are natural, its easy and has direct and more expressive gesture expression.	Has limitations while recognizing through gloves and function tracker needed, the sensors needed to be used are costly and hard to scale the application.

III. RESEARCH GAPS

Hand gesture recognition system confronts many challenges as addressed in these challenges are
Variation of illumination conditions: wherein any change in the lighting fixtures condition influences badly at the extracted hand pores and skin location. Any external lighting circumstance impacts badly on the extracted colour. Background problem refers to the complicated background in which there are other gadgets in the scene with the glove because of this it'd produce a misclassification hassle
Rotation trouble: this trouble arises whilst the hand location circled in any path withinside the scene.
Background trouble: refers to the complicated history wherein there may be different items withinside the scene with the hand items and these items would possibly comprise pores and skin like shadeation which could produce misclassification trouble.
Scale trouble; this trouble seems whilst the hand poses have exceptional sizes withinside the gesture image.
Translation trouble; the variant of hand positions in different pix additionally leads to misguided illustration of the features

One of the primary issues of the Fuzzy rule-based gadget is that rules need to be defined and expressed precisely for detection and increasing the variety of rules results in greater computation. Also, adjustments made in software features for gesture popularity can require modifications in guidelines or it'd affect the opposite parameters which results in multi parameter optimization issues.
Low robustness, markers on frame. Computational complexity, calibration difficulties. Cumbersome tool with masses of cables. Band needs to be in contact with the human body for operation. Operates in a contained environment. Line of vision is mostly needed between hand and the sensors. At one location, recognition capability is frequently limited to a specific number of users/hands.

IV. CONCLUSION

Thus, the aims is to provide control over computer without using traditional interfaces like mouse, keyboard which somewhere becomes a bottleneck that rely on heavy interaction of user with machine. from reading lots of related articles we have learned that we can easily reduce this bottleneck with computer vision and make it scalable and be used at large scale in various fields. This paper develops a hand gesture recognition system for interaction with different applications like image browser; games etc. and provides a fruitful solution towards a user-friendly interface between human and computer by the insertion of 2DCNN network to pre-process the frames. using a low frame rate which reduces the amount of data to be analysed and providing more time between frames for the execution of our model. Finally, by using smoothening technique, the flickering of the gesture-controlled mouse is reduced. Moreover, the proposed system gives more performance and uses a system of cooldown to avoid multiple computation of the same gesture.

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