iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: https://doi.org/10.22214/ijraset.2023.52100

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Gesture Controlled Virtual Mouse using AI

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Abstract: ***This project offers a cursor control system that quickly navigates system controls while using a voice assistant and a camera to record user motions. Using the aid of MediaPipe, the user can control the computer cursor with hand gestures. It will perform actions like left clicking and dragging using a variety of hand motions. Additionally, you have a choice to adjust the brightness, loudness, and a number of other things. The system is constructed using advanced Python packages like MediaPipe, OpenCV, etc. All i/o activities are physically controlled by a hand motion and a voice assistance. The research uses advanced technologies like machine learning and computer vision techniques, which operates well without the use of any additional computer resources, to recognize hand movements and spoken instructions.***
Keywords: MediaPipe, Machine Learning, Gesture Recognition, Virtual Mouse, Voice Assistant.

I. INTRODUCTION

Gestures are used to communicate nonverbally and to deliver a certain message. This message can be sent through a person's body, hands, or face movements. When interacting with others, gestures can be used to express information from easy to highly difficult hand motions. For illustrative example, we can employ straightforward gestures or motions that are expressed in sign languages and are included into their syntax to point to anything (a people or object), or employ range of many other simple gestures or motions. As a result, employing hand gestures as a tool, humans can engage with one another more efficiently with the aid of computers.

The movement of a visual object is one mouse function that has been replaced by hand movements. The work is designed to be cheap, and it captures hand gesture via a cam, one of many cheap input devices. Preset command-based movements are modelled to touch materials. There are numerous current systems. One can move around the monitor using a standard mouse (hardware tool). The monitor screen cannot be accessed with hand gestures. Another is the gesture system, which recognizes gestures using colored tapes. Additionally, the functions are static and simple in nature. Using current technique, we could operate the mouse and do some basic tasks on a computer or laptop with a web camera and microphone without the need of any other computer hardware. Other procedures can be done with a voice assistant.

II. LITERATURE REVIEW

Hardware-based system, by Quam [1] tells that with a human hand operating the DataGlove, an experiment was carried out to look at gesture recognition. In three classes, a total of 22 gestures were examined. Only finger flexure movements were used in the first class. There were movements in the second class that called for both finger flexion and hand orientation. The third class of gestures need finger motion in addition to flexure and orientation. The flex sensors which are present in the data glove make it easy to recognise up to 15 different movements.

Undoubtedly, the precise sensors required rely on the motions themselves as well as the kind of gestures that need to be identified. Although it appears that class 3 gestures could be recognised, additional research will be required to create recognition techniques.

Dung-Hua Liou and Chen-Chiung Hsieh proposed A Real Time Hand Gesture Recognition System Uses Motion History Image [2]. In this study, a face based skin colour model and a motion history image based hand movement detection technique were developed. Hands travelling up, down, left, right are the dynamic hand gestures as well as two static hand gestures the fist and the wave hand are suggested in this work. These hand gestures are simple and effortless. Using Harr-like features, the four-directional dynamic hand movements were identified. Static hand movements were extracted using the face-based adaptive skin colour model, and these motions were subsequently recognised by examining a face-based ROI. To test our suggested system, five people were invited. Experimental results revealed an average accuracy of 94.1% and proved the viability of the suggested approach.

Thumma Dhyanchand, Vantukala VishnuTeja Reddy came up with a Virtual Mouse Control Using Colored Finger Tips and Hand Gesture Recognition the system, [3] that makes the control of a cursor without any direct physical contact without any sensor. This activity involves identifying colourful fingertips and tracking them. For the same effect, different hand gestures might be used in place of colored caps.

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The mouse can beused to scroll, click once on the left side, click twiceon the left side, and do other functions. For variousprocesses, different arrangements of the coloured caps are employed. Depending on the person beingutilised and the lighting environment, the application can change the range of skin tones. After examining the programme output at various hand motions, an approximation of the area ratio that the hand is not using in the convex hull is made.As the brightness ranges from 500 to 600 lux the colour Red has a detection accuracy around 90% which is similar in case of Green and Blue which istypical of offices and well-lit classrooms. This problem is solved by adapting a hand gesture recognition technology that detects the contours ofthe hand.

An Introduction to Hidden Markov Models by *L. R..Rabiner B. H. Juang* [4] tells that a key tool for thereal-time, dynamic gesture identification process isthe Hidden Markov Model. The HMM approach ispractical and designed to function in static settings.The strategy involves using the HMM's LRB topology in co-occurrence with Baum Welch Algorithm and Forward and Viterbi Algorithms for training and testing respectively, produces the best recognition of patterns. Although the system in thisstudy looks to be simpler to use than more recent systems or command-based systems, it is less effective at spotting and recognising patterns. An Arduino Uno, ultrasonic sensors, and a laptop are used in this study's hand gesture laptop to carry outtasks including managing media playing and volume. Serial connections are made using Python, Arduino, and ultrasonic sensors. For more engaging and interactive learning, immersive gaming, and interacting with virtual things on screen, this kind of technology can be used in the classroom.

Akshaya U Kulkarni, Amit M Potdar proposed a system that is RADAR based Object Detector using Ultrasonic Sensor [5]. The project entailed developing an ultrasonic sensor based, RADARbased used for object detection, was provided in this publication. Instead of employing genuine RADAR, which is expensive and difficult to handle, it provides a solution for simple objectdetection using ultrasonic technology that functions like RADAR. The work of other authors focuses primarily on either of these subjects. IoT hardware and connection software were part of theendeavor. The Raspberry Pi 3 computer and Arduino Uno board processed data. In order toidentify objects, the boards were equipped with an ultrasonic sensor and servo motor. The SIM808 module was then used to send each object's distance, angle, and timestamp to the chosen number via SMS/message. Sample test cases were included in the results to verify the object detection's detection range. The study provides a simple approach for object detection since, as stated in the introductory part, ultrasonic detection has various benefits over RADAR.

D.Ghosh, P.K.Bora, and M.K.Bhuyan Co- articulation Detection in Hand Gestures [6] suggests that one of the biggest problems with dynamic gesture recognition is co-articulation. For the class of gestures taken into consideration here, there haven't been many documented vision-based methods for assessing co-articulation. The majorityof the algorithms that have been suggested up to this point have been successful only for a small number of gesture vocabularies and cannot be applied to all types of gestures when used in varioussettings. Another significant issue with dynamic gesture identification is the self-articulation ofgesture in the sequence of gestures. When employing the provided method for recognising co- articulation, the connected gesture sequences in the gesture vocabulary that are used in light of some particular applications, such as robotic control etc.

Deep Learning-Based Real-Time Artificial Intelligence Virtual Mouse by S. Shriram, B. Nagaraj[7] states that by using a built-in camera or awebcam that recognises hand movements and finger-tips and frames are detected to carry out certain mouse actions. The model's outcomes demonstrate the suggested AI virtual mouse system's outstanding performance which is more accurate than the current models, and also overcomes the bulk of the latter's shortcomings. Since the recommended system is more accurate this model can be easily put in practice. With the use of this system the usage of actual mouse can be avoided which reduces the spread of Corona Virus.

On-device Real-time Hand Tracking using MediaPipe by G. R. Fan Zhang, V. Bazarevsky [8]In this post, they recommended MediaPipe Hands, acomplete hand tracking system that operates in real-time on different platforms. The pipeline can beeasily installed on standard devices and predicts 2.5D landmarks without the need for specializedhardware. We open sourced the pipeline toencourage academics and engineers tocreatecutting-edge gesture control and AR/VRapplications utilizing it.

Real-time virtual mouse system using RGB-Dimages and fingertip detection by S.-H. Kim, N.-H. Ho, D.-S. Tran, H.-J. Yang, and G. S. Lee [9] this study introduced a novel virtual-mouse technique based on fingertip detection and RGB-D pictures. Just using fingertips in front of webcam user can perform certain actions. The method showed off not only extreme accurate gesture estimates useful applications. The proposed approach gets around the drawbacks of the majority of existing virtual-mouse systems. It has several benefits, including accurate fingertip tracking at a greater distance and with complicated backgrounds. It also works well in shifting light conditions. The results of the experiments showed this method is a better one for real-time hand gesture interfaces.

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Hand gesture recognition for human computer interaction by A. Subramanian, A. Haria, J. S. Nayak N. Asokkumar, and S. Poddar [10] we were able to create a robust gesture recognition system that was affordable and simple to use without the usage of any markers. With the help of our gesture detection technology, we aimed tooffer gestures for almost all HCI-related operations, such as system functioning, application activation, and opening a number of well-known websites. Increasing accuracy and adding additional movements to incorporate more features are future objectives. In addition, we intend to incorporate our tracking system intoa variety of hardware, including digital TV and mobile devices, and broaden the possibilities for our domain. Additionally, we wish to make this mechanism accessible to a wide range of users, including those with impairments.

III. METHODOLOGY

For hand tracking and gesture recognition, the MediaPipe framework is employed, for computer vision we use the OpenCV library.The technique tracks, recognises hand gestures and finger tips using ML concepts.

1) *OpenCV:* For images, OpenCV offers object detection techniques. Using the OpenCV module, the best applications of computer vision can be developed. This library is utilizedfor face and object identification, picture and video data processing, and video analysis.
2) *MediaPipe*: A machine learning pipeline employs a Google open-source framework known as MediaPipe. The MediaPipe framework may be employed for cross-platform computing as it was developed leveraging time series data. The MediaPipe architecture supports multiple audio and video formats since it is multimodal. The developer uses MediaPipe framework to build systems for application- related objectives as well as to design and analyze systems that employ graphs.

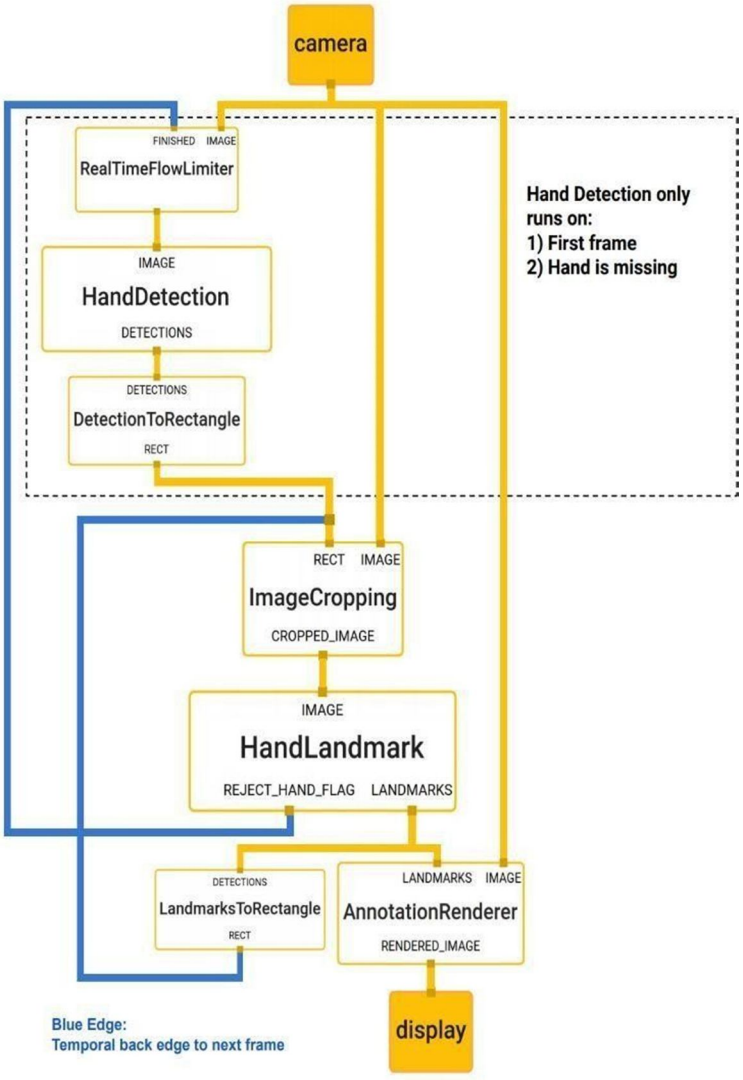
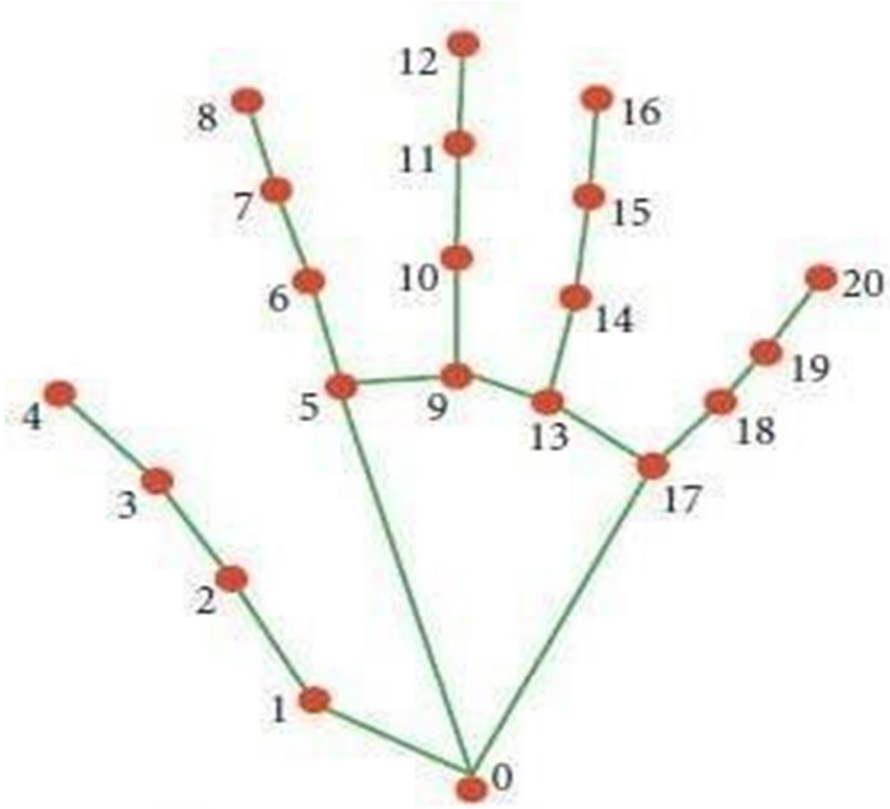


Fig 1: MediaPipe Hand recognition

3) *The AI-Powered Virtual Mouse System's Camera*: This AI virtual mouse system relies on the images from a laptop or PC. The video capture object is generated by using Python computer vision toolkit OpenCV and web camera used for recording. The web cam provides frames to virtual AI system that processes them.
4) *Video recording and analysing:* The webcam will be used by the AI virtual mouse system to record each frame till the programme is finished. The images are captured and converted to RGB to allow for frame-by-frame identification of the hands.
5) *Virtual Screen Matching:* This is used to movethe hand coordinates between the web cam and the computer's window to execute certain mouse functions, the AI virtual mouse technique enables a transformational method. After the recognition of the finger tips and hands we are notified of which fingers are capable of performing a cursor movement , a rectangle box may be generated on the computer screen showing the reference ofthe web cam. From there, we can see our cursor movements around the window.

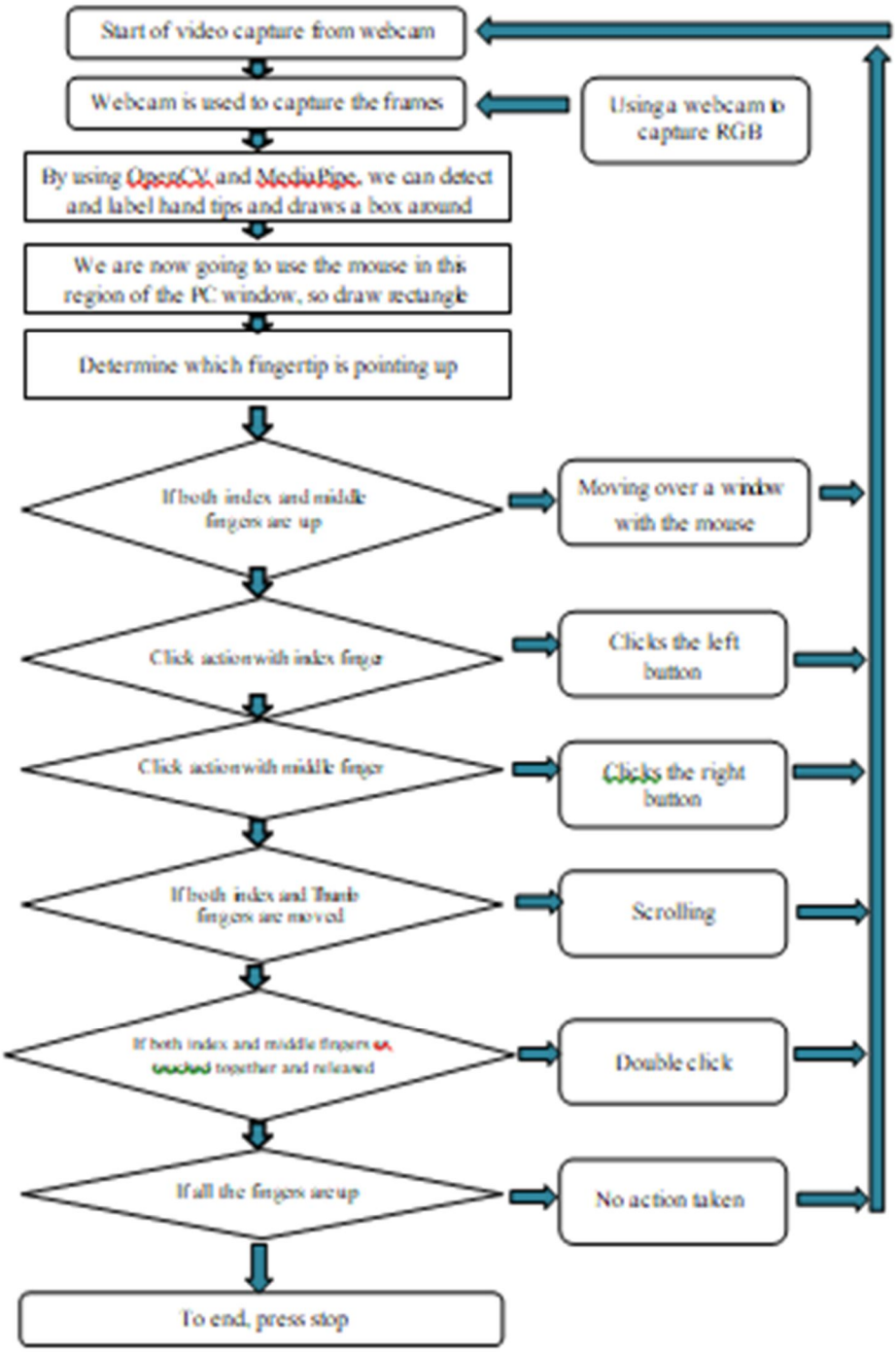


0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

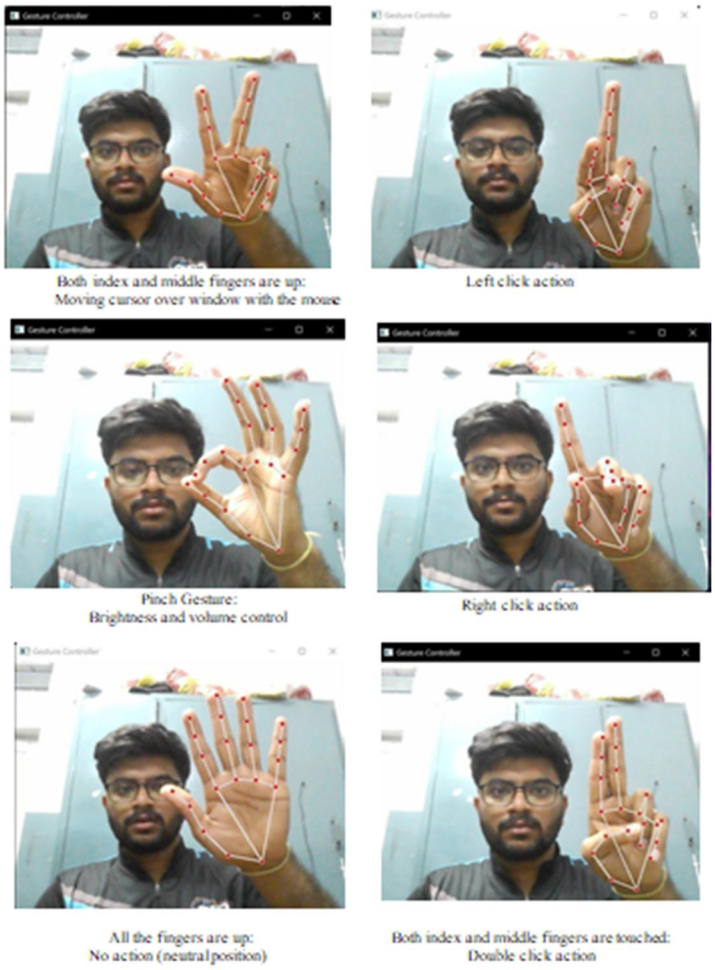
Fig 2: co-ordinates in hand

6) *Recognizing the finger which is up and performing out the appropriate mouse operation:* In order to transfer the hand coordinates between the webcam to the computer's window full screen for mouse operation, the AI virtual mouse technique enables a transformational mechanism. After thehands are detected and we are notified of which finger is capable of performing a certain mouse movement, a rectangular box is formed in reference to the computer window in the camera region. From that, we may move the mouse pointer around the window.

IV. IMPLEMENTATION



V. RESULTS AND EVALUATION

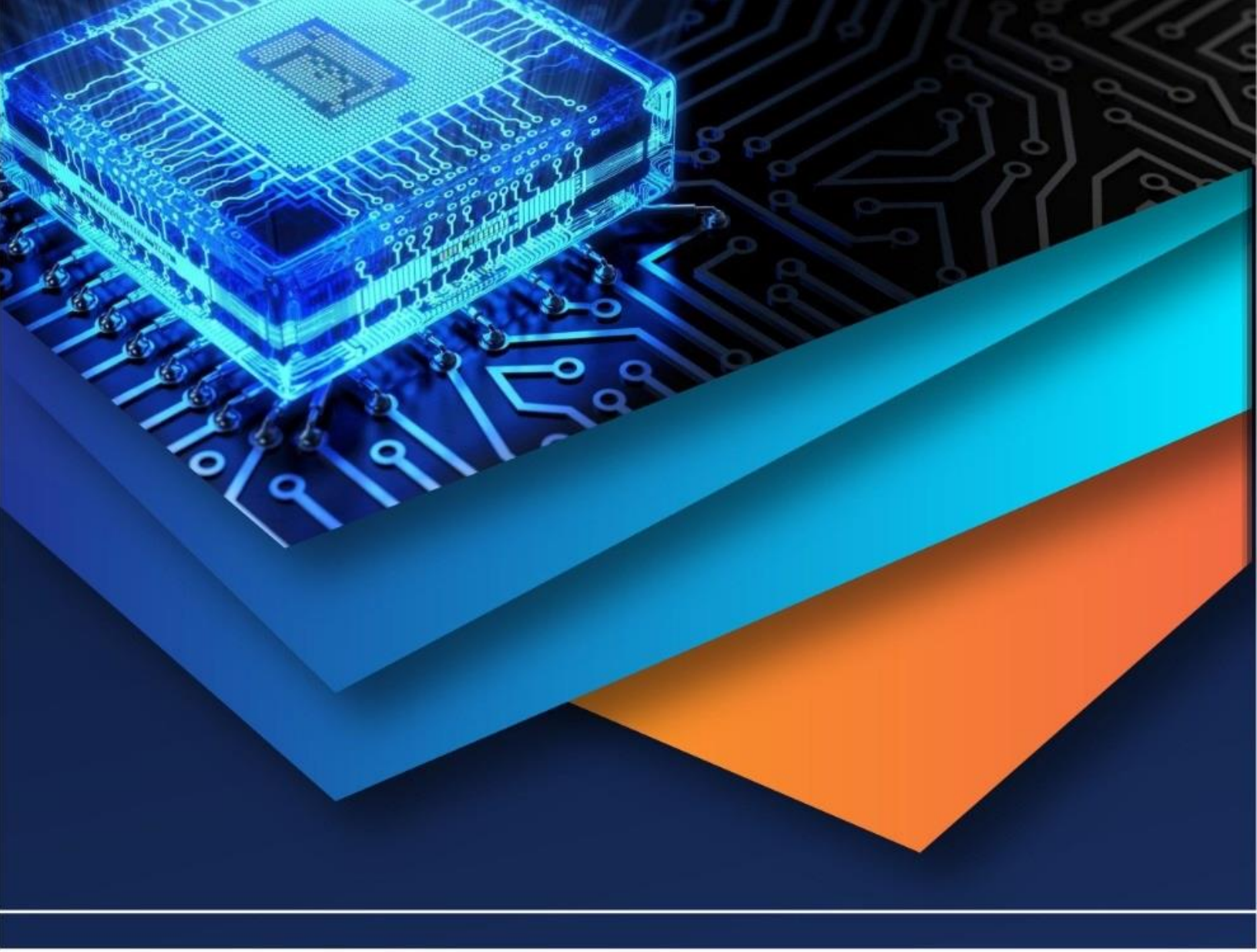


VI. CONCLUSION

The development of effective human-machine interaction has becomesignificantly impacted by the hand gesture detection and voice assistant systems. Wide- ranging applications in the technology sector are promised by implementation employing hand gesture recognition. The MediaPipe, a machine learning framework, has a significant impact on thecreation of this application that uses hand gesture recognition.

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