World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(REVIEW ARTICLE)

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Dynamic virtual assistance of I/O functionalities

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World Journal of Advanced Engineering Technology and Sciences, 2023, 08(02), 023–033

Publication history: Received on 11 January 2023; revised on 25 January 2023; accepted on 28 January 2023

Article DOI: https://doi.org/10.30574/wjaets.2023.8.2.0061

Abstract

With significant advancements being witnessed in the engineering industry daily, it has become increasingly vital for society to seek out particular new ways of interacting with computer technology and automation as their demand grows in society. Today, every device is developing the use of touch screen technology on its computer systems, although it is not cost-effective to use in all applications. A specialized system, similar to a virtual device, that provides object pursuit (tracking) and Gestures to let us engage; it might be an effective alternative to the standard touch screen and also the solid physical gadgets. The goal is to create an object pursuit (tracking) program that communicates with the computer system. This proposed model is a computer vision-based control system that involves hand movements taken from a digital camera via a hand detection technique implemented with OpenCV libraries.

Our project applies gesture recognition as a topic that comes under two computer science fields augmented reality and human-computer interaction and we have created a virtual gesture system to elucidate human gestures through mathematical algorithms. Users can use simple finger or hand gestures to control or interact with the system without physically touching them and also included voice assistance to start and end the gesture controlling system. Gesture recognition can be viewed as a way for computers to begin to recognize human body language and signs, thus stuffing the void between computing systems and humans than the earliest text user interfaces or even graphical user interfaces, which still limit the majority of input to keyboard and mouse are may not be very efficient at all times.

The algorithm is focused on deep learning for detecting the gestures. Hence, the proposed system will avoid the pandemic situation of COVID-19 spread by reducing the human interaction with the devices to control the system

Keywords: Open CV; Pyauto GUI; Gesture Recognition; Virtual control device; Voice assistant

1 Introduction

The years 2019 to 2021 have shown humans some eye-opening series of events among which the COVID-19 pandemic is the most turn around event that has started in the whole world since the year began. Infecting human health and lives, COVID-19 has called for strict protocols to be followed to avoid the spread of COVID-19. In this project, we have attempted to lower the gap between the natural world and the augmented reality environment to bring out a mixed reality system. For that reason, we created a virtually controllable keyboard, mouse control, and some other gesture controlling system and voice assistance.

To provide an easy enveloping augmented experience that is also gesture control enabled, we employ a web camera that is united with OpenCV libraries through a compiler. Using our project, users can control virtual systems using their finger movements and fingertip gestures. Additionally, users can convey things to people who are watching their screen, the user selects an alphabet with the help of hand gestures. This paper expresses the way of executing a virtual

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keyboard, mouse, and some other gesture-controlling system without any additional hardware support but by using the webcam available in the system. The webcam captures the back-to-back frames and compares them to recognize it as a click if there is a change in the contour.

Objective of the project

The general motive of the project is to develop a Virtual Interface system to support contactless communication with the computer system in public places. The specific objective of the project is to replace the traditional physical Input/Output devices with a virtual AI framework using hand gestures and voice assistance.

1.1 Problem statement

The task here is to access and analyze the webcam images and let the computer act accordingly to them.

We want to build a system that allows the user to interact with the computer system with hand gestures and voice assistance.

1.2 Scope of the project

There are no efficient contact-less interactive computer applications to allow the user to have a safe experience. This increases the demand for an efficient interface system in public places like ATMs, Airports, Railway Stations, etc. This project uses Human-Computer Interaction using OpenCV and Voice assistance to perform input operations without direct interactions.

2 Literature survey

2.1 Title: A Static Hand Gesture Recognition based on local contour sequence

- Author: Sandeep Bhargava
- Context: Local Contour Sequence (LCS) technology is used for this technology.
- So, it demands very less prerequisites and even less analysing and processing functionalities. Because even under slightly different conditions it cannot differentiate between the fingers, it is known to be the least efficient tracking method.

2.2 Title: Virtual Gesture with RGB tapes

- Author: Kanchana Venkatasubbaiah
- Context: RGB image capturing is used here, including Coloured tape technology.
- It analyses the gestures in a 2D plane with 3 critical points thus opening up more opportunities than what the contour sequence system initially offered.
- It cannot analyse the depth of the fingers which severely limits the possibilities of gesture recognition.

2.3 Title: Gesture Recognition Apparatus and Method

- Author: Youichi Miyake
- Context: A gesture control appliances that controls a display device based on a gestures performed by a user in front of a screen includes: a picture obtainment unit which obtains a picture of the vicinity of the screen; a direction determination unit which determines, based on position information indicating a direction of a movement to be recognized as the gesture operation; a gesture recognition unit which recognizes, as the gesture operation. A movement to recognized as the gesture operation; the movement of the whole part of the body of the user in the operational direction determined by the direction determination unit.

2.4 Title: Customized Voice Assistant

- Author: Senthur R, Prashant P, Ragul P
- Context: There are some widely used mobile application voice assistants like SIRI, and Google Voice Assistance which helps the users to interact with the system for maximum utilization of automation. Windows voice assistant Cortona is made for business and productive malignant to automate their work in a faster way. But still, many companies and industries request extreme automation to improve their work effectively. But our proposed voice assistant with voice recognition intelligence, takes the input from the end-user, process it, and

executes it in various form like what the user is needed. Basic Operations which are done by some voice assistants such as Alexa, Siri, and Google are integrated into our voice assistant. In addition, a unique automation feature is added 'Automatic Login Authentication' where the user's respective 'Gmail', 'Instagram', etc., accounts can be signed in automatically using our unique feature using the AES cryptographic key. This may be the better outcome of our voice assistant to process the information quickly with the help of Google API and Packages. The system is designed in such a way that all the services that are provided by the computer systems are accessible by the user on the user's voice commands.

2.5 Title: Hand Gesture Recognition for Home Automation

- Author: V. Savitha, J. Nandhini, S. Kokilavani
- Context: Here, we describe an Expectation Maximization-based system for controlling various appliances by simply recognizing hand motions, such as indicating that showing the first finger would switch the first gadget. Using a simple camera and microcontroller- based embedded system, real-time image processing is used for hand gesture recognition. This project paper provides a viable technique to control gadgets for employees in industries who cannot contact electric panels too frequently throughout their work; devices can be controlled simply by showing hand gestures. There will be a computer application written in MATLAB that will require real-time picture processing. A camera that feeds photos to a computer application and after analysing the images and detecting the command for switch choice, data is transferred to the microcontroller hardware based on the Arduino environment.

3 Existing system

The current model includes a mouse that can be wireless or tethered to operate the pointer, and we know that hand gestures could be used to monitor the system. The existing virtual mouse control system is comprised of a simple mouse operation that uses coloured tips for detection that are captured by a webcam, so coloured fingers operate as an object and the webcam detects colours like red, green, and blue to monitor the system and therefore could perform basic mouse operation like minimize, drag, scroll up, scroll down, left-click right-click using hand gestures without any coloured finger because skin colour recognition system is more flexible than the existing system.

Figure 1 Existing system with colored tapes (refer in: Virtual Mouse Reference Paper)

3.1 Disadvantage Of Existing System

- Insists on Physical Contact
- Costly
- Depends on mechanical parts which may fail at any time.
- Not always handy
- The components change concerning the region, so not universal.
- If fails, no backup plan

4 Proposed system

The system works by identifying the colour of the hand and decides the position of the cursor accordingly. The proposed system can work for the hand skin of any colour and as well as can work perfectly in any lighting condition. To click the user needs to create an angle between his/her finger. This is done using a hand gesture recognition which receives inputs from a webcam.

The proposed system can easily replace the traditional I/O hardware as well as the algorithm that requires coloured tapes for controlling the gesture system. This research paper can be a pioneer in its field and can be a source of further more research in the corresponding field. The project can be developed with "Zero Cost" and can easily integrate with the existing system. This work can easily replace the traditional mouse and keyboard system that has been in existence for decades. With the use of this algorithm, the user can control the mouse without the fuss of any other hardware device.

4.1 Advantage Of Proposed System:

- No chance of failure
- Easily modifiable, so universal
- No need for physical contact
- 100% mobile and handy
- No wires and physical or mechanical components
- No compatibility issues
- Fun to use

Figure 2 Proposed system with critical points (refer in: Media pipe documentation)

4.2 Working Of Proposed System

Instead of using a standard input and output device, the suggested system uses a web camera or a built-in camera in the computer to create computer input and output functions as well as some gesture control features. Computer vision is used to identify hand gestures and tip detection as a human- computer interaction with the computer system. We can utilize a web camera to monitor the fingertip of a hand gesture and conduct mouse and keyboard activities, among other things, with the help of an artificial intelligence virtual system.

When employing a wireless mouse, you'll need a physical mouse, a dongle to link to the computer, and a battery to keep the physical mouse charged up. Moreover, in this project, the user can control the computer system operations through his or her built-in webcam and hand gestures.

The constraints of the suggested gesture control system can be overcome by using a webcam or built-in camera to capture hand movements using computer vision. The project's algorithm is based on a machine learning technique. The system can be controlled remotely using hand gestures and can execute left-click, right-click, and mouse cursor functions without the necessity of a physical device.

4.3 Applications of Proposed System

Many computer applications benefit from the virtual gesture system. It can be used to act as an intermediary between using physical devices and using them in environments where we are unable to use physical devices. The virtual system reduces the need for I/O devices while improving human-computer interaction.

4.4 Major applications

- This approach has a higher accuracy of 99 percent, which is significantly higher than several other developed models for virtual gesture systems and has a wide range of applications.
- In the COVID-19 condition, it is prudent to use computer devices by touching them directly since contacting the systems may result in the major cause of disease propagation, therefore this virtual gesture system can be utilized to operate computer I/O functions without employing physical devices.
- The gesture approach can be used to control robots and electronic automated systems without the use of physical systems
- With the help of hand movements, the AI virtual gesture system can draw two-dimensional and three-dimensional patterns.
- Without the usage of wired equipment, an AI virtual system can be utilized to play virtual reality and augmented reality-based games.
- People who have difficulty with their hands can use this gesture controller to manage the computer's I/O features.
- Human-computercomputer Interaction, for instance, can be used to control robots in the field of robotics.
- In the designing and architecture area, this system can be used for designing virtually for prototyping.izational devices that guide the reader through your paper. There are two types: component heads and text heads.

5 Software specification

The system guidelines are outlined in the software essential document. It must provide both details and a list of requirements. The software specification serves as the foundation for developing the software requirements specification.

5.1 Software Requirements

- Python 3.9
- Libraries – OpenCV, NumPy, PyAutoGUI
- Pycharm IDE

6 Hardware specification

The hardware specification may serve as the ground for a contract for the application of the system and should therefore be an entire and consistent requirement of the system. They are used by IT engineers as the kick-off point for the system design.

6.1 Hardware Requirements

- Processor - i7
- Memory - 512 GB
- RAM - 2GB(Minimum)
- Web Camera

6.2 Introduction to Python

Python is a high-level programming language for purpose of programming, created by Guido Van Rossum and released in 1991. Python, an interpreted language, has a design idea that insists on code readability (using white space indentation to eliminate code blocks as a substitute for curly brackets or keywords), which might be utilized in languages like C++ or Java. The language anticipates constructs that will allow for the creation of clear programs on both a small and large scale.

Python provides a dynamic type structure and automatic storage management, as well as support for a variety of programming paradigms such as object-oriented programming, imperative programming, functional programming, and procedural styles. It comes with a wide standard library. Python interpreters for various operating systems are available, allowing python Programs to execute on a wide range of computer platforms.

6.3 Features of Python

- Easy to code.
- Simple than other languages.
- Explicit programming language.

7 Architecture diagram

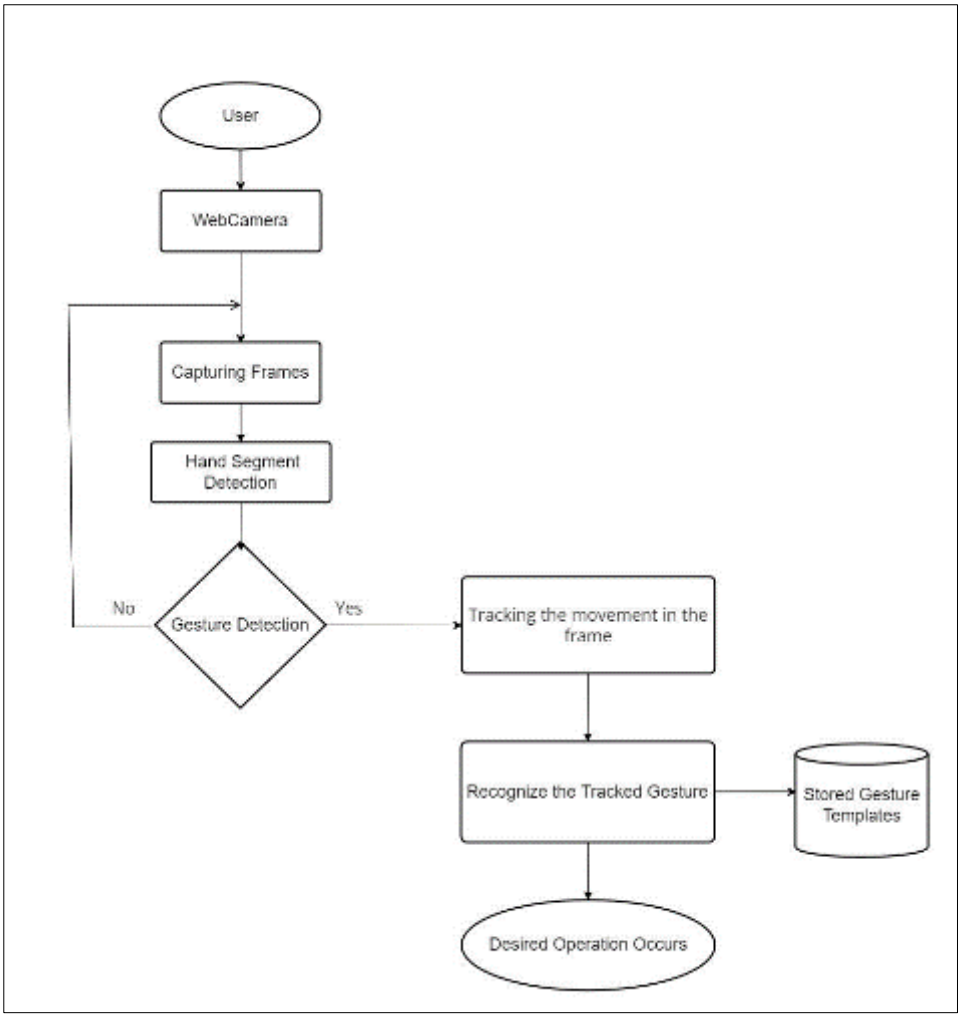

Figure 3 Architechture Diagram

8 Module description

We have revised a smart framework for creating a virtual interface in this project. As the cases of the covid-19 pandemic are decreasing maximum public places are opening at half or full capacity. ATMs are always open. If we install this facility, the spread of disease, germs, bacteria, and viruses can be a great system in public places like ticket counters, ATMs, and computerized docking reduced.

The block diagram of the developed framework is depicted in Fig. 1.

- Hand Detection

In this module, the main focus is to access the webcam and allow the program to access the hand images.

- Gesture Detection and Recognition

In this module, the accessed images are analyzed and the movements and the significant gestures are noted and stored.

- Accessing the Database to Check Verify Gesture

In this module, the recorded gestures and movements are cross-checked with the pre-programmed gestures and movements to facilitate the program's functioning.

- Desired Actions Occur

In this module, the cross-checked gestures are triggered to perform the preprogrammed actions like moving the cursor, selecting letters, clicking, double- clicking, etc.

- Help from Voice Assistance

In this module, we create a voice assistant to facilitate and help us use the virtual interface more efficiently and safely. It can also perform many other basic functions.

9 Result and discussion

By using various modules, we were able to build a virtual interface system. The system's efficiency level is enough to fully function in a public environment. Even though there is still ground for development in the voice control module, as of right it fulfils its responsibilities perfectly.

The program captures the images, processes them, analyses them, extracts necessary information from them, and completes the pre-programmed tasks satisfactorily.

Figure 4 Hand Recognition by the System

The present virtual gesture system is based on the images that have been captured by the built-in camera or webcam in a computer. The video capture object variable is created with the Python computer vision package OpenCV, and the camera begins recording video, as shown in Figure 4 The camera takes pictures and sends them to the virtual gesture system.

The virtual gesture technology allows the use of the camera, and every image is captured until the end of the program. The frames are transformed from BGR to RGB color to find the objects (hands) in the video frame by frame, as demonstrated in the code below:

def find Hands(self, img, draw = True): img RGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB) self. results = self. Hands. process (img RGB)

The virtual gesture system employs the reframing algorithm, which transposes the coordinates of the hand from the camera screen to the computer screen to control the gesture system. When the hands are detected and we determine which finger is available for performing the required I/O function, a bounding box is generated in the camera area with a reference to the frame window in which we navigate all over the screen using the virtual cursor; for the time being, we hide that box to have a clear view of the screen.

We are analyzing which finger is open by using the tip Id of the corresponding finger that we detected using the Media Pipe library and the relevant coordinates of the open fingers, and the specific I/O function will be executed using the pyautoGUI python package.

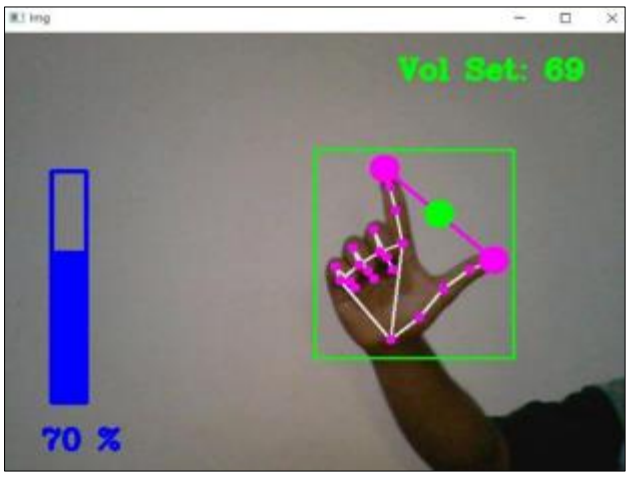

Figure 5 Gesture Recognition by the System

For performing Gesture control, we will find and set the tip ID for respective operations. For example, if the index finger is open with tip Id = 1 or both of the index finger and thumb finger with tip Id = 2 are up, we may control the volume of our system using the Python Pycaw library, as shown in Figure 5.

Here we just implemented only volume control gesture, like this we can perform more gesture control operations such as slider control, scroll wheel control, tab control, etc., using OpenCV libraries.

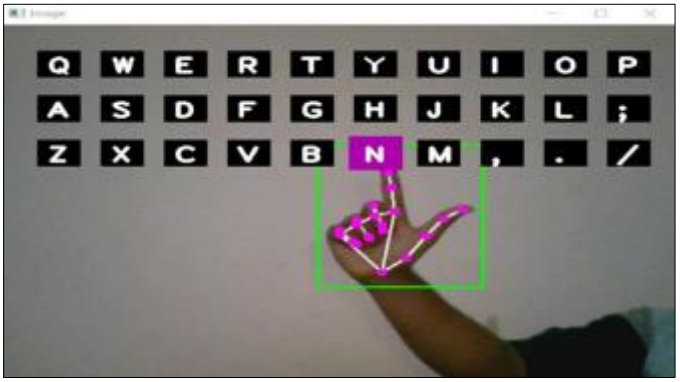

Figure 6 Onscreen Keyboard to Facilitate Virtual Typing

The gesture system includes aspects of the traditional system I/O devices(keyboard or mouse) with gesture-related approaches to inputting data. To enter text, users implement an assigned gesture in which their index finger traces over the letters in the screen of their intended word.

For example, if the index finger with tip Id = 1 is up and the separation between the two fingers is less than 30px, the system is made to execute the mouse click over the letter on the screen, which inputs the letter in the system using the pynput Python module, as shown in Figure 6.

A gesture related interface in which a user can input data in a hands-free way presents a solution to this specification.

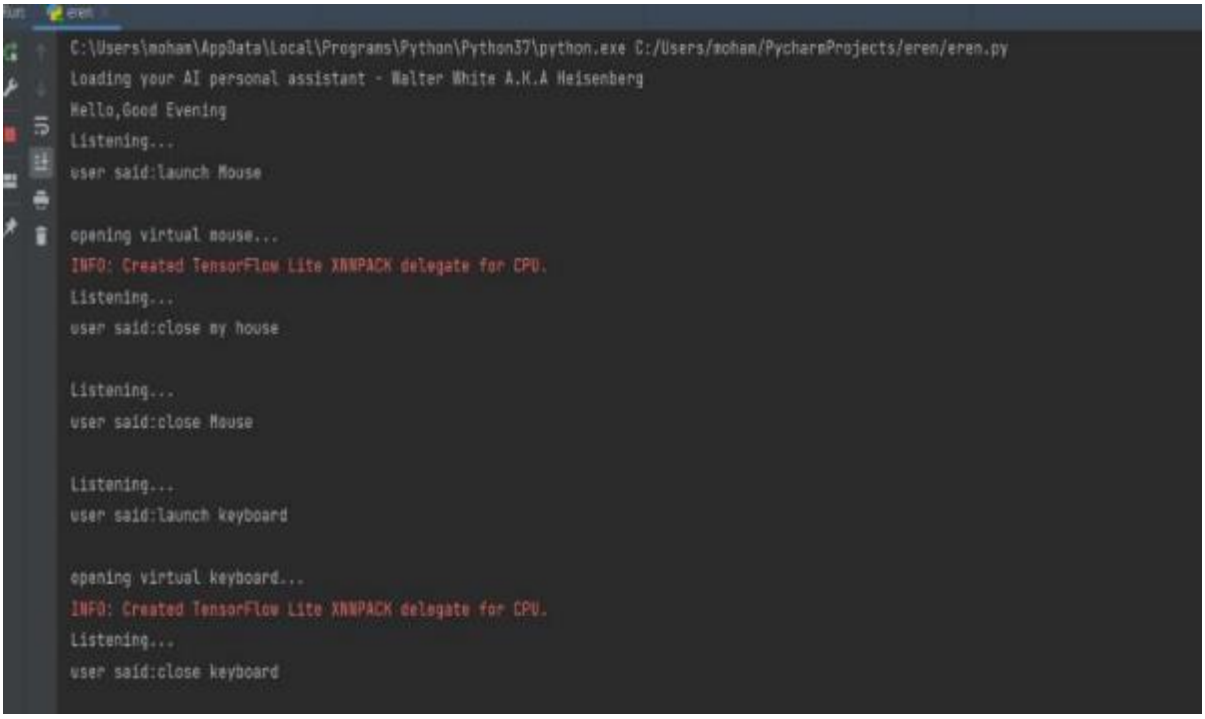

Figure 7 Voice Command Recognition And Assistance

We aim to operate the system without direct interactions. The gesture-control system we implemented will do a lot of operations without direct interactions even though, we might need to interact with the system to start the gesture control process.

So, we included voice assistance, which can help us to start and terminate the process of the gesture-control system as shown in Figure 7.

It works with the pyttsx3 and speech-recognition in python modules which will fetch the word from our voice and convert it to text and recognize it with our command which we assigned with some operations(opening virtual mouse, closing virtual mouse, etc.,).

10 Conclusion

As the technology is booming with emerging trends therefore the virtual I/O interface can be present in public healthcare. We used OpenCV and TensorFlow libraries to find movements and gestures of the hand. The models were evaluated with images and real-time video frames. The perfection of the model is executed and, the development of the model is a continuous operation and we are building an absolute solution by tuning the hyperparameters. This particular model could be used as a use case for Virtual Human-Computer Interaction. By developing this gesture system, we can allow the user to have a contact-less interactive experience with the system, which would be of great help to humans.

Based on the project outcomes, we can conclude that the suggested Gesture control system performed very well and with higher perfection than the current models and that the model outperformed much of the restrictions of current systems. Because this model is more ideal, the Gesture control system can be utilized for real-world computer applications, as well as to reduce the transmission of diseases such as COVID-19. This system can be operated virtually using hand gestures rather than traditional physical instruments.

This project contains minor weak spots, such as a slight decrease in precision in the right-click mouse functionality and some difficulty in drag-drop or selecting text. As a result, we will aim to overcome these restrictions in the next months by upgrading the fingertip detection techniques to deliver a more definitive solution.

Compliance with ethical standards

Acknowledgments

I express my gratitude to all scholars, faculty members who helped me throughout the project.

Disclosure of conflict of interest

I truly do hereby declare that there is no conflict between us -the authors of this paper.

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