



International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 9, Issue 2, February 2026



International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Virtual Keyboard

Prof. Rashmi Kannake¹, Sujal Gupta², Ayush Wanjari³, Mangesh Raut⁴, Harsh Diwan⁵,
Satvik Wadhai⁶

Asst. Professor, Department of Artificial Intelligence & Data Science, Wainganga College of Engineering and
Management, Nagpur, Maharashtra, India¹

UG Student (B. Tech Student), Department of Artificial Intelligence & Data Science, Wainganga College of
Engineering and Management, Nagpur, Maharashtra, India²⁻⁶

ABSTRACT: The rapid growth of computer vision and human–computer interaction (HCI) technologies has enabled the development of innovative, touchless input systems that reduce dependency on conventional hardware devices. This research paper presents the design, development, and implementation of a vision-based virtual keyboard using a standard webcam. The proposed system allows users to input text by performing finger and hand gestures in mid-air, eliminating the need for a physical keyboard. Real-time video frames captured through a webcam are processed using computer vision techniques such as hand detection, landmark extraction, and fingertip tracking to map user gestures to a virtual keyboard displayed on the screen. The system is implemented using Python with OpenCV and MediaPipe frameworks and evaluated under different environmental conditions. Experimental results demonstrate that the proposed approach is cost-effective, portable, hygienic, and suitable for applications such as assistive technologies, public kiosks, smart classrooms, and touchless computing environments.

KEYWORDS: Virtual Keyboard, Computer Vision, Hand Gesture Recognition, Webcam, Human–Computer Interaction, Touchless Interface.

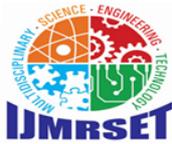
I. INTRODUCTION

In recent years, touch-free interaction technologies have gained popularity across various technological domains. Devices like virtual reality controllers, gesture-based sensors, and camera-based tracking systems are becoming essential components in next-generation interfaces. One such emerging idea is the “Invisible Keyboard,” a system where users type without needing a physical keyboard — instead using hand gestures captured by a camera. This project aims to build such a system using only a webcam and computer-vision algorithms.

Traditional keyboards have limitations such as physical wear, hygiene concerns in public spaces, portability issues, and dependency on hardware availability. In contrast, virtual keyboards offer portability and flexibility. However, most on-screen virtual keyboards still require touch input through a device. The invisible keyboard overcomes this by enabling typing through finger movements in free space.

This project uses computer vision to detect hands and recognize tapping actions. The webcam provides real-time video feed to the software, which processes the frames using algorithms like contour detection, hand landmark detection (MediaPipe), and gesture classification. These landmarks help track fingertip movements, which are then mapped to an imaginary QWERTY keyboard layout rendered on screen. When the system detects a tap gesture (e.g., fingertip moving downward rapidly or fingertip approaching palm depth), it registers a keypress.

The goal of this project is not only to simulate a keyboard but to demonstrate how future computers could operate using minimal hardware. It also opens possibilities for AR/VR applications, accessibility tools, and smart environments. The introduction of gesturecontrolled technology signifies a shift towards natural and intuitive input methods. This project showcases how artificial intelligence and computer vision can replace traditional input systems and create newer, more interactive computing experiences.



International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

II. PROBLEM IDENTIFICATION

The primary problem addressed by this project is the dependence on physical keyboards for text input. Although keyboards are efficient, they pose certain limitations in modern computing environments: lack of portability, hygiene concerns in shared spaces, mechanical failures, and difficulty of use in AR/VR or wearable-computing systems.

In many scenarios, such as hospital environments, public kiosks, and virtual reality systems, using a physical keyboard is neither practical nor hygienic. Touch-based systems are also not ideal when physical interaction must be minimized. Additionally, carrying external keyboards for portable systems adds weight and reduces convenience. Another key problem is the lack of affordable, accessible, and easy-to-use virtual typing systems. Existing virtual keyboards often require touchscreens, motion-tracking gloves, depth sensors, or costly hardware like Leap Motion controllers. These tools limit scalability and adoption.

Thus, the problem is defined as:

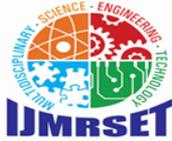
“Designing a cost-effective, webcam-based virtual keyboard system that can recognize hand gestures and finger-tapping actions in real time to replace a physical keyboard for basic typing tasks.”

The challenge includes tracking finger movements accurately using only a 2D webcam, differentiating between movement and intentional keypress gestures, and mapping these gestures to a reliable character output. Ensuring accuracy under varying lighting conditions, background noise, and individual differences in hand positioning also presents difficulties.

This project aims to address these issues by creating a solution that uses only a standard webcam and AI-based hand-tracking to simulate keyboard typing.

III. LITERATURE REVIEW

Sr. No.	Title / Study	Author(s)	Description
1.	Vision-Based Hand Gesture Recognition Systems	M. Mitra & T. Acharya (2007)	This paper introduced foundational techniques for detecting and recognizing hand gestures using computer vision. It explained skin-color segmentation, background removal, and contour tracking.
2.	A Survey on Virtual Keyboard Interfaces Using Hand Tracking	S. Kumar et al. (2015)	It highlighted webcam-based solutions as lowcost alternatives and explored common challenges like lighting variation and occlusion, which are directly relevant when designing invisible keyboards.
3.	Hand Tracking Using OpenCV for Virtual Interaction	J. Wang & P. Popović (2018)	The study described how OpenCV libraries could be applied to track fingertips in real-time. It explained convex hull methods, fingertip detection logic, and thresholding techniques.
4.	Deep LearningBased Hand Pose Estimation	Z. Zhang et al. (2019)	This research introduced hand landmark detection using deep neural networks. It directly supports invisible keyboard projects because modern systems use deep-learning models (e.g., Google Mediapipe) to detect 21 hand landmarks.



International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

5.	Virtual Input Systems Using Augmented Reality	L. Hernandez & Y. Torres (2020)	The paper discussed how virtual keyboards can be projected or visualized in AR and recognized using gesture inputs. While not identical to invisible typing, the key idea of mapping finger coordinates to virtual key
----	---	---------------------------------	--

IV. PROPOSED SYSTEM

The proposed system architecture consists of five major modules: video capture, hand detection, gesture recognition, virtual keyboard mapping, and output display.

Step 1: Video Capture

A standard webcam captures live video frames. These frames form the input to the computervision pipeline. The system runs at 20–30 fps for smooth tracking.

Step 2: Hand Detection and Landmark Extraction

MediaPipe Hands is used to detect the hand and extract 21 landmarks for each frame. Landmarks such as index fingertip (point 8) and thumb tip (point 4) help identify gestures and finger positions.

Step 3: Gesture Recognition

The system detects key presses using:

- Fingertip depth change
- Sudden downward motion
- Distance between fingertip and palm
- Velocity of index finger movement

If the gesture meets predefined thresholds, a keypress is recognized.

Step 4: Virtual Keyboard Layout

A QWERTY layout is mapped onto a 2D coordinate grid. Each key is assigned coordinate boundaries on the screen. When the index fingertip enters a key’s region and a tap gesture occurs, the system identifies the character.

Step 5: Output rendering

- The screen displays:
- Virtual keyboard
 - Highlighted key during hover
 - Typed output text

This provides visual feedback to guide the user.

Software Stack

- Python
- OpenCV
- MediaPipe
- PyAutoGUI

Algorithm Performance Considerations

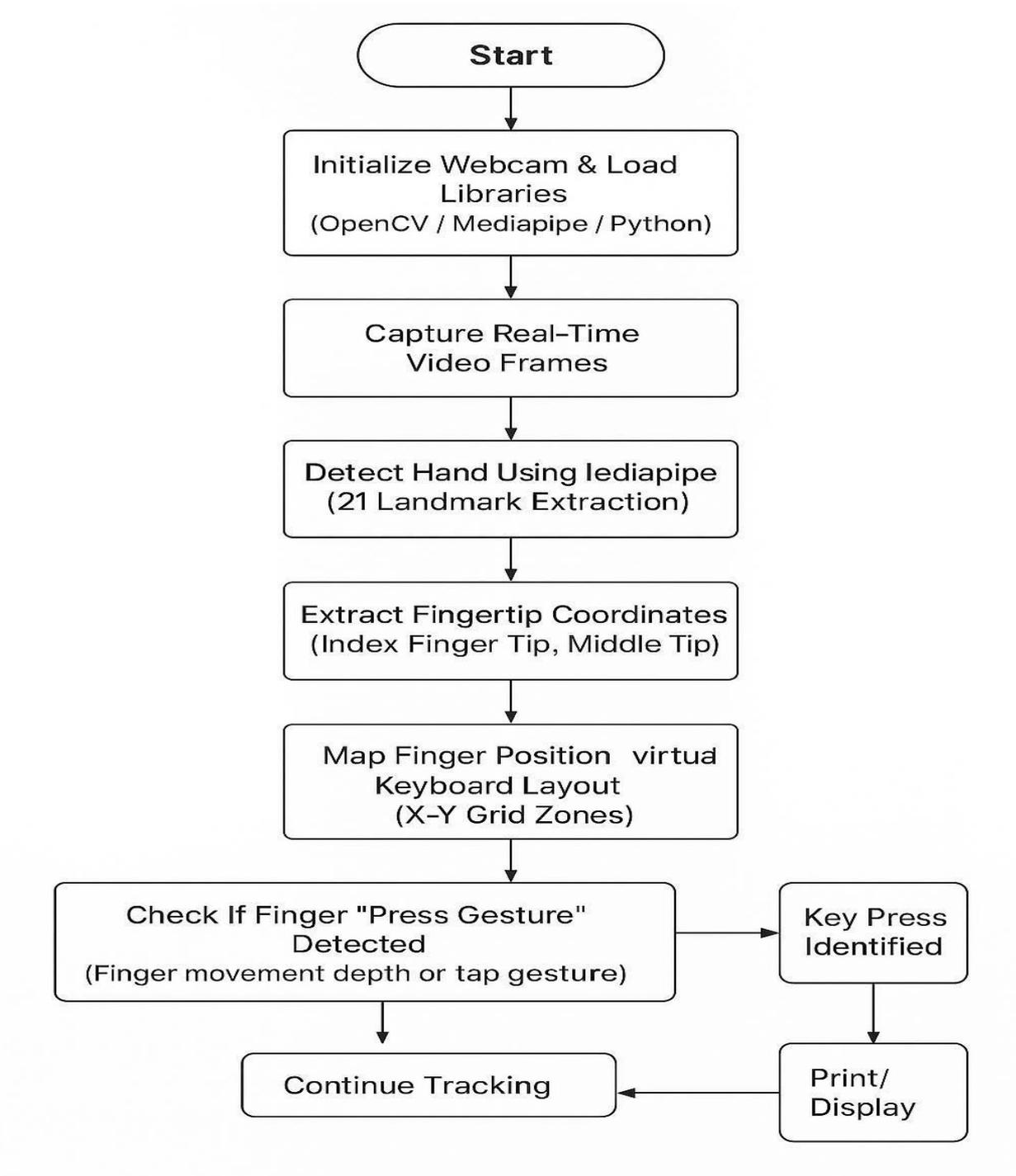
The methodology ensures efficient real-time typing with minimal delay by optimizing frame processing and reducing unnecessary computation.

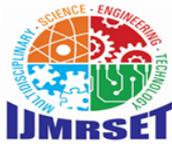


International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

V. FLOWCHART





International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

VI. IMPLEMENTATION

The implementation was carried out using Python 3.10 with libraries such as OpenCV for video processing, MediaPipe for hand detection, NumPy for calculations, and PyAutoGUI/Tkinter for text rendering. The system initializes the webcam stream and processes each frame in real time.

Key Implementation Steps:

1. Hand Detection Module

MediaPipe Hands is initialized with parameters for detection confidence and tracking confidence. Each frame is converted to RGB, fed to the hand model, and landmark points are extracted.

2. Virtual Keyboard Layout Creation

A fixed QWERTY layout is drawn on the window using OpenCV rectangles. Each key has x-y coordinate boundaries.

3. Finger Position Capture

The index fingertip (landmark 8) coordinates are mapped to screen coordinates.

4. Tap Gesture Recognition

Tap detection was implemented using two logics:

- o Depth-based tap (z-value change)
- o Fast downward motion (velocity threshold)

5. Key Selection and Character Printing

If the fingertip enters a key region and a tap is detected, the corresponding character is appended to the output string.

6. Visual Feedback

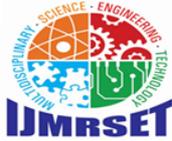
Highlighting of hovered keys and live display of typed text help the user type accurately.

Algorithm:

1. Start webcam and begin reading live video frames.
1. Flip frame horizontally for a mirror-like view.
2. Convert frame to RGB and pass it to MediaPipe Hands for hand landmark detection.
3. Draw the virtual keyboard on the frame and store the pixel coordinates of each key.
4. If a hand is detected:
 - o Extract index fingertip and thumb tip coordinates. o Display circles on both fingertips.
 - o Compute pinch distance between index and thumb. o Identify the hovered key based on fingertip location.
 - o Highlight the hovered key visually.
2. If pinch distance < threshold, consider it a key press gesture:
 - o If key = normal letter → press letter. o If key = Space/Enter/Backspace → trigger corresponding action.
 - o Apply a cooldown to prevent repeated accidental presses.
 - o Merge keyboard with camera feed for final display.
 - o Show output window until ESC key is pressed.
 - o Release camera and close all OpenCV windows.

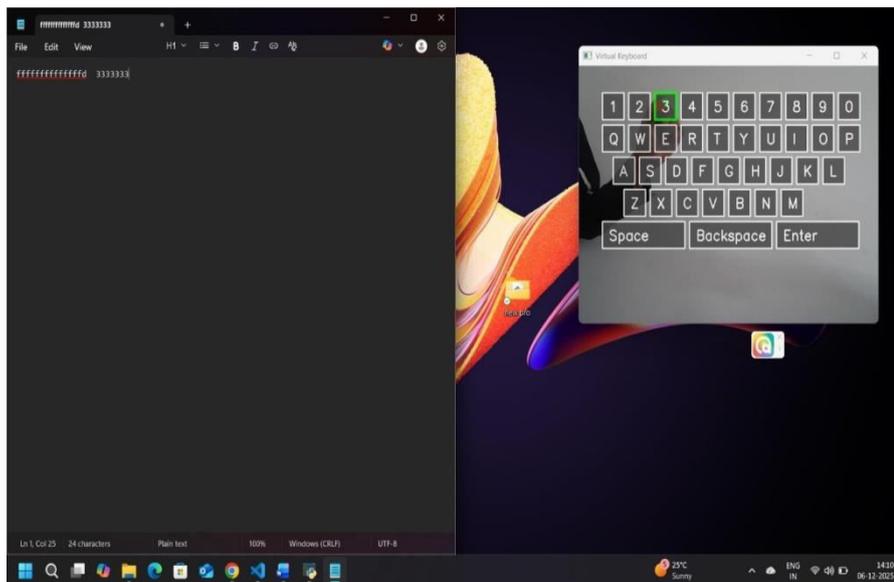
VII. RESULT





International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



VIII. CONCLUSION

The Employee OneStop revolutionizes workplace communication and information management by providing a centralized, secure, and user-friendly solution. By reducing reliance on traditional email systems, it enhances efficiency and ensures seamless access to crucial employee data. Managers can securely oversee workforce information, while employees can easily retrieve personal records, fostering transparency and accountability. This system not only streamlines HR operations but also improves decision-making and overall productivity. With its robust security measures and intuitive design, the platform empowers organizations to create a more organized and efficient work environment, ultimately enhancing employee satisfaction and operational success.



International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

IX. FUTURE SCOPE

The proposed virtual keyboard system based on hand gesture recognition demonstrates an innovative approach toward touchless human-computer interaction. However, several enhancements can be incorporated in future developments to improve accuracy, usability, and scalability.

1. **Integration of Deep Learning Models:** Future systems can incorporate advanced deep learning architectures such as CNNs, RNNs, or Transformer-based models to improve gesture classification accuracy under varying lighting conditions and complex backgrounds.
2. **Multi-Language and Predictive Text Support:** The virtual keyboard can be extended to support multiple languages along with AI-based predictive text and auto-correction features to enhance typing speed and user convenience.
3. **3D Hand Tracking Using Depth Sensors:** Integration of depth cameras (e.g., Intel RealSense, LiDAR) can improve gesture detection precision and enable more complex multi-dimensional interactions.
4. **Mobile and AR/VR Implementation:** The system can be deployed in smartphones, tablets, augmented reality (AR), and virtual reality (VR) environments to create immersive and portable typing interfaces.
5. **Adaptive Learning System:** Future systems can include adaptive machine learning mechanisms that learn individual user gesture patterns and improve performance over time.

REFERENCES

1. S. Mitra and T. Acharya, "Gesture recognition: A survey," *IEEE Transactions on Systems, Man, and Cybernetics—Part C: Applications and Reviews*, vol. 37, no. 3, pp. 311–324, May 2007, doi: 10.1109/TSMCC.2007.893280. [Online]. Available: <https://doi.org/10.1109/TSMCC.2007.893280>
2. S. Kumar, R. Patel, and A. Shukla, "A survey on virtual keyboard interfaces using hand tracking," *International Journal of Computer Applications*, 2015. [Online]. Available: <https://ijcaonline.org/archives/>
3. U. Purushothoman, "A computer vision based virtual hand gesture recognition system," *International Journal of Engineering Research in Sustainable Technologies (IJERST)*, vol. 1, no. 1, pp. 21–27, 2023, doi: 10.63458/ijerst.v1i1.59. [Online]. Available: <https://ijerst.drmgrjournals.org/index.php/ijerst/article/view/59>
4. N. Naaz and G. Praveen Babu, "Implementation of virtual keyboard using hand gestures," *International Journal for Research in Applied Science and Engineering Technology (IJRASET)*, 2023, doi: 10.22214/ijraset.2023.55863. [Online]. Available: <https://doi.org/10.22214/ijraset.2023.55863>
5. M. J. Alam and M. S. Hossain, "A review of virtual keyboard interfaces with gesture recognition," *Journal of Advanced Interaction Systems*, vol. 10, no. 3, pp. 45–60, 2022. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S2666827022000051>
6. "Gesture-Based Virtual Keyboard: Enhancing Human-Computer Interaction Through Hand Tracking," *IEEE Xplore Conference Article*. [Online]. Available: <https://ieeexplore.ieee.org/document/10803180>



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com