# Gesture-Controlled User Interface for Disabled Users

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**Abstract— Traditional computer interfaces rely heavily on keyboards, mice, and touch input, which create accessibility barriers for users with physical disabilities. This paper proposes a gesture-controlled user interface (GCUI) designed to assist disabled users in interacting with digital devices using hand gestures. The system uses a standard camera and computer vision techniques to detect and interpret gestures in real time. MediaPipe and OpenCV frameworks are utilized for hand landmark extraction and gesture recognition. The proposed method reduces the need for external hardware, making it cost-effective and easy to deploy. Experimental results show high accuracy in gesture detection and responsiveness, demonstrating the system's potential for enhancing digital accessibility.**

**Keywords** ***Gesture-Controlled User Interface (GCUI), Human-Computer Interaction (HCI), Accessibility Technology, Assistive Computing***

## I. INTRODUCTION

Human–Computer Interaction (HCI) has evolved significantly, but traditional interfaces remain challenging for individuals with motor impairments. People who cannot use keyboards or mice face difficulties in performing essential digital tasks such as browsing, typing, or operating basic applications. According to WHO, over one billion people live with some form of disability, highlighting the need for more inclusive technological solutions.

Gesture-based interfaces provide an intuitive and natural form of interaction by leveraging hand movements captured through a camera. Unlike specialized hardware (e.g., eye trackers, wearable devices), camera-based gesture systems are affordable and widely accessible. This research presents a gesture-controlled user interface designed to increase digital accessibility for disabled users by enabling hands-free or minimal-movement interaction.

## II. LITERATURE REVIEW / RELATED WORK

Various studies have explored gesture-based interaction for accessibility:

### A. Vision-Based Gesture Recognition
Several researchers have used computer vision to track hand gestures. Early systems relied on skin-color segmentation, but performance degraded under varying light conditions. With the introduction of deep learning frameworks, accuracy improved significantly.

### B. Wearable Device-Based Gesture Input
Gloves equipped with sensors or flex detectors were previously used. These solutions provide accurate tracking but are expensive and uncomfortable for users with limited mobility.

### C. MediaPipe-Based Hand Tracking
Recent studies utilize Google's MediaPipe framework, which provides real-time, high-fidelity hand tracking using machine learning. This has enabled lightweight and highly accurate gesture recognition.

### D. Accessibility Technologies
Assistive technologies such as speech recognition, switch controls, and eye-tracking systems exist, but many are costly or unsuitable for users with speech impairments or weak head movement.

Gap Identified:
Existing solutions either require expensive hardware or do not provide sufficient accuracy in real world environments. There is a need for a cost-effective, camera-based gesture interface optimized for disabled users.

## III. METHODOLOGY / PROPOSED WORK

A. System Architecture
The system consists of:
1. Input Module – Standard webcam for capturing hand movements.
2. Processing Module – MediaPipe Hand Landmark Model + OpenCV for image processing. 3. Gesture Recognition Engine – Classifies gestures such as click, scroll, drag, and navigation. 4. Output Module – Executes mapped actions on the user interface.

B. Hand Detection and Landmark Extraction
MediaPipe generates 21 hand landmarks per hand. These landmarks represent joints and fingertips. The coordinates are used to determine gesture patterns based on distances, angles, and relative positions.

C. Gesture Classification
The system detects gestures such as:
- Tap/Click – Index finger down
- Swipe Left/Right – Horizontal hand motion
- Open Palm – Menu trigger
- Fist – Stop / Pause
- Pinch – Zoom or drag

Rules-based classification (non-AI) is applied to reduce computational load. D. User Interface Mapping Recognized gestures are mapped to OS-level commands:
- Mouse movement
- Click / double click
- Scroll
- Application navigation

This mapping can be customized depending on user disability severity.

E. System Implementation
- Programming Language: Python
- Libraries: OpenCV, MediaPipe, PyAutoGUI
- Hardware: Standard laptop webcam
- OS: Windows/Linux

The system runs in real time at 20–30 FPS on mid-range hardware.

## IV. RESULTS AND DISCUSSION

A. Experimental Setup
Testing was conducted with 15 participants, including 5 users with mild motor impairments. Tests were performed in varying lighting conditions.

B. Performance Metrics
- Gesture Recognition Accuracy: 92%
- Response Time: 80–120 ms
- Frame Rate: 24 FPS (average)
- Error Rate in Low-Light Conditions: 9%

C. User Feedback
Participants reported:
- High responsiveness
- Ease of learning gestures
- Reduced dependency on physical input

Disabled users indicated that the system significantly improved their ability to operate a computer independently.

D. Limitations
- Reduced performance in very low light
- Background clutter may occasionally affect detection
- Continuous gesture usage may cause hand fatigue

## V. CONCLUSION AND FUTURE SCOPE

This paper presents a low-cost, camera-based gesture-controlled user interface designed to improve computer accessibility for disabled users. The system uses MediaPipe and OpenCV to accurately detect gestures and translate them into real-time actions. Results demonstrate high accuracy, low latency, and positive user acceptance.

Future Scope:
- Integration with virtual keyboards
- Voice + gesture hybrid interaction
- Adaptive gesture models based on user mobility level
- Implementation on mobile devices
- Support for sign-language-based interactions

The proposed system has strong potential to enhance digital inclusion and empower disabled users with greater independence.

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