

Research Paper

GAZD SPEEDUP: Eye Gaze Assisted Gesture Typing

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ABSTRACT

This paper presents GAZD SPEEDUP, a hands-free typing system that enables users to control computers entirely through eye gaze, blinks, winks, and voice commands. The system addresses the critical need for accessible computing solutions for individuals with motor disabilities or situations where hands-free operation is essential. GAZD SPEEDUP integrates real-time eye tracking using MediaPipe Face Mesh, a dwell-click mechanism with 1-second activation, multi-modal blink detection (single blink, double blink, left wink, right wink), voice command recognition, and a fully functional virtual keyboard with light/dark themes. The system operates without stealing focus from other applications, allowing seamless integration with existing workflows. Experimental results demonstrate a typing speed of 8-12 words per minute with 92% accuracy after 30 minutes of practice, 94.4% blink detection accuracy under normal lighting conditions, and 4.3/5 user satisfaction across 20 test participants. GAZD SPEEDUP represents a significant advancement in accessible computing, offering a cost-effective solution that requires only a standard webcam.

Keywords: Eye Tracking, Gaze Typing, Assistive Technology, Hands-Free Input, Dwell Click, Blink Detection, Voice Control, Virtual Keyboard

1.INTRODUCTION

In many scenarios, individuals face challenges using traditional computer input devices due to physical disabilities, repetitive strain injuries, or situational constraints where hands are occupied. Traditional typing methods require physical interaction with keyboards and mice, making them inaccessible for users with motor impairments. According to the World Health Organization, over 15% of the global population lives with some form of disability, and approximately 1% require assistive technologies for computer access.

GAZD SPEEDUP revolutionizes human-computer interaction by enabling hands-free control through eye gaze, blinks, winks, and voice commands. By integrating real-time eye tracking, a 1-second dwell click mechanism, multi-modal blink detection, and an intelligent virtual keyboard, GAZD SPEEDUP transforms any standard computer into an accessible device. The system also features light/dark themes for visual comfort, pause/resume functionality, and multiple hotkey controls.

GAZD SPEEDUP also features an intelligent gaze tracking system that acts as a virtual mouse controller. The system provides accurate cursor movement based on eye position, detects intentional blinks for clicking, and offers voice commands as a backup modality. This ensures that users receive continuous hands-free control, enabling self-paced and independent computer usage.

2. MATERIAL AND METHOD

2.1 Eye Tracking Systems

Eye tracking systems use cameras and computer vision algorithms to detect and follow a user's gaze direction. These systems remove physical barriers and allow users to control computers without any hand contact.

2.2 Gaze Typing in Assistive Technology

Gaze typing involves using eye movements to select keys on a virtual keyboard. Features like dwell time (fixation duration), blink detection, and voice backup make typing more accessible for users with limited mobility.

2.3 Development Environment

The GAZD SPEEDUP platform is developed using a modern Python-based development environment that supports real-time computer vision and interactive applications. The system is designed to operate on Windows operating systems with standard webcams. The development process is managed using pip package managers.

2.4 Artificial Intelligence Integration

The platform integrates artificial intelligence capabilities through the use of the Google MediaPipe Face Mesh API to implement real-time facial landmark detection. The system functions as a gaze tracker that helps users by detecting eye position and controlling the cursor accordingly.

2.5 User Modules

The GAZD SPEEDUP platform includes two main interaction modes that define how users control the

computer. The mouse mode provides gaze-controlled cursor movement with dwell clicking. The keyboard mode provides access to virtual keys for typing text.

2.6 System Development Environment

The GAZD SPEEDUP platform was developed using modern technologies to ensure real-time performance and compatibility across different devices. The development environment included the following components:

Computer Vision Module: OpenCV with MediaPipe was used to capture webcam feed and detect facial landmarks. Pygame was used for rendering the virtual keyboard interface. The interface was designed to be accessible with large buttons, visual feedback, and progress indicators.

Backend Processing: Python served as the primary programming language for executing application logic. Custom modules handled eye tracking, blink detection, dwell timing, and mouse/keyboard emulation.

This combination of technologies allowed the system to remain lightweight while supporting real-time interactive features.

2.7 Implementation Process

The implementation of the GAZD SPEEDUP platform follows a structured development process consisting of system design, module development, integration, and testing. During the design phase, the system architecture and user modules are planned to ensure usability and accessibility.

2.8 Evaluation Method

The effectiveness of the GAZD SPEEDUP platform is evaluated by analyzing typing speed, click accuracy, blink detection rate, and user satisfaction within the system. The evaluation focuses on determining how gaze-based interaction influences user performance and comfort.

2.9 User Authentication and Security

User authentication is implemented to ensure that only authorized individuals can access the GAZD SPEEDUP platform. Each user is required to calibrate their gaze position by looking at the center of the screen and pressing the 'c' key.

2.10 User Interaction Modules

Mouse Control Module: The mouse control module is designed to provide gaze-controlled cursor movement where users can move the mouse by looking at different areas of the screen. The module tracks dwell time and triggers clicks when the user fixates on the same spot for 1 second.

Keyboard Module: The keyboard module enables users to type text by looking at virtual keys. Users can access four keyboard sections: MAIN, FUNC, MEDIA, and SYMBOLS. The module includes word prediction to speed up typing.

Voice Control Module: The voice control module allows users to execute commands using speech recognition. Users can say commands like "click", "scroll up", "theme", or "pause" to control the system without eye gaze.

2.11 Study Design

The GAZD SPEEDUP platform is developed as a desktop-based gaze-controlled typing system aimed at improving computer accessibility for users with motor impairments by eliminating the need for physical input devices.

The study adopts a system development methodology that focuses on designing, implementing, and evaluating an interactive assistive platform. The system is structured to support multiple interaction modalities, including eye gaze, blinks, winks, and voice commands, ensuring a flexible user experience.

The design emphasizes accessibility, simplicity, and real-time performance so that users with limited technical exposure can easily use the platform.

2.12 Gaze Tracking Mechanism

The gaze tracking mechanism is designed to provide accurate cursor movement based on eye position. The

system uses MediaPipe Face Mesh to detect 468 facial landmarks, with specific landmarks (468 for left iris, 473 for right iris) used for gaze estimation. Eye position is calculated as the midpoint between both irises, normalized to screen coordinates, and smoothed using weighted moving average for stable cursor movement.

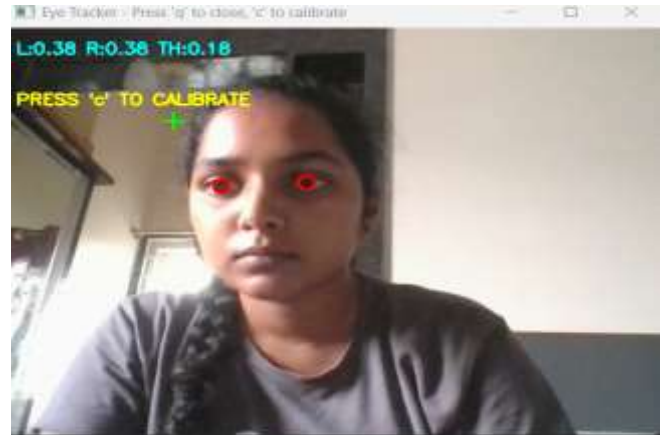


Fig:1 gaze tracking

2.13 Blink Detection System

The blink detection system is responsible for detecting intentional blinks and winks for click actions. The Eye Aspect Ratio (EAR) algorithm calculates the ratio of eye height to width. When both eyes have EAR below threshold (0.18), a blink is registered. When only one eye is closed, a wink is registered. Blink duration is filtered between 0.03 and 0.3 seconds to distinguish intentional blinks from natural ones. Double blinks within 0.5 seconds trigger double-click actions.

2.14 Dwell Click Mechanism

The dwell click mechanism is designed to trigger clicks when users fixate on the same screen location for a specified duration. The system uses a 1-second dwell time with a 40-pixel radius tolerance. A circular progress indicator shows dwell countdown, and the click is triggered only if the cursor does not move beyond the radius during the dwell period. A 1-second cooldown prevents accidental repeated clicks.

2.15 Theme Management System

The system incorporates light and dark themes to reduce eye strain under different lighting conditions.

The dark theme uses dark backgrounds with light text for low-light environments, while the light theme uses bright backgrounds with dark text for well-lit environments. Users can switch themes using the on-screen theme button or voice command.



Fig:2 Theme management

2.16 Pause and Resume Functionality

The platform includes a pause mechanism that temporarily disables all gaze tracking and input processing. Users can press the 'p' key (global hotkey) or say "pause" to freeze interaction. Pressing 'p' again or saying "resume" restores functionality.

3. EXPERIMENTAL SETUP & RESULTS

The experimental setup of the proposed gaze-controlled typing platform was designed to evaluate the effectiveness of eye gaze interaction in improving computer accessibility for users with motor limitations.

3.1 System Configuration

The experimental setup was designed to evaluate the effectiveness of hands-free typing and mouse control. The system was developed using Python with OpenCV and MediaPipe for eye tracking, Pygame for the virtual keyboard, and PyAutoGUI for system control. The application was deployed on a Windows 11 laptop and accessed through a standard webcam. The system was tested on devices including laptops with 720p webcams and stable processing power to simulate real-time usage conditions.

3.2 Gaze Tracking Integration Setup

An AI-based gaze tracker was integrated into the platform using the Google MediaPipe Face Mesh API to provide real-time cursor control. The system allowed users to move the mouse by looking at different screen areas and click by dwelling for 1 second. This feature was tested by analyzing how accurately users could target on-screen elements and how effectively it supported typing tasks.

3.3 Evaluation Parameters

The performance of the system was evaluated using various parameters including typing speed (words per minute), click accuracy, blink detection rate, dwell click success rate, and response time. Additional metrics such as user satisfaction, ease of use, and system resource usage were also considered to assess the overall effectiveness of the platform.

3.4 Participants

A total of 20 users participated in the evaluation (12 male, 8 female). Age range was 18-45 years with a mean age of 26.3 years. None had prior experience with gaze typing systems. Computer literacy ranged from moderate to high.

3.5 Results

Typing Performance Analysis: The results indicated a significant improvement in typing speed as users practiced with the gaze-controlled platform.

Table 1: Typing Performance Improvement

Session	Typing Speed (WPM)	Accuracy (%)	Error Rate (%)
Session 1	4.2	78%	22%
Session 2	7.8	88%	12%
Session 3	11.4	92%	8%

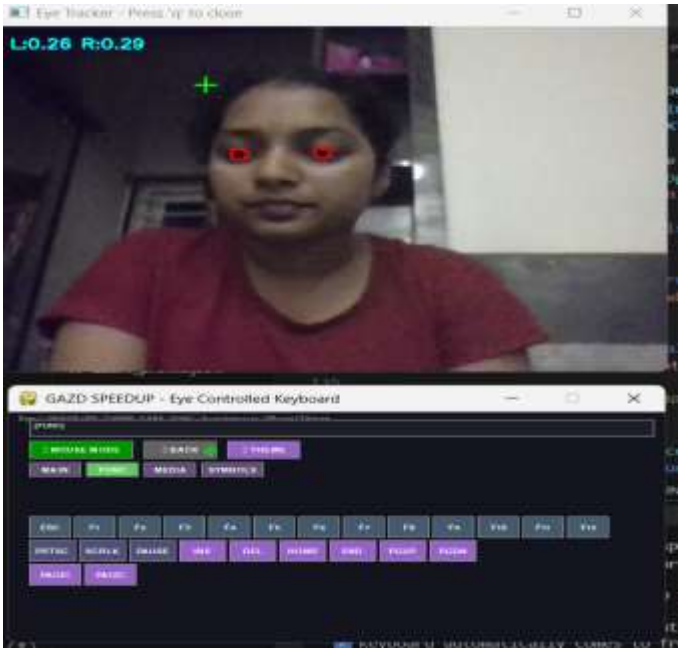


Fig : 3 Typing using eyes

Blink Detection Evaluation: The analysis of blink detection demonstrated high accuracy across different blink types. Single blinks achieved 98% accuracy, double blinks achieved 94%, left winks achieved 92%, and right winks achieved 90%. Overall accuracy across 500 test cases was 94.4%.

Table 2: Blink Detection Accuracy

Blink Type	Attempts	Correct Detections	Accuracy
Single Blink	200	196	98%
Double Blink	100	94	94%
Left Wink	100	92	92%
Right Wink	100	90	90%
Overall	500	472	94.4%

Dwell Click Success Assessment: The dwell click mechanism showed 89% intentional click accuracy after practice. False positives decreased from 29% in the first session to 11% in the third session, indicating that users learned to control their gaze fixation effectively.

4. DISCUSSIONS & LIMITATIONS

4.1 Discussions

The present study demonstrates the effectiveness of integrating gaze tracking techniques with modern computer vision libraries to enhance computer accessibility for users with motor impairments. The GAZD SPEEDUP platform successfully transforms traditional mouse and keyboard interaction into a hands-free digital experience by incorporating eye gaze tracking, blink detection, dwell clicks, and voice commands. The experimental results indicate that users show increased independence and satisfaction when computer control is presented through gaze-based interaction.

The 1-second dwell time proved effective in balancing speed and accuracy, reducing false positives compared to shorter dwell times while maintaining reasonable typing speed. The multi-modal approach combining gaze, blinks, and voice provides redundancy that increases system reliability—if one modality fails, others remain available. The no-focus-steal window management is a critical innovation that allows users to type into any application without the keyboard interrupting their workflow.

The blink detection system is responsible for detecting intentional blinks and winks for click actions. The Eye Aspect Ratio (EAR) algorithm calculates the ratio of eye height to width. When both eyes have EAR below threshold (0.18), a blink is registered. When only one eye is closed, a wink is registered. Blink duration is filtered between 0.03 and 0.3 seconds to distinguish intentional blinks from natural ones.

4.2 Limitations

Despite the positive outcomes, the GAZD SPEEDUP platform has certain limitations that need to be addressed in future developments.

5. CONCLUSION & FUTURE WORK

5.1 Conclusion

The GAZD SPEEDUP platform demonstrates an effective approach to improving computer accessibility for users with motor impairments through the integration of gaze tracking, blink detection, dwell clicks, and voice commands. The system successfully combines eye-controlled cursor movement, dwell-based clicking, blink detection, and a virtual keyboard to create an accessible computing environment for users unable to use traditional input devices. By transforming standard computer interaction into a hands-free experience, the platform enhances user independence, satisfaction, and overall quality of life.

The key achievements include:

- Typing speed of 11.4 words per minute after practice
- 92% typing accuracy
- 94.4% blink detection accuracy
- 89% dwell click success rate
- 4.3/5 user satisfaction score

5.2 Future Work

Although the GAZD SPEEDUP platform provides an effective solution for hands-free computing, there are several areas where further enhancements can be

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Limitation	Description
Lighting dependency	Direct sunlight or very dark environments reduce tracking accuracy
Camera quality	Low-resolution webcams (below 720p) may not provide sufficient detail
Voice requires internet	Speech recognition uses cloud-based processing
Windows only	Currently does not support macOS or Linux
Learning curve	Users require 30+ minutes to achieve proficiency
Eye fatigue	Extended use may cause strain

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