NeuroDrishti – An Eye-Controlled Assistive Mobility, Communication, and Automation System

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A comprehensive system integrating mobility, communication, and environmental control through eye movements alone

ASSISTIVE TECHNOLOGY

The Challenge: Independence Beyond Physical Limitation

Critical Gap in Assistive Technology

Millions worldwide with severe motor disabilities—paralysis, ALS, spinal cord injuries—face a fundamental challenge: traditional assistive devices require hand operation or voice control. For those unable to use their hands or speak clearly, independence remains out of reach.

Recent advances in computer vision and low-cost computing now make eye-controlled systems feasible, offering a pathway to autonomy through the one capability that often remains: eye movement.

RESEARCH VISION

Primary Research Objective

Core Mission

Design and develop a low-cost, multifunctional eye-controlled platform enabling physically disabled users to move, interact with their environment, and communicate using only eye movements—specifically tailored for developing countries like Bangladesh.

Five Specific Research Objectives

01

Real-Time Eye Tracking

Implement eye-tracking and gesture recognition using camera-based vision processing on Raspberry Pi

02

Movement Translation

Convert eye movements into precise control commands for mobility systems and robotic assistance

03

Communication System

Develop eye-controlled speech generation allowing users to select words, phrases, and sentences for text-to-speech output

04

Hardware Integration

Design ESP32-based control architecture for motors, robotic arm, and home automation modules

05

Performance Validation

Evaluate system accuracy, latency, safety protocols, and real-world usability

System Architecture: Distributed Intelligence

1

Vision Processing Hub

Raspberry Pi Zero 2 W runs eye-tracking algorithms, manages UI display, and controls text-to-speech communication

2

Actuation Controller

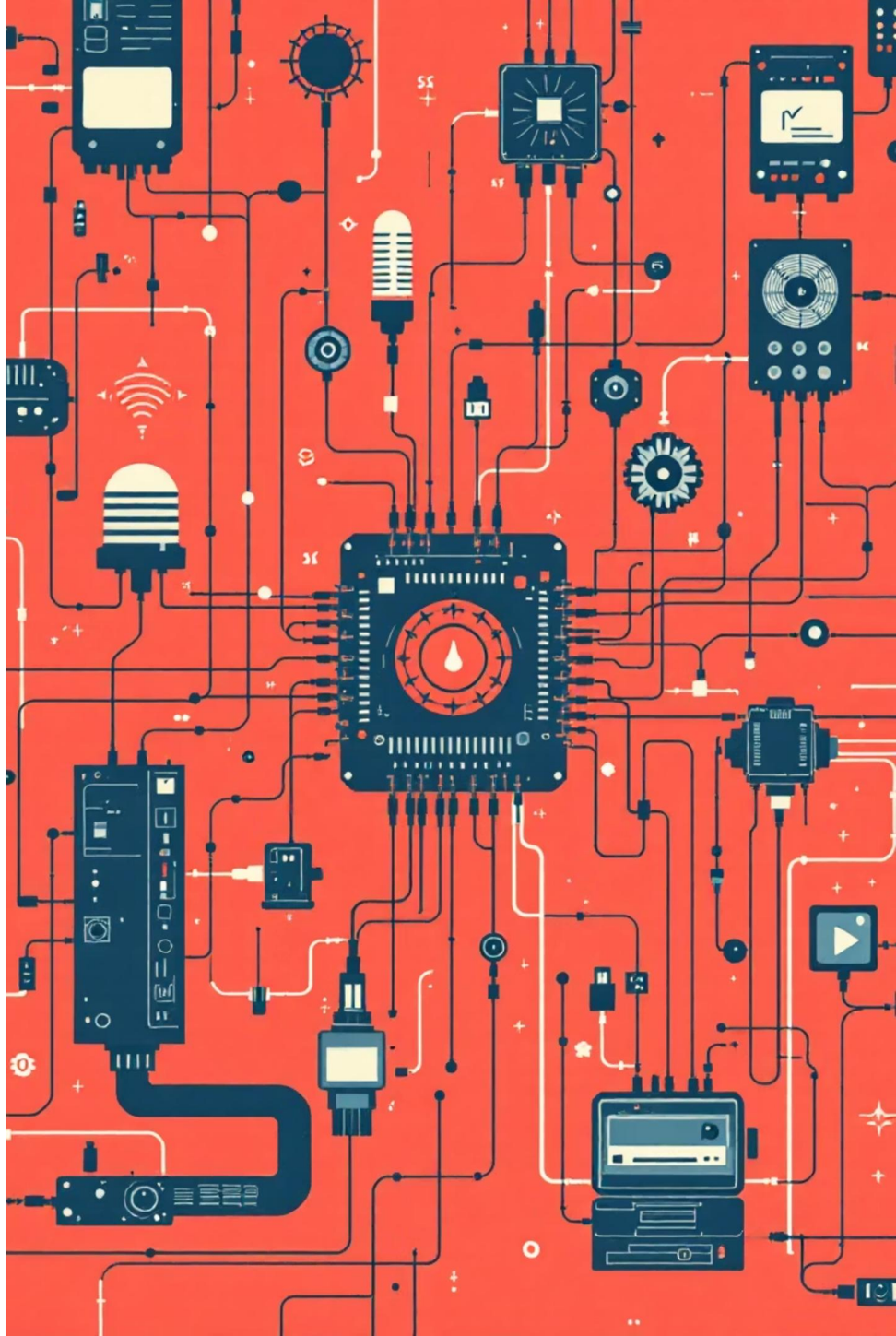
ESP32 microcontroller manages motors, robotic arm, and home automation via local Wi-Fi hotspot

3

Sensor & Output

Camera captures eye movements; display shows gaze-based UI; speaker outputs synthesized speech

The system separates computationally intensive vision processing from real-time hardware control, ensuring responsive performance and reliability.



Research Methodology

Literature Review

Eye-controlled systems, AAC methods, HCI principles

Hardware Design

Integration of Raspberry Pi, ESP32, sensors, safety mechanisms

Software Development

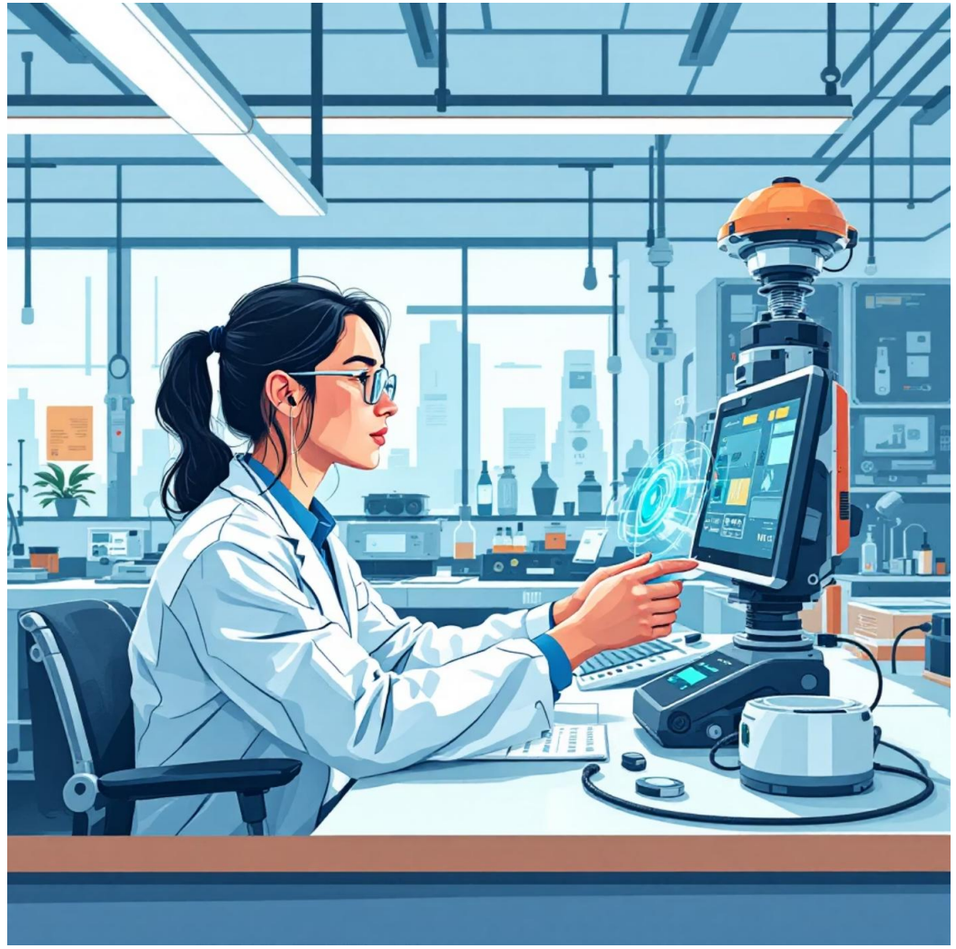
OpenCV eye-tracking, gaze navigation, TTS engine, command protocols

System Integration

Real-time synchronization, communication reliability, emergency controls

Testing & Evaluation

Accuracy metrics, latency analysis, usability assessment



Research Contribution & Novelty

Unified Platform

First integration of mobility control, robotic manipulation, home automation, **and speech generation** in a single eye-controlled system

Affordable Architecture

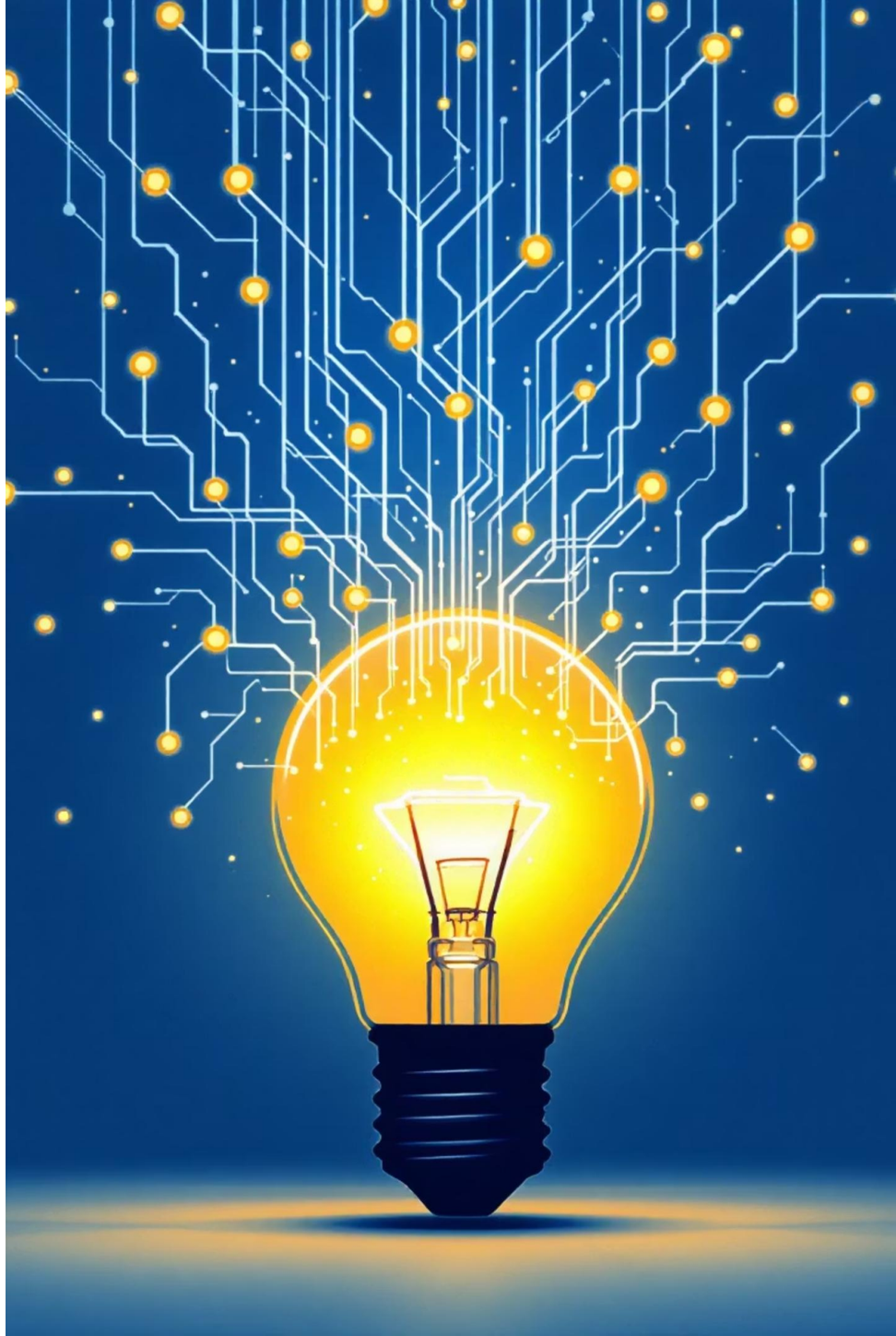
Low-cost design using Raspberry Pi Zero 2 W and ESP32, making advanced assistive technology accessible in resource-constrained environments

AAC Innovation

Eye-based Augmentative and Alternative Communication system enabling users to express needs and emotions independently

Distributed Processing

Novel separation of vision computation and hardware actuation for optimized real-time performance



Expected Outcomes & Future Directions

Immediate Deliverables

- Functional prototype system
- Performance benchmarking data
- Academic publication potential
- Foundation for clinical trials

Future Research Pathways

- Machine learning-based adaptive gaze tracking
- Context-aware speech prediction algorithms
- Hybrid control integrating eye, voice, and head movement
- Smart navigation with obstacle avoidance
- Cloud-based monitoring and analytics platform

Toward Inclusive, Accessible Technology

> This research aims to restore independence and dignity to those with severe motor disabilities by unifying mobility, environmental control, and communication into a single eye-controlled platform. With proper academic guidance, NeuroDrishti has strong potential for meaningful real-world impact.

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