Non-Intrusive Head Movement Control for Powered Wheelchairs

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ABSTRACT— While joysticks are commonly used to control wheelchairs, they may not be suitable for individuals with severe disabilities such as quadriplegia. Existing solutions like headrest switches, sip-and- puff devices, or tongue drive systems have limitations in terms of usability and control. This study explores a non-intrusive head movement control system for powered wheelchairs, aiming to improve mobility for people with motor impairments.

Using head movement tracking technology, the system interprets gestures and translates them into wheelchair commands. Experimental trials and user feedback demonstrate the system's effectiveness and positive user experience, indicating its potential as a practical assistive technology tool for enhancing wheelchair maneuverability and user autonomy.

1. INTRODUCTION

The introduction section provides an overview of Spinal cord injuries often result in loss of personal mobility, presenting a significant challenge for affected individuals. Traditional wheelchair control interfaces like joysticks are inadequate for quadriplegics who lack hand function. Tracking head movements has emerged as an alternative solution, but research in this area is limited. This study introduces a vision-based, non-intrusive system for wheelchair control using head movements, utilizing a simple web camera and advanced neural network technology. The system offers customization through calibration for individual users and enables continuous control, addressing limitations of existing approaches.

2. RELATED WORK

Sensor-based approaches, including the Tongue Drive System (TDS) and head position tracking using various sensors, have been explored for hands-free wheelchair control.

While effective, these methods may involve discomfort or limited functionality. Previous studies have utilized ultrasound sensors or infrared LEDs to track head movements and translate them into wheelchair commands

However, these approaches often lack precision or require complex hardware setups.

3. PROPOSED SYSTEM

The proposed system utilizes computer vision and deep learning algorithms to accurately detect the orientation of the user's head for wheelchair control. Unlike discrete head switches, this method allows for continuous navigation, enhancing user control and freedom of movement. Additionally, the system allows for individual calibration, ensuring optimal Individual calibration ensures optimal performance tailored to each user's needs. The system integrates seamlessly with existing electric powered wheelchairs (EPWs) and supports compatibility with various controllers. Signal processing algorithms interpret head-tracking data and translate it into precise wheelchair commands, facilitating intuitive control. Real-time feedback enhances usability and safety by informing users of the system's status and potential obstacles in their environment.

4. WORKING OF POWERED WHEELCHAIR

The operation of non-intrusive head movement control for powered wheelchairs involves sensors detecting head movements, which are then translated into commands for controlling the wheelchair's movements. These sensors can be gyroscopes, accelerometers, or cameras, depending on the design. The system analyzes the user's head movements and converts them into directional signals, allowing the user to navigate the wheelchair by moving their head.

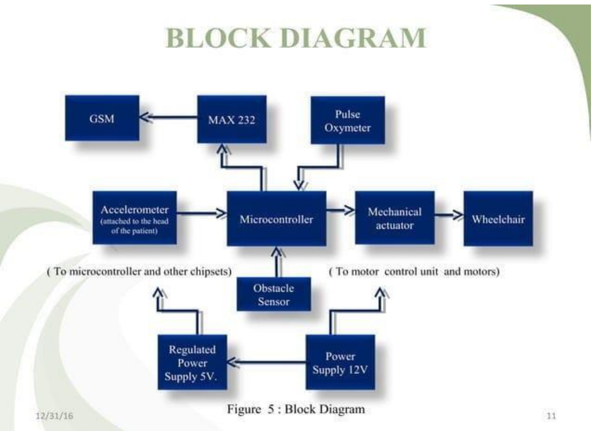

Fig 1. Image intensifier process

Signal processing is applied to the collected sensor data to filter noise and extract relevant information. Algorithms analyze the raw sensor data to identify patterns corresponding to specific head movements, such as tilting the head left or right, which are interpreted as commands for the wheelchair.

5. METHODOLOGY

The methodology for designing a robust head-controlled wheelchair focuses on two main modules: head orientation estimation and translating this orientation into velocity commands for the wheelchair.

Initially, the goal is to accurately estimate the user's head orientation, particularly capturing pitch and yaw angles. This is achieved by combining 'YOLO' (You Only Look Once), a state-of-the-art Convolutional Neural Network (CNN), with a facial landmark detector.

This combination allows precise determination of the user's head position and orientation in real-time.

Following successful head pose estimation, the next step is to map this orientation into actionable commands for the wheelchair's control system. Two methodologies are explored: discrete control and continuous control. Discrete control involves predetermined velocity values for different head orientations, while continuous control establishes a direct relationship between the user's head yaw angle and the wheelchair's turning velocity.

6. CONCLUSION

The study demonstrates the feasibility and effectiveness of employing non-intrusive head movement control for powered wheelchairs.

Through rigorous testing and analysis, it has been shown that this approach offers a viable alternative for individuals with motor impairments, enhancing their mobility and independence. Future research could explore further refinements to the system, including real-time adaptation algorithms and enhanced user interfaces, to optimize performance and usability. Ultimately, the continued development of non-intrusive control methods holds great promise in advancing accessibility and quality of life for individuals with mobility challenges.

REFERENCES

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