DESIGN AND DEVELOPMENT OF INTELLIGENT MOBILITY SUPPORT SYSTEM FOR PHYSICALLY IMPAIRED INDIVIDUALS USING ROBOT OPERATING SYSTEM (ROS2) AND MACHINE LEARNING MODELS.

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College : Sahyadri College of Engineering and Management, Mangaluru
Branch : Robotics And Automation Engineering
Guide(S) : Mr. Suhas
Student(S): Mr. Aniruddha Wagle K
Mr. Ashish S Talekar
Mr. Rohan Balamkar
Mr. Kailas Rai D

Keywords:

Assistive robotics, mobility support, health monitoring, Raspberry Pi, GSR sensor, indoor navigation, IoT, elderly care, user-centric design.

Introduction:

This project presents the development of an intelligent mobility support system for individuals with physical impairments. Combining advanced robotics with real-time health monitoring, the system incorporates a Raspberry Pi-powered navigator to enable indoor navigation. Sensor-driven data enhance adaptability and functionality. Health parameters such as pulse rate and galvanic skin response are remotely monitored to enable timely intervention. Real-world testing validated its reliability and usability, leading to iterative enhancements. Modified and developed based on user feedback. This innovative solution emphasizes mobility, safety, and independence, advancing assistive technologies to improve quality of life.

Objectives:

- To design and develop an easy mobility system that provides support for physically impaired people, helping them to walk with assistance.
- To develop a navigation system that instructs user on how to move to a specified location.
- To integrate a remote health monitoring system.

Methodology:

The development process begins with Problem Statement Selection, identifying the primary challenge or need. A Literature Review follows to analyse existing technologies and highlight gaps. Insights from this phase guide the Ideation stage, where innovative solutions are conceptualized.

The process then branches into two parallel streams:

1. Hardware Development:

3D Modelling: Creating a digital representation of the system's physical structure.

Material Selection: Choosing materials based on durability, weight, and cost.

Fabrication: Manufacturing and assembling physical components.

2. Software Development:

Software Architecture Design: Defining system structure and components.

Software Development: Coding and programming the software.

Simulation: Virtually testing the software for functionality.

The streams merge at Hardware Programming, where software is integrated with physical components to enable functionality. This is followed by the Final Assembly of all system components.

Next, Testing and Validation ensures performance, safety, and reliability. Finally, the Documentation phase records the entire project for future reference and replication.

This iterative approach allows continuous feedback and improvement, ensuring a comprehensive and robust design.

Result and Conclusion:

The intelligent mobility system, tested in both controlled and real-world environments, effectively provided navigation and health monitoring for physically impaired users. The Python-OpenCV-based navigation module on Raspberry Pi 4B successfully guided users with real-time obstacle detection and feedback but required improved calibration for bright conditions. IoT health monitoring, using MAX30102 and Grove GSR sensors, enabled real-time tracking of heart rate and stress levels, ensuring timely alerts. User feedback led to key improvements, including a smaller navigator box, enhanced sensor accuracy, and optimized navigation graphs. The system demonstrated significant potential in improving mobility, safety, and accessibility.

Figure: The Mobility Support System

Figure: Dashboard

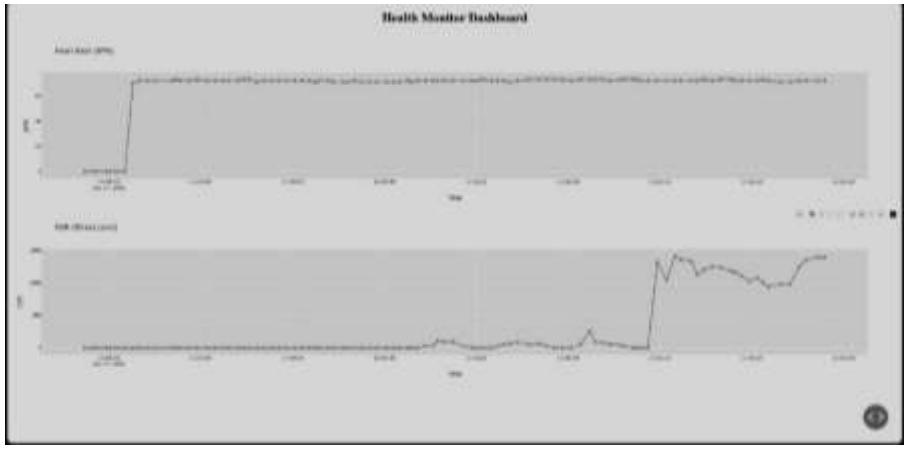

Figure: Remote Health Monitoring System

Future Scope:

- Advanced Navigation with ROS2 and SLAM: Implementing ROS2 and SLAM for precise path planning and real-time environmental mapping to enhance navigation accuracy and efficiency.
- Compact Design Using PLCs: Integrating programmable logic controllers with built-in cameras and LiDAR to create a smaller, less complicated system for better portability and usability.
- IoT for Enhanced Health Monitoring: Incorporating IoT for real-time health tracking and alerts for critical conditions like heart attacks and strokes, ensuring comprehensive user safety.