IT4010 – Research Project - 2024

Topic Assessment Form

Project ID:

24 – 25J - 048

1. Topic (12 words max)

Smart Wheelchair with Integrated Treatment Features for Leg Disabled Persons

2. Research group the project belongs to

Technology Integration & Management (TIM)

3. Research area the project belongs to

Internet of Things (IoT)

4. If a continuation of a previous project:

Project ID	24 – 25J - 048
Year	2024

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

The rising number of people with disabilities, especially in the elderly population, poses a serious threat to contemporary healthcare systems. The World Health Organization estimates that 15% of people worldwide live with a handicap, with a significant percentage having significant functional restrictions. Mobility limitations are a significant hindrance to independence and quality of life, especially when they affect the lower limbs. While they do not have the sophisticated features needed for integrated health monitoring and individualized care, traditional wheelchairs do provide some mobility.

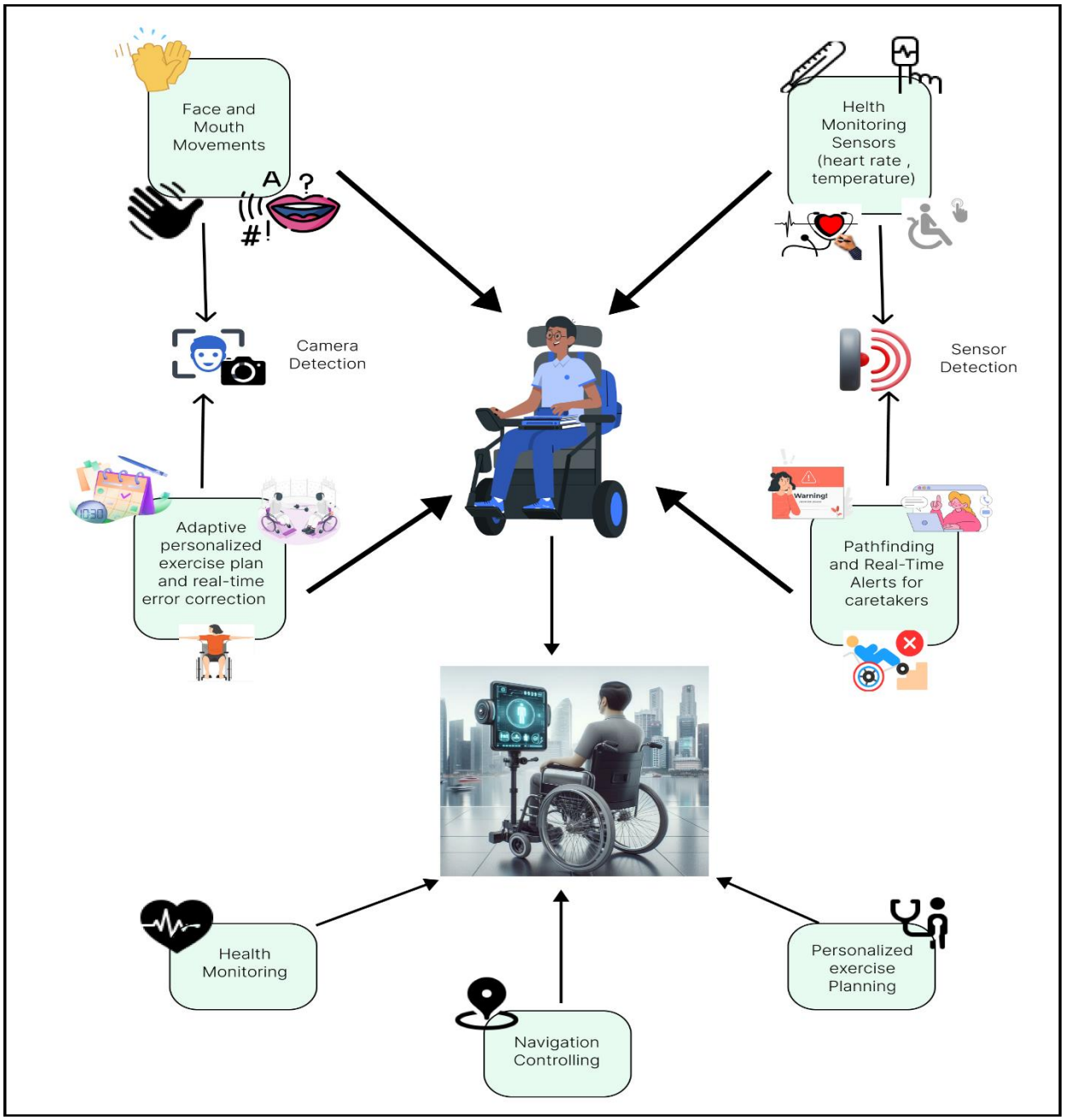
For those with severe disabilities, interacting physically is often necessary for current assistive devices, which can be difficult or impossible. Furthermore, these gadgets are unable to adapt dynamically to the user's health demands or the surroundings since they lack real-time health monitoring and adaptive functions. This functional gap can result in less-than-ideal care, decreased mobility, and a greater reliance on caregivers, all of which can affect the quality of life for people with disabilities.

To improve the independence of people with mobility limitations while maintaining their safety and well-being, creative solutions are required. These problems might be resolved by incorporating cutting-edge technology into smart wheelchairs, such as gesture control, facial recognition, real-time health monitoring, and adaptive workout planning. Enhancing the system's responsiveness and intuitiveness can provide users with more control and better health results.

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

   For people with severe disabilities, we suggest a smart wheelchair that integrates cutting-edge technologies to improve mobility and health monitoring. This system is responsive and easy to use since it integrates facial recognition, gesture control, real-time health monitoring, and customized exercise programming. The intelligent wheelchair facilitates hands-free control by detecting hand, mouth, and facial motions with advanced algorithms and a high-definition camera. To enhance their independence, users can operate the wheelchair by uttering words like "go" or altering their lip angles to change direction. Through constant wheelchair position monitoring and health monitoring, AI-driven pathfinding technology guarantees safe navigation. In the case that deviations from the intended path are discovered, caregivers receive real-time alerts that help to ensure user safety and prevent potential risks.

   Apart from specific sensors for measuring leg temperature, integrated biosensors track vital indications like heart rate, blood pressure, body temperature, and oxygen levels. This extensive health data is examined to provide in-depth reports available to users and medical professionals, enabling further care and treatment. Lastly, the wheelchair comes with an adaptive workout program that is customized to the individual profile of each user and emphasizes exercises for the upper body and neck. Throughout workouts, an integrated camera records user movements and provides real-time feedback to guarantee precision and efficacy. By combining these technologies, the smart wheelchair improves people with disabilities' quality of life and health outcomes in addition to increasing mobility.


Face and Mouth Movements
Helth Monitoring Sensors (heart rate , temperature)
Camera Detection
Sensor Detection
Adaptive personalized exercise plan and real-time error correction
Pathfinding and Real-Time Alerts for caretakers
Health Monitoring
Navigation Controlling
Personalized exercise Planning

7. Brief description of specialized domain expertise, knowledge, and data requirements

(300 words max)

Specialized Domain Expertise

1. **Artificial Intelligence and Machine Learning:**
   - Develop systems to interpret facial expressions, hand gestures, and path deviations.
   - Knowledge areas: computer vision, natural language processing, real-time data processing.

2. **Embedded Systems and Microcontrollers:**
   - Develop hardware components of the wheelchair.
   - Knowledge areas: sensor integration, real-time data acquisition, control systems.

3. **Human-Computer Interaction (HCI):**
   - Design user-friendly interfaces and intuitive system responses.
   - Knowledge areas: UX design, gesture recognition, adaptive interaction techniques.

Knowledge Requirements

1. **AI and ML Models:**
   - Image and gesture recognition, pathfinding algorithms, anomaly detection in health monitoring data.

2. **Sensor Technologies:**
   - Types of sensors (heart rate, blood pressure, temperature) and their integration into a monitoring system.

3. **Health Data Analytics:**
   - Analyzing health data to identify trends, detect anomalies, and generate health reports.
   - Knowledge areas: data preprocessing, feature extraction, health informatics.

4. **User Interaction Design:**
   - Designing accessible interfaces for users with disabilities.
   - Knowledge areas: voice commands, gesture-based controls, real-time feedback mechanisms.

5. **Exercise Physiology:**
   - Designing and adjusting exercise plans based on individual health metrics.
   - Knowledge areas: safe exercise practices for disabled individuals.

Data Requirements

1. **Training Data for AI Models:**
   - Datasets of facial expressions, mouth shapes, and hand gestures for training recognition algorithms.
   - Ensure diverse samples for accuracy and robustness.

2. **Health Monitoring Data:**
   - Continuous data from biosensors monitoring heart rate, blood pressure, body temperature, oxygen levels, and leg temperature.
   - Historical health data for personalized treatment plans.

3. **Pathfinding Data:**
   - Maps and environmental data for developing and testing pathfinding algorithms.
   - Real-time location data for monitoring the wheelchair's position and detecting deviations.

4. **Exercise Performance Data:**
   - Data on the user's physical condition, exercise performance, and progress.
   - Motion detection data and feedback from exercise sessions for personalized exercise plans.

8. Objectives and Novelty

Main Objective

This project aims to enhance mobility and healthcare for leg-disabled individuals by developing a gesture-controlled wheelchair system. Using facial and hand gestures, users will navigate the wheelchair without traditional physical controls. Biosensors will continuously monitor vital signs and alert caretakers to any health issues in real-time. The wheelchair will autonomously adjust its speed based on the terrain's angle for safe operation. Personalized exercise plans with real-time feedback will promote physical rehabilitation, supported by comprehensive health data analysis for personalized care.

Member Name	Sub Objective	Tasks	Novelty
Premathilaka H.G.K.D	**1.Face and mouth Movements Detection and Hand Gesture Recognition System**	• Gather data on various facial expressions, mouth movements, and hand gestures. • Use both real-time data collection and existing datasets for training. • Develop algorithms for real-time detection and recognition of face and mouth movements. • Implement hand gesture recognition algorithms using computer vision techniques. • Integrate the face and hand gesture recognition systems with the smart wheelchair control system. • Ensure the wheelchair can respond to user commands detected through facial and hand gestures.	Face and mouth Movements Detection and train it to specific letters (go, hmm…) (and Hand Gesture) which is helpful for controlling the system only using a single face movement.

		• Develop a user training module to help users familiarize themselves with the gesture recognition system. • Implement adaptive learning so the system can personalize itself to the user's specific movements and gestures. • Conduct extensive testing to ensure the accuracy and reliability of the detection systems. • Validate the system's performance in real-world scenarios with leg-disabled persons.	
Thennakoon T.M.S	**2. Pathfinding and Real-Time Alerts for Deviations**	• Create AI-driven algorithms to navigate the wheelchair through various environments, dynamically adjusting routes based on real-time data. • Integrate GPS and other positioning technologies to continuously monitor the wheelchair's location and ensure accurate positioning relative to predefined paths. • Develop methods to continuously monitor and integrate the user's health metrics (e.g., heart rate, blood pressure) with the pathfinding system. • Implement systems to detect when the wheelchair deviates from the intended path, setting acceptable deviation thresholds based on the environment and user-specific factors. • Develop mechanisms to send immediate alerts to caregivers when deviations are detected, including relevant information like location and nature of the deviation.	Adjust the wheelchair's moving speed according to the angle in the floor it is moving.

		• Create a user-friendly interface for caregivers to receive and respond to real-time alerts, providing clear, actionable information for quick intervention. • Develop comprehensive safety protocols and redundant systems to ensure continuous monitoring and alerting even in case of primary system failure.	
Samarawickrama A.W.D.M	**3.Integrated Health Monitoring System**	• Identify the specific health parameters to be monitored (e.g., heart rate, blood pressure, body temperature, oxygen levels). • Define the user and caretaker needs and expectations regarding health monitoring. • Research and select appropriate sensors for monitoring the identified health parameters. • Ensure sensors are non-invasive, comfortable for the user, and suitable for continuous monitoring. • Integrate sensors into the wheelchair in a way that does not hinder user movement or comfort. • Develop software to collect data from the health sensors in real-time. • Design a secure and efficient data storage solution for logging health data. • Implement data management practices to ensure data integrity, privacy, and compliance with relevant regulations • Conduct extensive testing to validate the accuracy, reliability, and usability of the health monitoring system.	Detect sudden spikes of the heart rate and give alerts.

		• Perform real-world testing with users to ensure the system meets their needs and performs well in daily scenarios. • Develop training materials and conduct sessions to educate users and caretakers on how to use the health monitoring system effectively. • Provide comprehensive documentation covering system setup, operation, maintenance, and troubleshooting.	
Bentotage S.N	**4. Adaptive personalized exercise plan and real-time motion detection of the exercises**	• Identify the specific exercise movements to be monitored, focusing on neck exercises. • Define the user and caretaker needs and expectations regarding exercise planning and real-time feedback. • Research and select appropriate sensors for monitoring exercise movements. • Ensure sensors are non-invasive, comfortable for the user, and suitable for continuous monitoring. • Integrate sensors into wearable devices or the wheelchair, ensuring they are positioned correctly. • Develop algorithms to create personalized exercise plans based on the user's physical condition and health metrics. • Ensure plans are adaptive, adjusting exercises based on user performance and progress.	The program evaluates each user's unique profile and suggests customized upper body workouts, emphasizing exercises for the neck. Using a camera to track users' motions while they complete these exercises, the device provides real-time feedback to guarantee accuracy and efficacy.

		• Design a feedback system to provide real-time guidance and corrections during exercises. • Implement visual, auditory, or haptic feedback mechanisms to guide users. • Develop a system to record exercise performance and progress after each session. • Implement algorithms to analyze performance data and update exercise plans accordingly. • Conduct extensive testing to validate the accuracy and reliability of the motion detection and feedback systems. • Perform real-world testing with users to ensure the system meets their needs and performs well in daily scenarios. • Establish a maintenance plan to ensure the system remains functional and up to date. • Provide ongoing support to address any issues or improvements based on user feedback.	

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9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes	✓	No	

b) Does the proposed topic exhibit novelty?

Yes	✓	No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes	✓	No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes	✓	No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

The components need further development and specifications but acceptable for the time.

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Ms.	Dinithi	Panditharathne	Dinithi Panditharathne 24/6/2024
Co-Supervisor	Ms.	Shashika	Lokuliyana	24/6/24
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				