SAMSUNG INNOVATION CAMPUS GRADUATION PROJECT

Project title	Smart IoT-Based Wheelchair System with Remote Monitoring and Control
Project Track	**IOT**

1. Project Information

Project title	Smart IoT-Based Wheelchair System with Remote Monitoring and Control
Project Track	IoT
partner	Samsung & Life Makers

2. Supervisor Information

Supervisor Name	**Omar Ramadan**

Mobile	**+20 127 581 3228**
E-mail	**oattalla716@gmail.com**

3. Project Members Information

#	Name	Department	Email
1	Salma Yasser Soliman	Mechatronics	saloomyasser962@gmail.com
2	Mohamed Samir Abowarda	Mechatronics	samermohammed941@gmail.com
3	Anton Samy Tawfeek	Department of Computer Science and Engineering	antonsamy2004@gmail.com
4	Mahmoud Tamer	Mechatronics	Mahmoudtamer12@gmail.com
5	Rana Hany Mohamed	Electronics and Communication	ranahanyyy64@gmail.com
6	Mariam Medhat Sadek	Mechatronics	20p8306@eng.asu.edu.eg

1. Problem Definition

People with physical disabilities often face challenges in mobility and safety. Traditional wheelchairs provide limited functionalities, leaving caregivers unaware of critical situations such as the wheelchair tipping over or a sudden need for assistance. Additionally, current wheelchairs lack real-time monitoring and control features that could improve both user experience and caregiver efficiency.

Objective: Design and implement a smart wheelchair system that provides:

- **Remote control** via PS4 controller.
- **Real-time location tracking** using GPS.
- **Emergency alerts** if the wheelchair tips over.
- **Live video streaming** for remote supervision.
- **Remote control capabilities** via MQTT commands.

2. Approach and Tools/Techniques

The project utilizes IoT technology to enhance the functionality of a conventional wheelchair. The primary components of the system are controlled using a PS4 controller, with added functionalities like GPS tracking, emergency alerts, live streaming, and MQTT-based remote control for caregivers. A combination of hardware and software tools has been employed for seamless communication between devices.

Key Components:

- **Hardware:**
  - Raspberry Pi 3 (central controller)
  - Arduino Uno (x2: one for motor control, one for GSM and IMU sensors)
  - GPS module
  - Motor drivers
  - GSM module
  - IMU (Inertial Measurement Unit)
  - PS4 controller
  - Camera for live streaming
- **Software:**
  - **Node-RED** for dashboard and real-time monitoring.
  - **MQTT** (HiveMQ) for communication between Raspberry Pi and external devices.
  - **GSM messaging** for emergency notifications.
  - **Python/Arduino C++** for programming hardware components.

3. Overview of System Modules

a. Control System

- The wheelchair's movement is controlled via a PS4 controller, connected through Bluetooth to the Raspberry Pi. The Raspberry Pi sends signals to the motor drivers that control the motors attached to the wheelchair wheels.

b. GPS Tracking Module

- A GPS module connected to the Raspberry Pi provides real-time location data of the wheelchair. This data is visualized on the Node-RED dashboard, allowing caregivers to monitor the wheelchair's position remotely.

c. Emergency Detection and Alerts

- An IMU (Inertial Measurement Unit) is used to detect if the wheelchair has tipped over. If such an event is detected, an alert message is sent from the Arduino (responsible for the IMU) to the Raspberry Pi. The Raspberry Pi publishes this alert to the MQTT server (HiveMQ), and a GSM module sends an emergency SMS to the caregiver.

d. Live Streaming Module

- A camera mounted on the wheelchair provides live video streaming to the caregiver via the Node-RED dashboard. This allows for real-time supervision of the wheelchair user.

e. Remote Control via MQTT

- The system allows the caregiver to remotely control the wheelchair through MQTT messages. These commands are sent from the Node-RED dashboard to the Raspberry Pi, which relays them to the Arduino responsible for motor control.

4. IMPACT

Why do we consider this project? What is its impact on community/market/end user/?

Why did we choose this project?

1. Empowering Mobility with Intelligence

- Wheelchair users deserve more than basic mobility—they deserve technology that enhances their experience.
- Our project integrates smart features that go beyond movement, offering real-time insights and immediate alerts.
- It's not just about convenience, but about giving users more control, safety, and autonomy in their daily lives.

2.Combining Tech and Real-Life Needs

- What's special about this project is how we're using cutting-edge technology to solve real-world problems.
- It's not just about building something for the sake of it—we're focusing on the human need for independence and dignity.
- By bringing together sensors, communication, and remote monitoring, we're creating a system that makes a real difference in people's day-to-day lives.

3.Thinking About the Future of Healthcare

- We're not just focused on solving today's problems.
- We're looking ahead to how healthcare and assistive technology will evolve.
- By creating a platform that can easily adapt to new innovations like AI or more advanced monitoring systems, we're building something that has the potential to grow and improve over time.
- We're setting the stage for what assistive devices could be in the future.

Impact on the Community/Market/End User:

1.Community Impact – A Lifeline for Caregivers:

- For caregivers and families, your system is much more than a wheelchair—it's peace of mind.
- Features like real-time alerts and GPS tracking ensure that caregivers can stay connected to their loved ones, even from afar.
- In critical moments when every second counts, our system can make all the difference, providing immediate help when it's needed most.
- This type of security changes how families and caregivers can support wheelchair users, allowing them to act faster and more efficiently.

2. The Market Is Ready for This

- Assistive technology is overdue for something like this.
- By using affordable components like Raspberry Pi and GPS modules, we're building something that can actually be scaled and brought to the market.
- This project isn't just a one-time solution—it has the potential to disrupt the industry and become a new standard for smart mobility devices.

3. For Users, It's a New Level of Freedom

- This wheelchair system isn't just about movement; it's about giving users the freedom to control their own lives.
- With features like remote control, health monitoring, and emergency alerts, they can be more independent without sacrificing safety.

- It’s a tool that empowers users to live more confidently and with less reliance on constant supervision.

1.NOVELTY AND FEATURES

Explain (i) novelty (ii) features, and (iii) related products

(i)Novelty:

The novelty of the smart wheelchair system lies in its integration of multiple advanced technologies into one comprehensive, cost-effective solution. While wheelchairs with some smart features do exist, this project builds on existing models by incorporating several modules that enhance both user experience and caregiver support:

- Multimodal Control: Combining PS4 controller-based manual control with remote control via MQTT adds flexibility, allowing users or caregivers to operate the wheelchair in different environments, either locally or remotely.

- Real-time Monitoring with Live Streaming: Many commercial smart wheelchairs lack live video streaming, which enables caregivers to visually monitor the patient’s condition and surroundings in real time, significantly enhancing safety.

- Tilt Detection and Automatic Alerts: While emergency alert systems exist, this project leverages IMU sensors for automatic detection of wheelchair tipping, instantly notifying caregivers via SMS, making the system highly responsive in case of accidents.

- Integration of IoT Technologies: By combining GPS tracking, remote monitoring, MQTT communication, and GSM alerts on a Node-RED dashboard, this project offers a complete, interconnected IoT solution, which increases the reliability and safety of patient management.

(ii) Features

- PS4 Controller-Based Manual Control: Users can control the wheelchair through a familiar, user-friendly PS4 controller, providing more ergonomic control than traditional joystick systems.

- Remote Control via MQTT: Caregivers can send movement commands via an MQTT dashboard (Node-RED), allowing for remote operation from anywhere with internet access.

- GPS Tracking and Location Monitoring: A GPS module provides real-time location data of the wheelchair, which can be accessed and monitored on a visual Node-RED dashboard.

- Tilt Detection with SMS Alerts: If the wheelchair tips over, an IMU sensor detects the event, and an SMS alert is automatically sent to the caregiver through the **GSM module**. The incident is also logged in the MQTT server for immediate action.

- Live Video Streaming: The wheelchair is equipped with a camera that streams live video to the Node-RED dashboard, allowing caregivers to visually monitor the user in real time.

- GSM-Based Emergency Communication: In case of an emergency, the system automatically sends a **text message alert to a designated caregiver, ensuring that assistance can be dispatched quickly.

(iii) Related Products

Several products in the market offer smart wheelchair functionality, but each typically lacks the full integration seen in this project:

1. Permobil F5 Corpus VS:

- Offers advanced standing functionality and basic smart features.

- Limitations: Does not include real-time GPS tracking, live streaming, or IoT-based remote control.

- Cost: High-end, expensive solution, often inaccessible to many users.

2. WHILL Model C2:

- A more compact and agile wheelchair with mobile app connectivity.

- Limitations: Lacks **live video streaming, MQTT remote control, and emergency alerts via GSM.

- Cost: Pricey, and it doesn't offer as complete a monitoring system as this project.

3. SmartDrive MX2+:

- Offers power-assist for manual wheelchairs via Bluetooth control.

- Limitations: No remote control, real-time GPS, or emergency tilt alerts.

- Cost: Also expensive for what it provides.

Originality:

This project adds novelty by integrating existing technologies—PS4 controller, GPS, IMU, MQTT, GSM, and live streaming—into a single, cost-effective smart wheelchair solution. By combining these features, the system provides greater accessibility at a lower cost, while significantly enhancing safety and monitoring capabilities.

1. DELIVERABLES

What is the project final outcome (HW device, SW package, simulation ...)?

Due to limited resources, the project was successfully implemented on a mini car prototype instead of a full-sized wheelchair. The prototype replicates all the key functionalities that would be applied to the actual smart wheelchair system.

Hardware Device

The final hardware outcome is a mini car prototype equipped with the same core technologies that would be used in the wheelchair system:

● PS4 Controller: Used to manually control the movement of the mini car.

● Motor Driver System: Controls the car's wheels through Arduino Uno.

● GPS Module: Provides real-time location tracking.

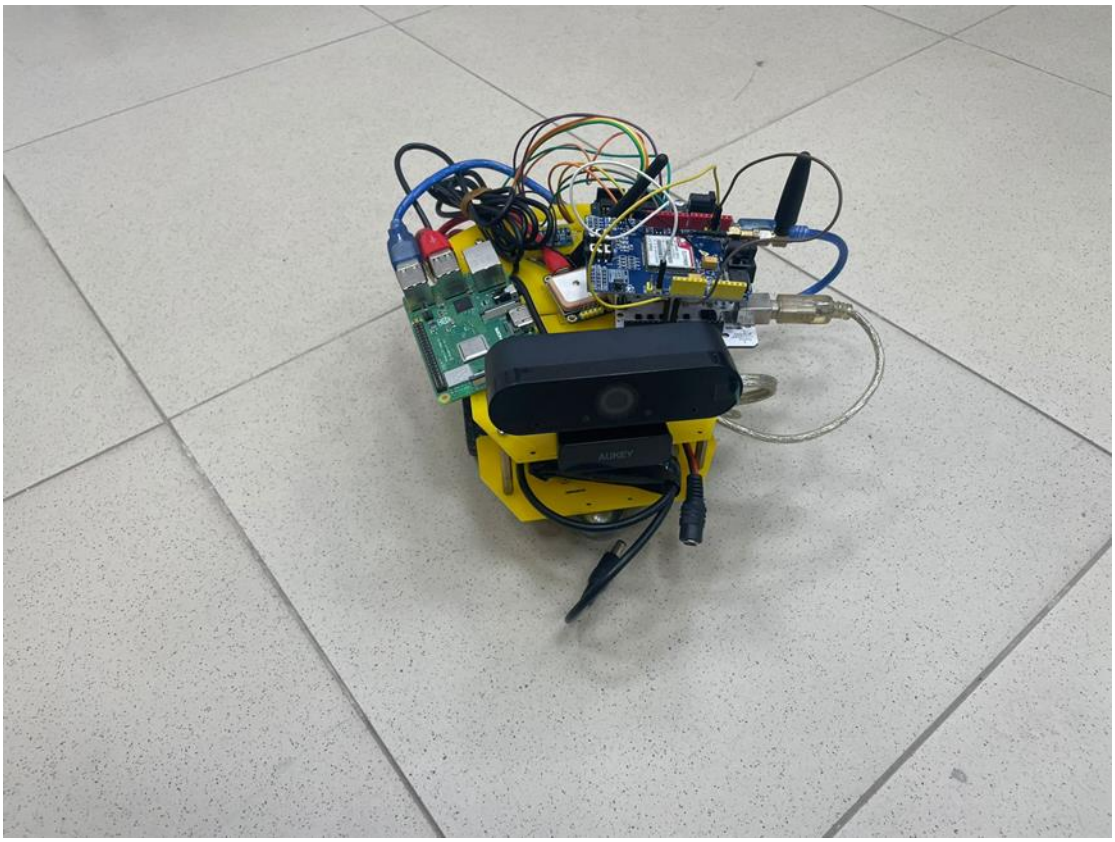
● IMU Sensor: Detects tilt or overturn events, simulating a wheelchair tipping over.

● GSM Module: Sends SMS alerts in the event of a detected emergency.

● Camera Module: Mounted on the mini car for live video streaming.

Evidence and Results:

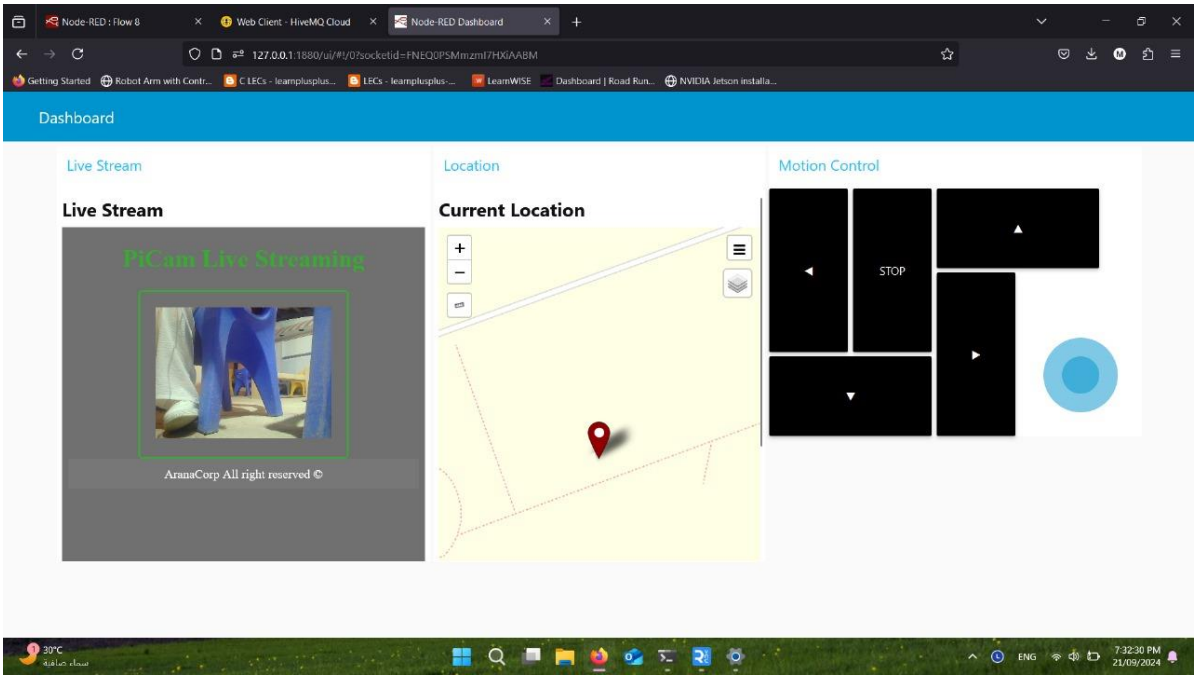
● The mini car prototype was assembled, and all hardware components (motor drivers, GPS, IMU, GSM, and camera) were tested and functioned as intended.

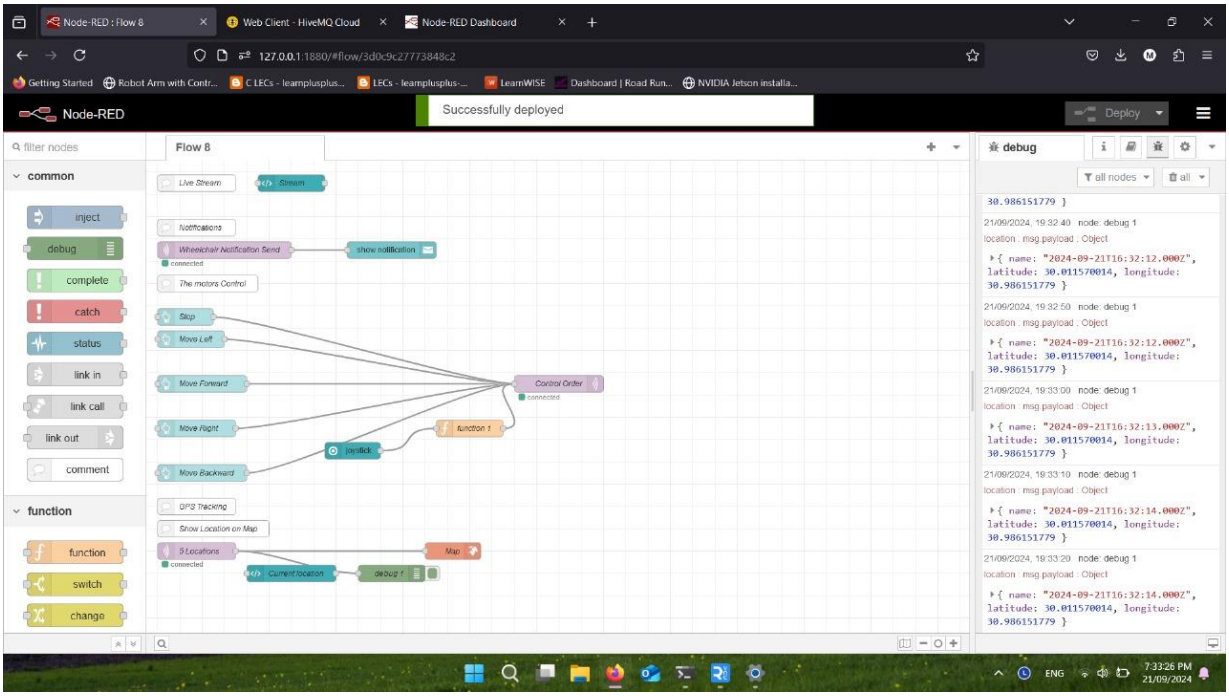


Software Package

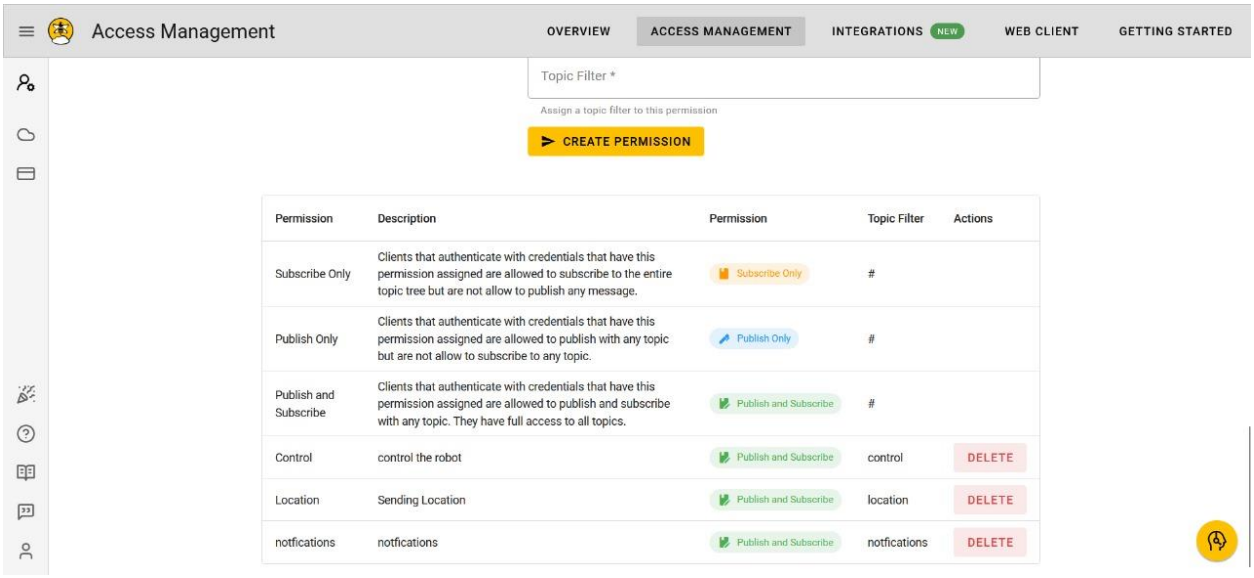
The software functionalities were fully implemented to work with the mini car prototype, showcasing the same capabilities planned for the full-sized wheelchair:

● Node-RED Dashboard: Displays real-time location tracking of the mini car, streams live video from the camera and allows remote control via MQTT.





● MQTT Communication: Handles data transfer between the prototype and the remote monitoring/control system.



● GSM Alerts: Automatically sends an SMS to a caregiver if the IMU detects a tilt or overturn event.

● Python and Arduino Code: Custom scripts control the car's movement, GPS tracking, and communication between the sensors.

Software Functionality:

https://drive.google.com/file/d/1WhRkubE90TezqiOku4p1w-ow-mI58ZWf/view?usp=sharing

https://drive.google.com/file/d/1WsTFzGk9TB8RE4I53whbgFr-edAzEaqw/view?usp=sharing

The Product Testing:

https://drive.google.com/file/d/1d1AOAxbaqxnTzbt8y5vHRFcKxT9xkg9d/view?usp=sharing

https://drive.google.com/file/d/16GjGyaqObJ5dKh9FE9Fcom-geKchBRnt/view?usp=sharing