1 Name of Use Case

Name of the Use Case	**IoT Platform for Elderly Health Monitoring**
Version No.	V0.3
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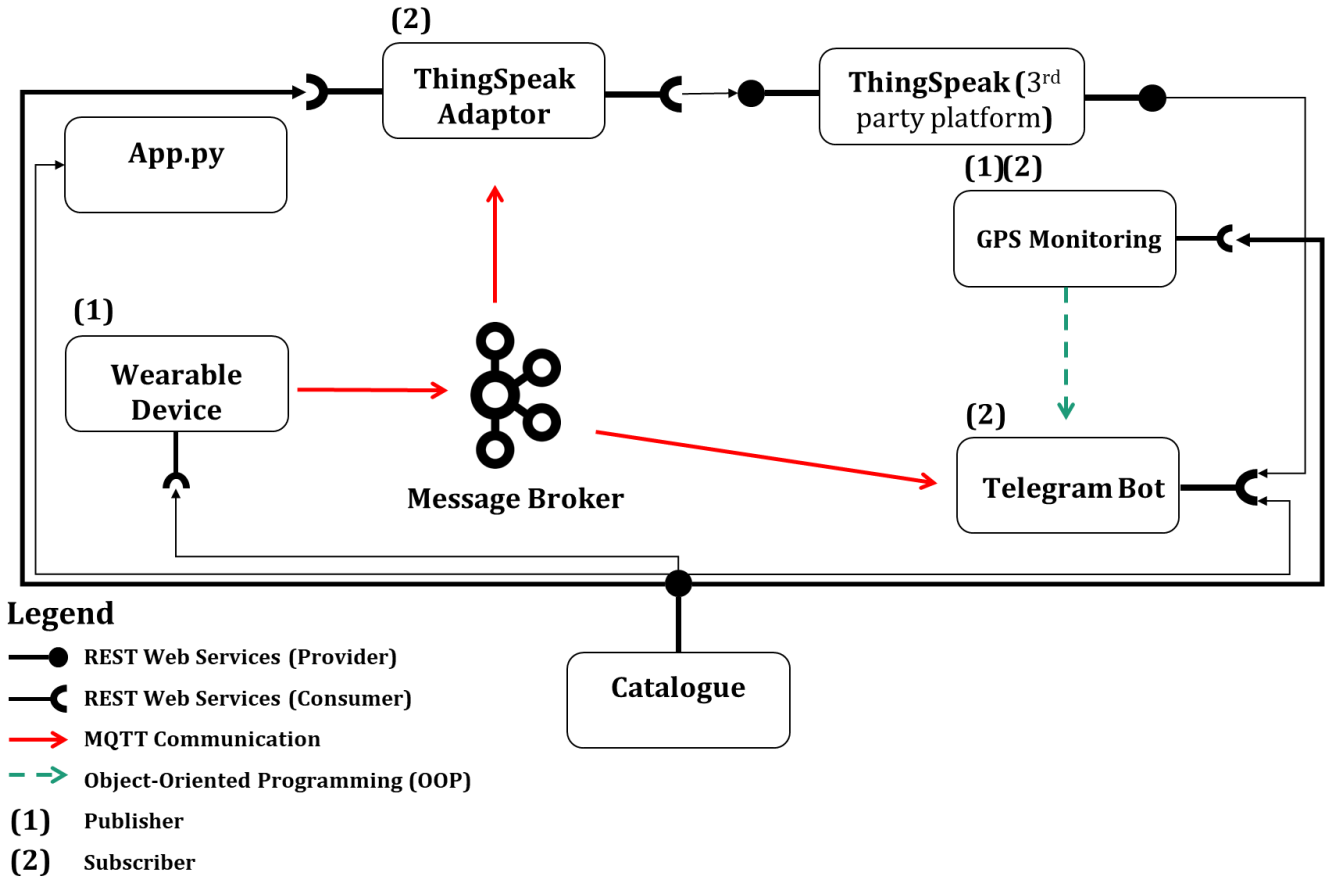
Team Members (with student ids)	s310319 Hesamedin Alemifar, s310515 Homa Jamalof, s314367 Sajedeh Jalalnejad, s310279 Tannaz Jamshidi, s316614 Arman Moradi

2 Scope and Objectives of Function

Scope and Objectives of Use Case	
Scope	The project focuses on designing an IoT platform dedicated to monitoring the health of elderly individuals, particularly those with illnesses such as Alzheimer's and dementia. The platform aims to track vital health metrics (e.g., heart rate, blood Oxygen) and provide GPS-based location tracking to ensure their safety within certain area.
Objective(s)	1. Develop an IoT platform for real-time health monitoring of elderly individuals. 2. Implement health sensors for tracking vital signs such as heart rate and blood Oxygen. 3. Integrate GPS tracking to monitor the location of elderly individuals. 4. Provide caregivers with real-time alerts in case of irregular health patterns or location concerns.
Domain(s)	Smart Health
Stakeholder(s)	Caregivers, Healthcare Providers, Families of Elderly Individuals
Short description	The IoT Platform for Elderly Health Monitoring is designed to address the specific needs of individuals with Alzheimer's and dementia. The platform integrates health sensors for continuous monitoring of vital signs and GPS tracking to ensure the safety of elderly individuals. It provides automated monitoring and alarming strategies to improve safety and health and reduce in-person caring. Summarizing the main features, it offers are: • Remote Monitoring of elderly people's health and safety; • Strategies for alerting caregivers; • Unified interfaces (i.e. REST Web Services and MQTT) available.

3 Diagram of Use Case



4 Complete description of the system

The proposed IoT platform for Elderly Health Monitoring follows the micorservices designing pattern. It also exploits two communication paradigms:

i) publish/subscribe based on MQTT protocol
ii) request/response based on REST Web Services

In this context, Seven actors have been identified and introduced in the following:

- The **Wearable Device** is a digital bracelet which is directly connected to the internet, it has a narrow space to put an eSIM inside it in order to connect the device to internet connection. It is a REST consumer of Catalog to read the configuration of sensors It compares the values of each sensor if they are out of range caregiver get an alert message through Telegram bot so Wearable device is a publisher and publishes the sensed data of heart rate through ("SmartHealth/{user_id}/heart_rate") and blood oxygen based on ("SmartHealth/{user_id}/blood_oxygen") to ThingSpeak Adaptor and publishes data based on ("SmartHealth/{user_id}/danger/{data_type}") to Telegram bot for alerts in case patient gets out of zone or their heart rate or blood oxygen is out of standard range. The caregiver can also get request for real-time values of heart rate and blood oxygen for the latest value. Also, it consists of three sensors:

1. Heart Rate Sensor:
   Unit of Measurement: Beats per Minute (BPM)
   Normal Range for Elderly Individuals (Restin):
   Resting heart rate can vary, but a typical range for elderly individuals at rest might be between 60 to 100 BPM.

2. GPS Sensor:
   Unit of Measurement: Latitude and Longitude coordinates.
   Normal range is the 500 meters from the patient's house.

3. Blood Oxygen Sensor (Pulse Oximeter):
   Unit of Measurement: Percentage of Oxygen Saturation in Hemoglobin (% SpO2)
   Normal Range for Elderly Individuals: A normal range for blood oxygen saturation is typically considered to be between 90% and 100%.

- The **Message Broker** provides an asynchronous communication based on the publish/subscribe approach. It exploits the MQTT protocol. It creates MQTT commiunication between wearable device and telegram bot, wearable device and ThingSpeak adaptor.

- The **Catalog** works as service and device registry system for all the actors in the system. It provides information about end-points (i.e. REST Web Services and MQTT topics) of all the devices consisting of sensor names, unit of measurement, normal range of each sensor, usernames and passwords of users and MQTT topics ("SmartHealth/{user_id}/heart_rate"), ("SmartHealth/{user_id}/blood_oxygen"), ("SmartHealth/{user_id}/gps"), in the platform. It also provides configuration settings for applications and control strategies. Each actor, during its startup, must retrieve such information from the Data Catalog exploiting its REST Web Services. Catalog is a rest provider to wearable device and ThingSpeak Adaptor ,all for reading configuration and also telegram bot for authorizing username and password.

- The **Thingspeak Adaptor** is an MQTT subscriber that receives measurements on heart rate and blood oxygen and upload them on Thinkspeak through REST Web Services. Thingspeak Adaptor is a REST consumer of catalog for reading configuration. It also has a MQTT commiunication and subscriber of ("SmartHealth/{user_id}/heart_rate"), ("SmartHealth/{user_id}/blood_oxygen") to get processed data of heart rate and blood oxygen through message broker.

- **Thingspeak** is a third-party software (https://thingspeak.com/) that provides REST Web Services. It is an open-data platform for the Internet of Things to store, post-process and visualize data (through plots). It is a REST consumer of ThingSpeak Adaptor.

- **GPS Tracking** is used to monitor patients' location and check if they are getting far from their homes. In this IoT platform we are using "folium" library of Python to demonstrate the location of users on the map. It consists of functions for calculating distance and creating html file and it is used in Telegram bot through Object-Oriented Programming (OOP).

- **Telegram Bot** is a service to integrate the proposed infrastructure into Telegram platform, which is cloud-based instant messaging infrastructure. It also allows users on

sending request commands to IoT devices. It is Consumer of Catalog to read configuration exploiting REST. Telegram bot is a MQTT subscriber to GPS Tracking based on ("SmartHealth/{user_id}/danger/gps") when the user is out of the safe area it sends alert message and html file and also, the caregiver can request data from wearable device to get real-time heart rate value and blood oxygen value and it is consumer of catalog for authorizing user name and password of users.

- **App.py** provides a RESTful web service for managing users and devices in an IoT platform by performing basic CRUD (Create, Read, Update, Delete) operations on a catalog file (Catalog.json). The catalog acts as a service and device registry, storing information about the different users and devices in the IoT system.

5 Desired Hardware components

Device Name	Quantity	Needed for…
ESP32 (Microcontroller Unit)	1	Acts as the central processing unit of the wearable device. It manages data collection from sensors, handles communication via MQTT and REST, and processes alerts and real-time data requests.
Quectel BG96 (eSIM Module)	1	Provides cellular connectivity to the wearable device, enabling it to communicate with the internet without relying on external networks.
Maxim Integrated MAXM86161 (Heart Rate Sensor & Blood Oxygen Sensor)	1	Measures the heart rate by detecting the pulse via photoplethysmography (PPG) and measures the blood oxygen saturation (SpO2) using a light-based sensor.
Quectel L86 (GPS Sensor)	1	Tracks the geographical location of the patient by receiving signals from GPS satellites.
Texas Instruments BQ24250 (Power Management Module)	1	Manages the power supply to the wearable device, including charging the battery and regulating power to the MCU and sensors.
Polymer Battery	1	Provides power to the wearable device.
ABS Plastic Sheet	1	Provides a protective and ergonomic enclosure for the wearable device, ensuring comfort and durability.