1 Name of Use Case

Name of the Use Case	Insurance health control and monitoring System
Version No.	1.1
Submission Date	18/07/2024
Team Members (with student ids)	Victor Cajubá: 304235 Atefeh Khalili Param 309328 Guilherme Portella: 304236 Victor Melo: 304216

2 Scope and Objectives of Function

Scope and Objectives of Use Case	
Scope	A smart system capable of interacting with sensors deployed in strategic parts of the home to monitor health information and various aspects of the patient. This system evaluates data to aid in the treatment of diseases, prevent illnesses, diagnose potential health problems early, and improve the overall quality of life for patients.
Objective(s)	Safety control:Ensuring mental and physical well-being of elderly
Domain(s)	Health care, Smart Home
Stakeholder(s)	Diseased, elders and comorbidities patients
Short description	The idea is to deploy sensors in key places in the home (bedroom, kitchen, bathroom) and provide a wearable for personal use by the patient using a Raspberry Pi where will run many microservices capable of to collect data about the environment and the user (body temperature and blood pressure) and perform operations. The microservices will be responsible for controlling appliances like lamps, air conditioning, and an emergency speaker, as well as evaluating health information to improve patient follow-up. The data will be sent to family members and doctors, enabling them to monitor health conditions and respond to emergency situations with real-time data. For the patient, the wearable includes a "panic" button to enhance their sense of security. Summarizing devices and data: • Raspberry Pi 4: Computes body and environmental temperature, blood pressure, and humidity; manages the catalog database; updates ThinkSpeak data; sends Telegram and dashboard messages; and sends equipment commands via MQTT.

3 Diagrams

3.1 General diagram

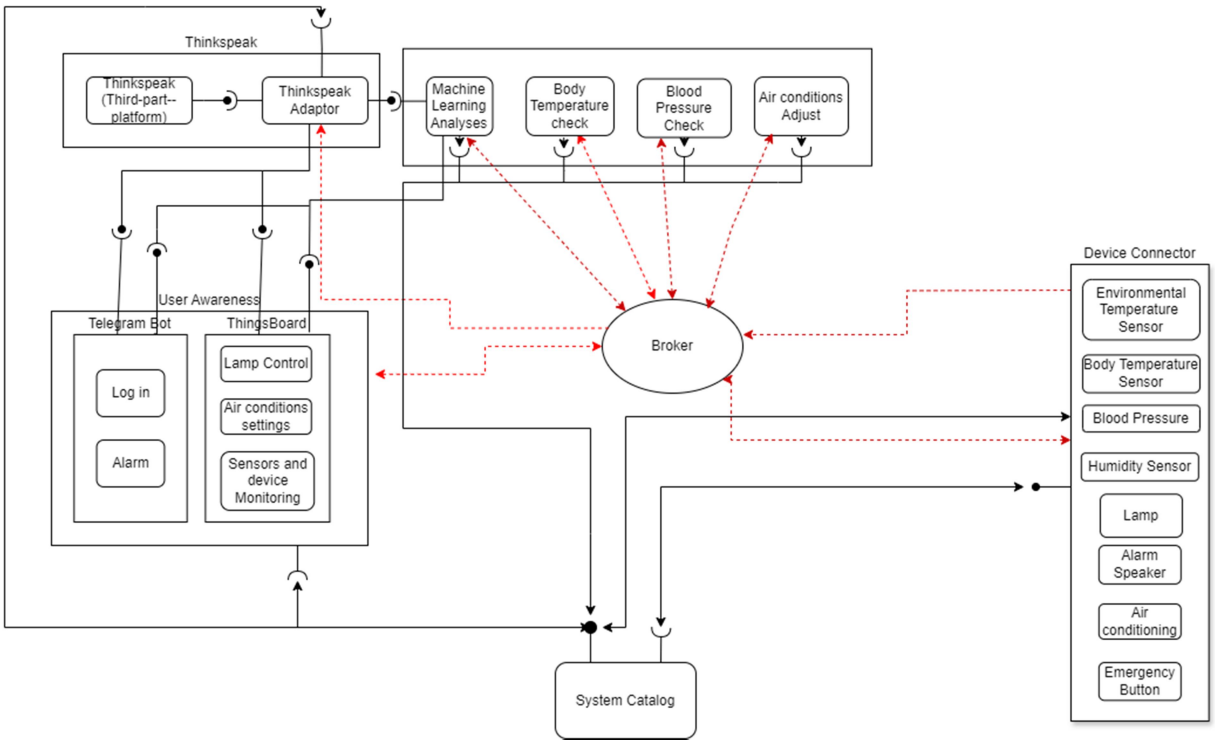

Figure 1

3.2 Database

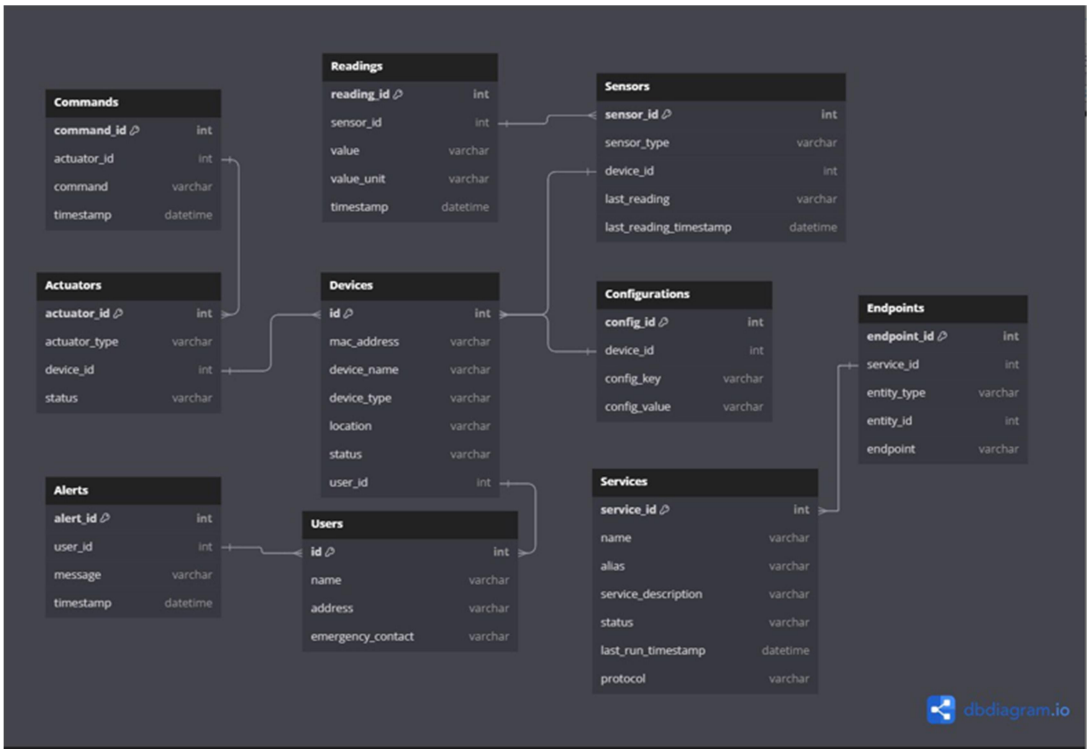

Figure 2

3.3Datatables Example:

id	name	address	emergency_contact
1	Pedro	123 Via Um	555-1234-555
2	Joao	456 Via Dois	555-5678-555

Figure 3

actuator_i	actuator_type	device_i	status
1	Lamp	3	Off
2	Air Conditioning	3	On
3	Alarm Speaker	3	Off

Figure 4

alert_id	user_id	message	timestamp
1	1	High body tem	2024-07-17 14:08:00
2	2	Low humidity l	2024-07-17 14:09:00

Figure 5

device_id	device_name	mac_address	device_type	location	status	user_id
1	RPi 4	001B44113A	Concentrator	Living Room	Active	1
2	RPi Zero	FF1B44113A	Wearable	Wrist	Active	1
3	Arduino	actuator	Actuator Control	Bedroom	Active	2

Figure 6

reading_i	sensor_id	value	value_unit	timestamp
1	1	22.5	°C	2024-07-17 14:00:00
2	2	45	%	2024-07-17 14:00:00
3	3	120/80	mmHg	2024-07-17 14:00:00

Figure 7

service_id	service_name	service_alias	status	service_description	protocol	last_run_timestamp
1	body_temp_check	Body Temperature Check	Active	Monitors body temperature and sends alerts	MQTT	2024-07-17 14:10:00
2	bp_check	Blood Pressure Check	Active	Monitors blood pressure and sends alerts	MQTT	2024-07-17 14:10:00
3	env_control	Environmental Control	Active	Adjusts air conditioning and lighting		2024-07-17 14:10:00

Figure 8

endpoint_i	service_id	entity_type	entity_id	endpoint
1	1	sensor	1	/1/body_temp_check/001B44113A/sensor/1
2	3	sensor	2	/1/env_control/001B44113AA/sensor/2
3	2	sensor	3	/2/bp_check/FF1B44113A/sensor/3
4	3	actuator	1	/2/env_control/BF9944113A/actuator/1
5	3	actuator	2	/2/env_control/BF9944113A/actuator/2
6	3	actuator	3	/2/env_control/BF9944113A/actuator/3

Figure 9

sensor_id	sensor_type	device_id	last_reading	last_reading_timestan
1	Temperature	1	22.5	2024-07-17 14:00:00
2	Humidity	1	45%	2024-07-17 14:00:00
3	Blood Pressure	2	120/80	2024-07-17 14:00:00

Figure 10

command_id	actuator_id	command	timestamp
1	1	Turn On	2024-07-17 14:05:00
2	2	Set Temp 24	2024-07-17 14:06:00
3	3	Activate Alarm	2024-07-17 14:07:00

Figure 11

config_id	device_id	config_key	config_value
1	1	temp_threshold	25
2	1	humidity_threshold	40
3	2	blood_pressure_thresh	130/85

Figure 12

1 Complete description of the system

The first version of the project model to be presented will consist of these general elements:

- **Device Conector:**
  - It is the device like Raspberry Pi where all the sensors and actuators are physically connected and works as the IOT enabled device
  - Runs MQTT and REST services.
  - Connected to sensors: Environmental thermometers, Body temperature thermometer, blood pressure and humidity sensors.
  - Controls actuators like a lamp, air conditioning, alarm speaker, and emergency button. Operating as MQTT subscribers to receive commands from the others services like: Air conditioning adjust, emergency situation and lamp control
  - It registers each sensor and actuator in the system catalog and search informations about the services in the System Catalog to perform the MQTT subscriptions to sensor

- **System Catalog**
  - Relational Data base showed in figure 3.2
  - **Relationships:**
    - **Users:** Each User can have multiple devices. Each User can receive multiple alerts.
    - **Devices:** Each device can have multiple sensors. Each device can control multiple actuators. Each device can have multiple configuration settings.
  - Registers all devices and services in the system.

- Can be explored by others services
- Provides information about the working principles of each and configuration settings for applications.

- **ThinkSpeak and ThinkSpeak Adapter:**
  - Consults the catalog through REST for endpoint information about all sensors (environmental and body thermometers, humidity sensors, and blood pressure sensors). The Thinkspeak Adapter reaches the catalog to learn about the sensors' topics, so it can retrieves their data using MQTT and then send to Thinkspeak by REST.
  - Establishes an MQTT connection and works as a subscriber to receive measurements from all sensors, uploading them to ThingSpeak using REST.
  - Received measurements from ThinkSpeak adaptor are used for post-processing, timestamping, and data visualization.
  - Provides historical data to other services through REST requests.
- **Body Thermometer Check:**
  - Makes REST requests to the catalog to update the list of sensors for measurements.
  - Monitors body temperature of patients by subscribing to MQTT for all values.
  - If fever is detected, works as a publisher to send alarm messages to the Telegram bot and dashboard. For temperatures above 39.5 °C, sends a command to turn on a red lamp and play a sound on the speaker.
- **Blood Pressure Check:**
  - Similar to the body thermometer check, consumes catalog data about all blood pressure sensors in the system and subscribes via MQTT to receive measurements.
  - If an illness value is detected, works as a publisher to send an MQTT alert message to the Telegram bot and dashboard and sends commands to lamps the speaker.
  -
- **Air Conditioning Adjust:**
  - Adjusts air conditioning based on environmental temperature and humidity. The user can define threshold accepted for changes in measurements in order to have thermal comfort. Example: User chooses the temperature 20 °C and threshold 1 degree for more or less than this value If the temperature becomes higher than 21°C for any reason. It sends a MQTT command to adjust base temperature 1 degree less.In case, from 20°C to 19°C .
  - Subscribes to MQTT to get all sensor measurements and then publishes commands to change parameters in the appliance connector.
  - It seeks for devices air conditioning in the Catalog system using Rest, intended to get the quantity deployed. Moreover, all the topics that should be used to

subscribe and send MQTT commands.

- **Machine Learning Analysis:**
    - Analyzes timestamp data collected by sensors.
    - Requests historical data to the ThinkSpeak adapter through REST services and processes it to provide insights and results.
    - It can make some predictions to future measurements of body temperature and blood pressure of each patient based on methods like linear regression, ridge regression and SVM in order to evaluate the health progression and send in the dashboard. A graphic for each method will be plotted about future predicted measurements.

- **User Awareness:**
    - **Telegram Bot:**
        - **Log in:** Allows users to log in to a specific room to follow information from a patient using REST.
        - **Alarm:** Users can see emergency alerts sent by others services using MQTT in case of critical situations happened. Example: Blood pressure out of normal and emergency button pressed by patient
        - **Historical Data:** User can retrieve past measurements for each sensor sending a command. Example: user sends ‘’Blood Pressure 01/04/2024” and all values related to blood pressure in that day are retrieved. A Rest request is made for ThinkSpeak adapter to get this information..
    - **Nodered:**
        - **Sensors and device Monitoring:** Provides a dashboard with measurements from all sensors by subscribing to MQTT services and in case of emergency, shows alarms messages. This applications also allows to show historical data from sensors measurements and plot graphics with the patient health progress.Throught, a Rest request to ThinkSpeak adapter to retrieve values.
        - **Air conditioning settings:** Allows users to control air conditioning remotely by sending MQTT publishes to each device based on time scheduled and a direct command can be sent to perform operation immediately.
        - **Lamp control**: Enables users to schedule times to publish MQTT commands for lamp control.In case of button “turn on Lamp“ or “Turn off lamp” is pressed, a direct MQTT command is published immediately to Arduíno connector to perform the operation chosen.

2 Desired Hardware components (only among those we can provide)

Device Name	Quantity	Needed for…
DHT11	1	Measure room's temperature and humidity
Body Thermometer	1	Measure body temperature of patient
Lamp	1	Control the light in the room
Button	1	In emergency situations to call for help
Relay Module	1	Control the power source of any equipment
Raspberry Pi 4	1	Controls the devices:Actuators and sensors. And runs Broker
Air conditioning	1	Control the temperature in room
Missing		
Blood Pressure	1	Measure the pressure from patient