Requirements Analysis

Scenario: Evacuation of patients in case of emergency

We presume that a hospital is equipped with IoT enabled devices capable of monitoring the environment and detecting foreign substances, smoke, water/gas leaks, earthquakes, disease spreading, other equipments, temperature, etc

The goal of this system is to help with the patient evacuation in case of an emergency.

In order to do so, we define key characteristics of the system:

The system has access to patient data (only data that the system can work with), building plans stored in such a way that it can be used computationally to perform operations like finding the best evacuation route.

The system should be able to also use devices in order to prevent more damage, or stop some devices if they become dangerous to the environment or the persons in the hospital.

The system should be able to interact with users (even though it is not necessary, it could be a closed system). They could use the live human assistance in decision making, provide notifications, recommendations and accept feedback.

There should be a broad type of devices (even if they are simulated) capable of producing data, processing data (e.g. camera that also attaches metadata to each image frame due to internal processing or an audio stream with noise reduction filters applied) and consuming data (e.g. devices that take commands or execute actions like a robotic arm).

The system should be able to collect internal data, decision factors, important internal processes and create reports in order to analyze and further improve it's efficiency.

This is a big project. There are many questions that this analysis must satisfy. Some of them are enumerated below:

1. What metadata should be taken into account for a device?
2. Can we consider these resources as software agents?
3. Does the system or the resources (IoT devices) interact with the hospital's own institutional hardware?
4. How should the system handle the fault tolerance issue?
5. How does the system handle the noise tolerance (in the produced data)

This project has 4 main components to take into account:

- Microservices
- Core
- Planner
- Security

1. Microservices

The microservices layer will be the one that simulates a network of IoT devices. These will abstract the type of the device, the communication protocol, the information being manipulated/transmitted to (actionable device - alarm) or from (sensor) the IoT device.

The microservices can be classified in three categories. Read-Only, Write-Only, Read-Write.

- Read-Only:
  - Patient pulse
  - Temperature
  - Luminosity
  - Smoke/gas detection
  - Object recognition
- Read/Write:
  - Medical patient data monitors

    - Information streams
    - Monitoring equipment (movable video camera)
- Write:
    - Alarms
    - Monitors
    - Evacuation signs
    - Water sprinklers

2. Core & decizion making

The core consists of a distributed system that aggregates the required data either from the IoT devices or from other sources like databases with patient data, handles the physical aspects of the infrastructure and integrates all other components.

Also this is the component responsible for the decision making problem using the aggregated data in order to produce results in our evacuation plans.

In order to create a strong, reliable decision making algorithm we require a comprehensive data set so that we can train the algorithm.

We could take into consideration the use of behavioral trees.

The decision making component should be responsible with the following:

- Filtering data
- Pruning data
- Transforming the data formats
- Extract data in order to make reports
- Change system states
- Send commands to other actionable resources in order to maintain a stable environment

3. Planner

The planner is a problem solver that uses adaptive algorithms to solve a problem with constraints. The constraints can be related to patient data, information from the network of devices and so on...

Also, the planner can have more than one goal and it should be able to choose the best course of action based on the available information and a pre-configurated list of priorities. (Here we can use an Ontology-Based approach to specify relationships between patient data and relevance to help in the decision making)
It should also be fairly fast so we might have to compromise the optimality but not so much so that the planner becomes useless.

The input for the planner can vary. It could be used to plan a route for one person keeping in mind the other people present in the building and their movement. Or we could construct a best plan for keeping the damage done to the hospital to a minimum. In order to achieve this we must take into account the format of the input and output.

4. Security

The IoT system is vulnerable without reliable security protocols. Each device should have support for securing its data and since the IoT nature is broad and scarce, we need good protocols that ensure us that confidential information like the hospital staff, hospital hardware, structure, patient information and so on, remains a secret to the entitled entity.

This component will handle all the security aspects of the system in order to assure a safe environment.