isep
École d'ingénieurs du numérique

Development of a healthcare/wellbeing platform in the context of smart home

Cahier des charges

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Context

The Healthcare and wellbeing is considered as another key feature of the smart homes. Health-monitoring systems in smart environments are gaining increasing attention in order to provide complementary solutions to traditional healthcare services. The advances in wearables, smart phones and medical sensors (blood glucometer, oximeter, blood pressure, electrocardiogram sensor (ECG),wearable sensors, etc.) allowed the possibility of collecting a large amount of real-time health data. Subsequently, these data can be processed in order to provide a comprehensive and predictive picture of an individual wellbeing and health, with the aim of maintaining better health outcomes and conducting early interventions to anticipate health needs.

Possible Target / Use case:

- **To be defined by each group (Step 1)**
  - Normal users of the house
  - Elderly follow up
  - Special disease monitoring
  - Etc.

General Architecture

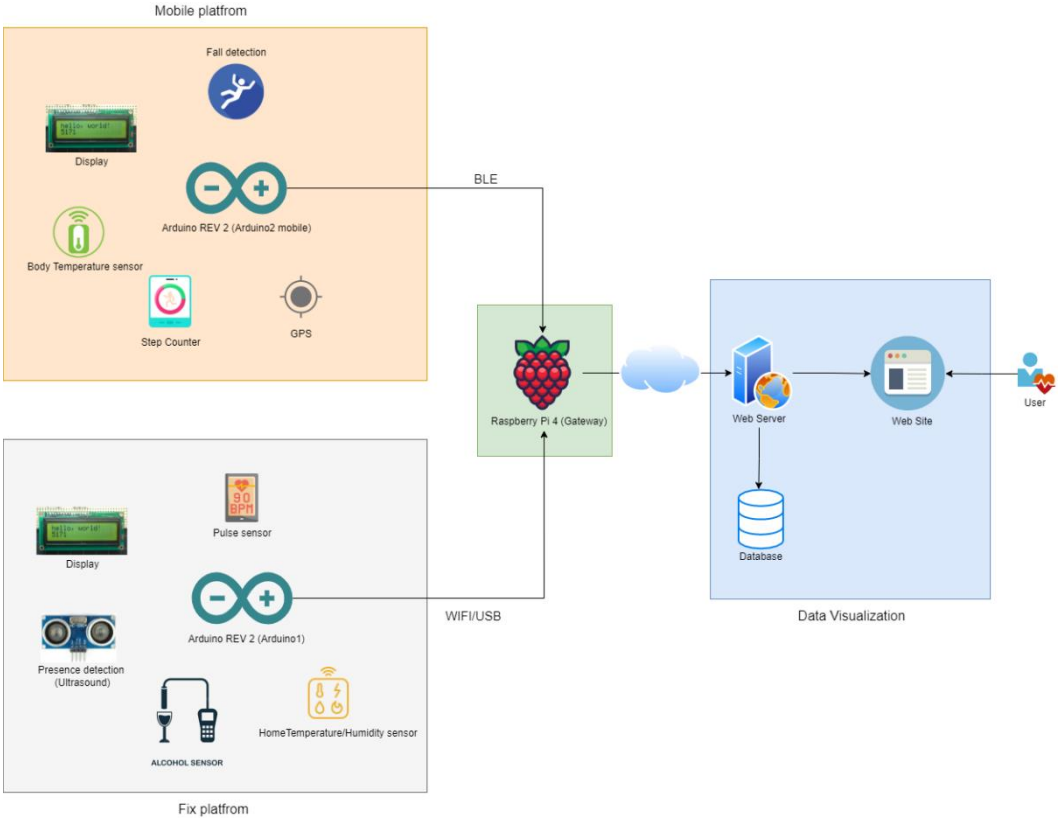

Figure 1: Project architecture

The general architecture of the project is presented in Figure 1. It can be divided to four parts:

- **A fix platform**: represented by an Arduino (Arduino 1). Its main role is to collect/control information from:
    - Home temperature and humidity
    - Pulse sensor
    - Ultrasound for presence detection
    - Alcohol sensor
    - LCD display

  The collected information are then sent to the home gateway (represented by the raspberry pi). The fix platform simulates a maquette which allow the smart home users to check their vital signs (pulse, temperature) and the ambient values in the smart home (temperature and humidity. Every functionality of this part will be explained in the next section. Some functionalities may raise alerts (sensors threshold exceeded for instance).

- **A mobile platform**: which can be considered as a device attached to the body of the smart home user. It also collects and sends information's to the gateway. This second Arduino (Arduino2) controls:
    - GPS
    - Step counter (using the accelerometer)
    - Fall detection
    - Body temperature sensor
    - An LCD display

  Every functionality of this part will be explained in the next section. Some functionalities may raise alerts (a fall detected for instance).

- **A gateway**: the raspberry pi collects and processes all the received information from both Arduinos. The gateway is connected to the Arduino1 through WIFI or USB and to the Arduino2 through Bluetooth low energy (BLE). The results are then sent to the data visualization part.
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- **The Data visualization**: is composed of:
    - A web server: (Apache, NodeJS, …) any technology can be used to represent the web server. It allows to receive information from the raspberry pi and to process them if necessary.
    - A database: to store the sensor/user's data
    - An IHM to provide an elegant visualization of the sensor's data
    - An (optional) authentication part where the user is authenticated before displaying the different information

  The user can then though his/her browser check and see the different sensors data.

Functionalities :

I. Fix part of the platform

1. Arduino1

Dotted with WIFI/BLE and USB communication capabilities its collects the different information from the different sensors then:

- Display some information on the LCD display
- Sends the data through WIFI or USB to the home gateway (raspberry pi)
- Can do some processing on the received data and also raise alerts (**where the processing is done needs to be précised by each group**)
- All the fix platform sensors/functionalities need to be connected to this Arduino1

2. Pulse sensor

Is a sensor to measure the heart-rate for a given user. For this functionality, students need to:

- Check the standard values of heart rates
- Preform some calibration and signal processing to get the sine (sinusoïdale) curve
- Raise alerts in case of abnormal values (can be done by either the Arduino1 or the raspberry)

3. Presence detection

Using the ultrasound (ultrasonic) sensor, the platform need to detect the presence of a user nearby. It can be used to turn on and off the platform based on the user presence in order to save energy for instance.

4. Home temperature and humidity sensor

Allows to measure the smart home temperature and humidity values. Same:

- Check the standard values
- Raise alerts in case of abnormal values (can be done by either the Arduino1 or the raspberry)

5. Alcohol sensor

A grove alcohol sensor is provided and the objective is to detect the alcohol level.

6. LCD display

Can be used to display some sensors' data (temperature & humidity for instance + date and time + …)

II. Mobile part of the platform

1. Arduino2

Dotted with WIFI/BLE and USB communication capabilities its collects the different information from the different sensors then:

- Display some information on the LCD display
- Sends the data through BLE to the home gateway (raspberry pi)
- Can do some processing on the received data and also raise alerts (**where the processing is done needs to be précised by each group**)
- All the mobile platform sensors/functionalities need to be connected to this Arduino2

2. Fall detection

The mobile platform must detect when the user's falls. The group must:

- Find a good and accurate fall detection algorithm from the state of the art
- The device will have to cancel by itself (without doubt) a maximum of false positives.
- The use can also cancel the alert in case of false positive, by pushing a button for instance

3. Body temperature sensor

Allows to measure the user's temperature via the high precision temperature sensor. Same:

- Check the standard body temperature values
- Raise alerts in case of abnormal values (can be done by either the Arduino1 or the raspberry)

4. Pedometer/Step counter

The platform must count the number of steps taken per day. The students will have the possibility to add objectives or "rewards" for certain levels reached.

5. Geolocation

The caregivers and the family must be able to locate the user indoor or outdoor. For instance:

- In case of an elderly with Alzheimer, if the person gets out of the house a family member needs to be notified.
- To locate the mobile platform in case it is lost somewhere in the house

III. The home Gateway

- All the data collected by both parts of the platform must be sent to the raspberry pi.
- Processing of the data can be done at this level since the raspberry pi is powerful enough.
- The gateway is connected to the Arduino1 through WIFI or USB and to the Arduino2 through Bluetooth low energy (BLE).
- The results are then sent to the data visualization part.

IV. Data visualization

Is composed of:

- A web server
- A database

- An IHM to provide an elegant visualization of the sensor's data
- The user can then though his/her browser check and see the different sensors data.

The platform through the raspberry pi must send all the information to a server. To visualize the collected data, an IHM interface must be developed.

- The data can be raw or processed data from the raspberry pi.
- The web interface will show the users (and eventually the healthcare providers) or the family though his/her browser the details of the user's activity: number of steps, cardiac rhythm, body temperature, house temperature and humidity, etc.
- It must show all the sensors' data from both mobile and fix platform in a representative format (graph, just value, message/alerts zone, …)
- The data is stored in a database
- (Optional) The users can be authenticated to view the data

Objectives and Organization

1) Objectives:

- Separation of tasks between group members (Gantt)
- Temporal organization of the work (Gantt)
- Time dedicated to the final phase of the project (integration)

- The project will be divided on 2 Teams (Team Alpha, Team Beta) . Each Team will work on the whole project from A to Z.
- The specifications will be divided into two parts. Each group of the team will have to develop a part of the platform **(4 weeks)** and with the final objective to merge the two prototypes into one functional prototype **(2 weeks)**.

2) Organization:

Team Alpha (9 students)

Groupe 1 (G1) - (4 students)

- Fix platform
- Corresponding gateway
- Corresponding IHM

Groupe 2 (G2) - (5 students)

- Mobile platform
- Corresponding gateway
- Corresponding IHM

Teamwork G1 & G2:

- Coordination

- Integration

Team Beta (9 students)

Groupe 3 (G3) - (4 students)

- Fix platform
- Corresponding gateway
- Corresponding IHM

Groupe 4 (G4) - (5 students)

- Mobile platform
- Corresponding gateway
- Corresponding IHM

Teamwork G3 & G4:

- Coordination
- Integration

3) Deliverables:

At the end of the project (Soutenance session the 1st of June) each Team must:

- Make a presentation of the prototype and the work done: **Demo required**
- Hand in a technical report in two parts
  - The part specific to each group in the team
  - The integration part (which must be written by both groups of the Team)

4) Bonuses

- Adding a **security layer** to the solution
- Portability and design of the platform
- Android application
- Extra sensors (SIM module, Microphone, Speaker)