MINISTRY OF EDUCATION

TECHNICAL UNIVERSITY
OF CLUJ-NAPOCA, ROMANIA

FACULTY OF AUTOMATION AND COMPUTER SCIENCE
COMPUTER SCIENCE DEPARTMENT

SUMMARY
of the License Thesis entitled:

SMOKING DETECTION USING PHYSICAL SENSORS

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1. Requirements:

The main requirement was to study, design and implement a support system for assisting people to quit smoking. The application monitors smoker's behavior using smart sensors (e.g., smartphone or smartwatch), analyzes the effect of smoking and determines its effect on health.

2. Proposed solutions:

The application aims to achieve the recognition of human activity (HAR) using sensors on smart devices such as mobile phones or smart watches. This detection is integrated into an application that can be run on any device that has an Android operating system. The project is divided into 3 large and important modules, the first module is the front-end application that was developed in Android Studio, this is the interface through which the user interacts with the application. Within this, the data from the sensors are transmitted and at the same time the results from the other components are displayed. The next component is the back-end, which deals with all the business logic application except for the human activity recognition itself, however, past smoking data is distributed directly from this component to the front end. Therefor, the data that arrives from the user device, is sent further to the next component which, based on this data produces a result. The last module deals with the detection and classification of data in human activities, and then the results, once computed, are sent to the user interface.

Studies [1], [2], [3] and [4] discuss the best place to place the sensors, as mentioned in these studies, the best place to wear the recording devices is the wrist area. In these studies, [5] and [6 it is explained why the combination of accelerometer, gyroscope and linear acceleration sensor is the best.

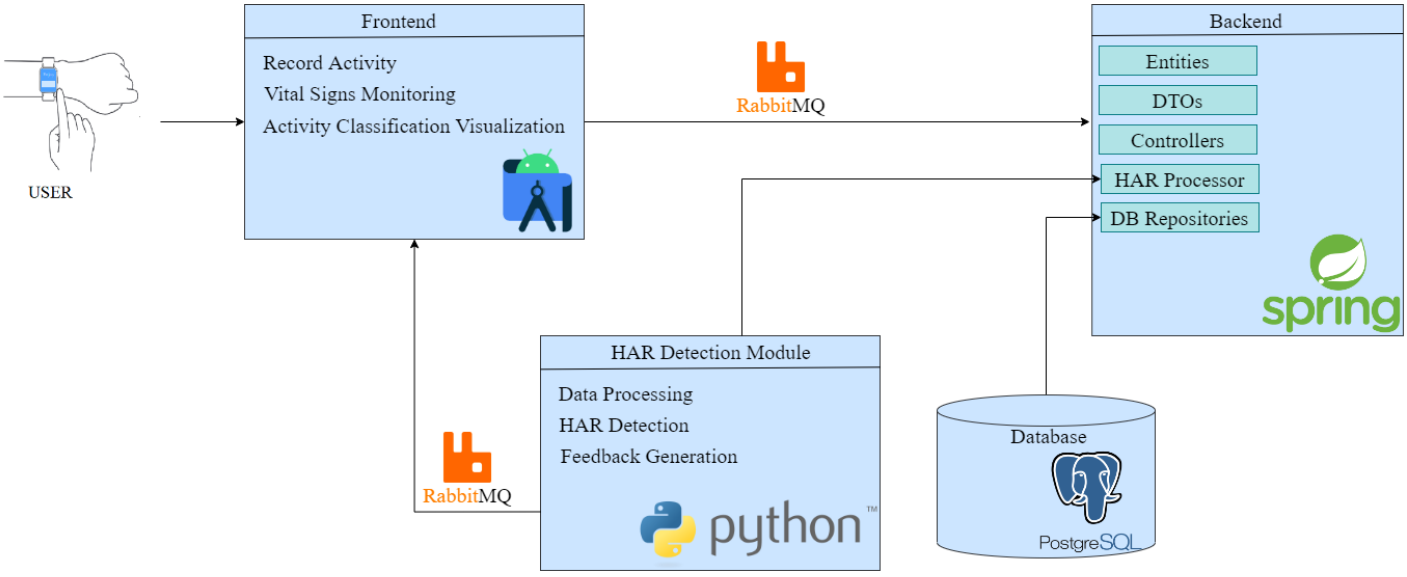

Figure 1. Conceptual architecture

3. Experimental Results:

Most of the tests were done using applications developed by both the developer and other individuals who had no contact with the implementation process. Manual tests were performed according to certain tables to ensure the same conditions for all testers. The most important case is also presented in Table 1, where the main operation case is tested.

Step	Result
Open application	On the device screen, the home page of the application is displayed, with 2 buttons on it.
Press ”Activity Recognition” Button	The application will redirect to the page for human activity recognition.
Press ”START” button	Next to the ”Status” label should appear ”start recording...” and in a short time an activity name will change that text.
Press ”STOP” button	Next to the ”Status” label the text will change to ”no recording” and next to ”Result” label the main activity is displayed.

Table 1. User want to use activity prediction feature

We used two different types of devices, a smartphone and a smartwatch, we chose this approach, because the smartphone has 3 different types of sensors, an accelerometer, a gyroscope and a linear acceleration sensor , but the inconvenience of wearing a phone in the wrist area led to the need to use a device that is more practical. This is the smartwatch, which has a single accelerometer, to present the differences in accuracy between the two options, we displayed in Table 2 the data obtained from five different participants.

	Smartphone Accuracy	Smartwatch Accuracy
Participant 1	**0.94**	**0.92**
Participant 2	**0.92**	**0.87**
Participant 3	**0.94**	**0.91**
Participant 4	**0.89**	**0.87**
Participant 5	**0.94**	**0.89**

Table 2. Comparing the accuracy between 2 devices

4. Personal contributions:

The main contributions of this thesis are the following:

- Implementation of an application to identify basic human activities along with smoking.
- Finding a suitable data set for model training.
- Providing bar charts to create a visualization of the number of smoking activities in the past.
- Implementing the front-end, back-end and physical activity recognition components, then ensuring a continuous communication between them.

5. Documentation sources:

[1] Shoaib, Muhammad, et al. "A hierarchical lazy smoking detection algorithm using smartwatch sensors." 2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom). IEEE, 2016.
[2] Shoaib, Muhammad, et al. "Complex human activity recognition using smartphone and wrist-worn motion sensors." Sensors 16.4 (2016): 426.
[3] Parate, Abhinav, et al. "Risq: Recognizing smoking gestures with inertial sensors on a wristband." Proceedings of the 12th annual international conference on Mobile systems, applications, and services. 2014.
[4] Tang, Qu. Automated detection of puffing and smoking with wrist accelerometers. Northeastern University, 2014.
[5] Justa, Josef, Václav Šmídl, and Aleš Hamáček. "Fast AHRS filter for accelerometer, magnetometer, and gyroscope combination with separated sensor corrections." Sensors 20.14 (2020): 3824.
[6] Shuster, Malcolm David, and S. D_ Oh. "Three-axis attitude determination from vector observations." Journal of guidance and Control 4.1 (1981): 70-77.

Date: 03.07.2022

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