

Report for Computer Systems

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1 Introduction

In this report, we describe the implementation of monitoring physical activity, using ESP8266 microcontroller. We use data from the accelerometer and gyroscope to monitor the following activities: standing, walking, running, jumping and riding. We implement additional features to achieve better results. The processed data is then sent to a HTTP server where the web page can be updated accordingly.

2 Implementation

This section follows the steps taken to process raw data into required results.

Before monitoring activity, the microcontroller needs to be calibrated. Over 500 iterations, accelerometer and gyroscope accumulate raw data. It takes the mean of the sum to predict expected error, to correct accelerometer and gyroscope readings. In the meantime, the board needs to be placed on a motionless platform horizontally so that there are as little vibrations as possible and so that the gravity for z plane can be accounted for.

In the next step, the algorithm reads new data to obtain roll and pitch angle for x and y directions, respectively. The roll angle ϕ and pitch angle θ can be obtained from vector $a = (a_x, a_y, a_z)$ in the following way:

$$\tan \phi = \frac{a_y}{a_x} \tag{1}$$

and

$$\tan \theta = \frac{-a_x}{\sqrt{a_y^2 + a_z^2}} \tag{2}$$

In the next step we compute vertical and horizontal components from the accelerometer. To achieve this, we use the following equations:

$$\text{vertical} = a_x \cos \theta \quad (3)$$

$$\text{forward} = a_x \cos \theta + a_y \sin \theta \sin \phi \quad (4)$$

$$\text{right} = a_y \cos \phi - a_z \sin \theta \sin \phi \quad (5)$$

$$\text{horizontal} = \sqrt{\text{right}^2 + \text{forward}^2} \quad (6)$$

Since vibrations and external forces affect pitch and roll angle, we can mitigate the error by using filters such as complementary filter. For our approach, filters were not used. In the end, the standard deviation is computed, from which we can determine if the monitored subject is standing, walking, jumping, running or running a bike.

3 Server

Our server solution set ups a server that connects to a Wi-Fi network using the provided credentials. The server is started on port 80, and two request handlers are defined: one for the root path ("/") and another for the "/activity" path.

The `server.handleClient()` method in the `loop()` function ensures that the server remains responsive to incoming HTTP requests while also performing activity detection.

The `handleRoot()` function generates an HTML page that periodically (every second) sends an AJAX request to the "/activity" path to get the current activity and display it on the web page. The `handleActivity()` function responds with the current activity when a request is made to the "/activity" path.

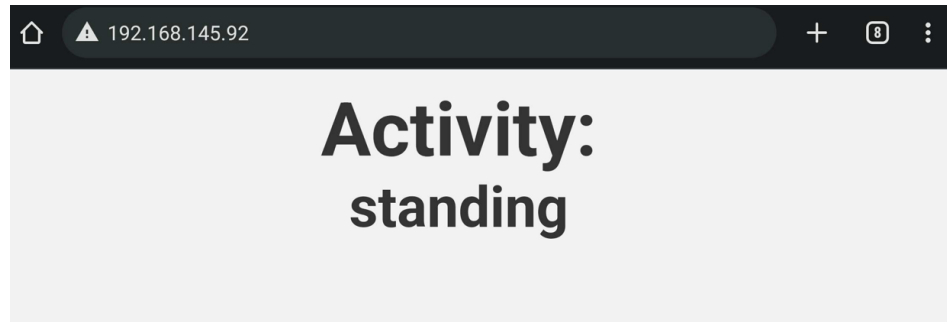


Figure 1: Current activity depiction on the server