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Booklets

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Title: System implementation for gait gratification for analysis with a low-cost development board and a real-time application

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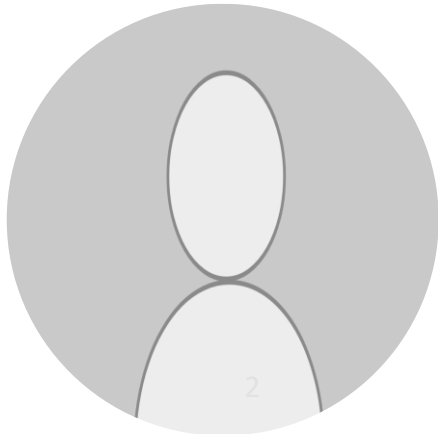
Introduction

- Gait analysis is important to detect abnormal patterns in human motion caused by injuries or diseases in different body parts. Through this, suitable treatments can be determined for the patients.
- Using technologic gadgets and devices, this analysis can help health experts as a second data-set, in order to look information in different angles.



Introduction

- According to Massimiliano Zanin “Gait analysis under the lens of statistical physics” (2022) , gait analysis can be done majorly by image processing systems, or sensor-based systems, being space, budget, portabilty and usability the main differences

Introduction

- Wearable sensor-based systems (as accelerometers), are a common and practical technique to perform these studies, but prices can vary depending on the microcontroller and sensors used in the device. So the goal is to achieve a low-cost gadget easy to use, that can store locomotion data for off-line graphic analysis and also graph movement in a real-time on-line way.

Methodology

- Techincal device features:
  - Portability and test suitable characteristics
  - Wireless communication
  - Different communication protocols between peripherals
  - Low power consumption
- Using/coding features:
  - Fast development system
  - Easy to use system
  - Low-cost manufacture

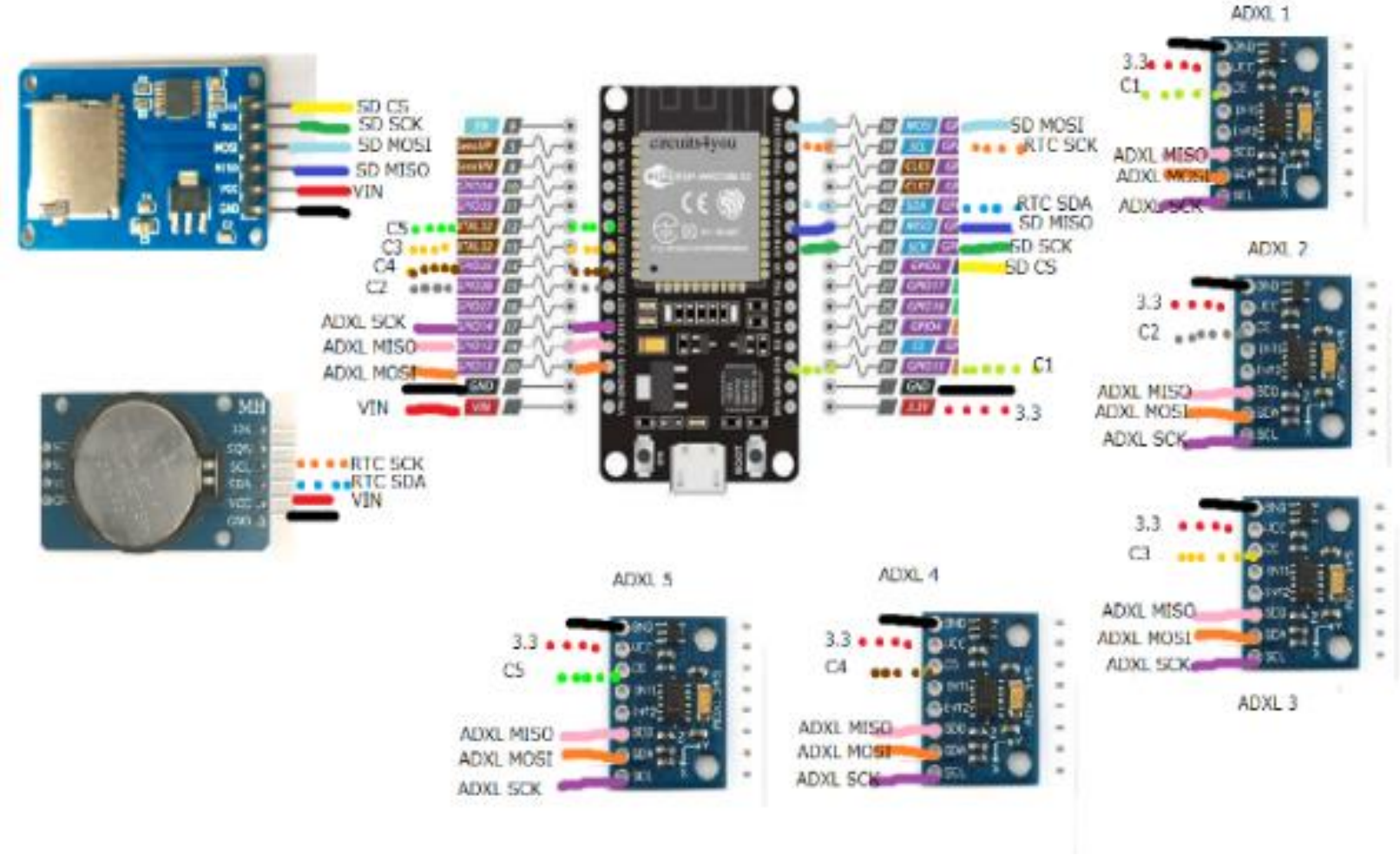
Methodology

- Used Devices:
  - ESP32-WROOM (Wi-fi module embedded)
  - Accelerometer AXL345 (SPI communication), 5 units
  - Real-time clock DS3231 (I2C communication)
  - MicroSD card Module (SPI communication)
- Extra:
  - Wire
  - Arduino IDE
  - AAA batteries

Methodology

- Devices connection diagram

Fig. 1 *System elements and pin-connections*



Methodology

- Device initialization:
  - Device turns on, initialize SPI communication, SD, RTC Wi-fi module
  - Previously up-loaded .txt file with Wi-fi network name/password
  - Microcontroller reads the file and connects with Wi-fi network
  - Gets date and time from RTC an creates a file with this name

- JavaScript AJAX system (asynchronous data sending system)
  - HTML file loaded in the controller for the online data view
  - Asynchronous server, send raw data from each sensor each 200ms and graph it in real-time

Methodology

- Loop process:
  - Gets time lecture
  - Gets a lecture of each accelerometer and stores raw data in a vector
  - Data procesing: get each sensor value
  - Concatenate time and sensor value in a string variable, and write it down in the .txt file
  - Waits 200 ms and starts again

Methodology

- Online data
  - Each sensor data is sent and graphed each 200ms to the website
- Offline data treatment
  - The data file in the SD card is read in a Python-based script, using Pandas library, to get the data table and graph info from each sensor, comparing the obtaned data

Results

- Test was perfomed in a regular person with no locomotion problems, but there’s an agreemnt with an educational nursing program, to test this device in real life patients in future rehabilitation practices.

Results

- Real time graphed data vs Python-based graphed data from microSD

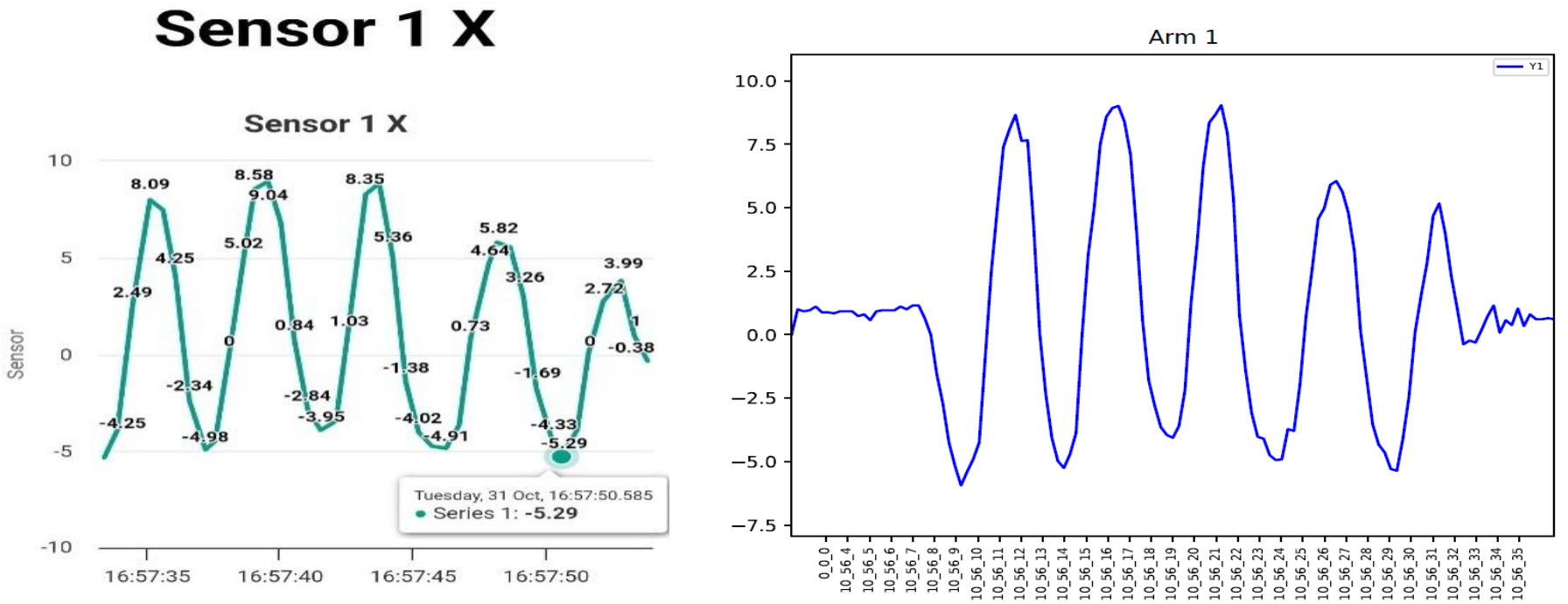


Fig. 2 *a) Real-time application graphic shown on the website (right arm) vs b) Data storage in the microSD module graphed with Python*

Results

- Real time graphed data vs Python-based graphed data from microSD

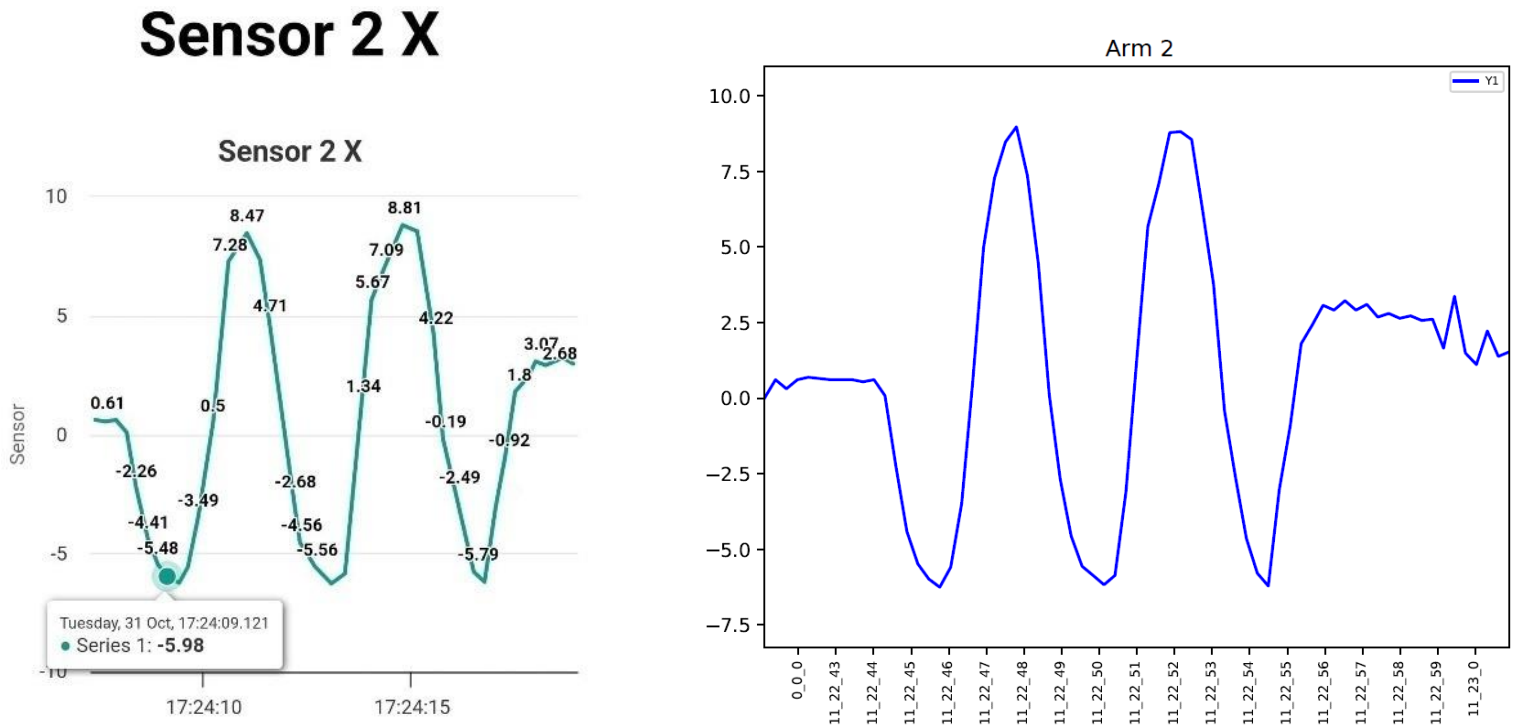


Fig. 3 *a) Real-time application graphic shown on the website (left arm) Vs b) Data storage in the microSD module*

Results

- Real time graphed data vs Python-based graphed data from microSD

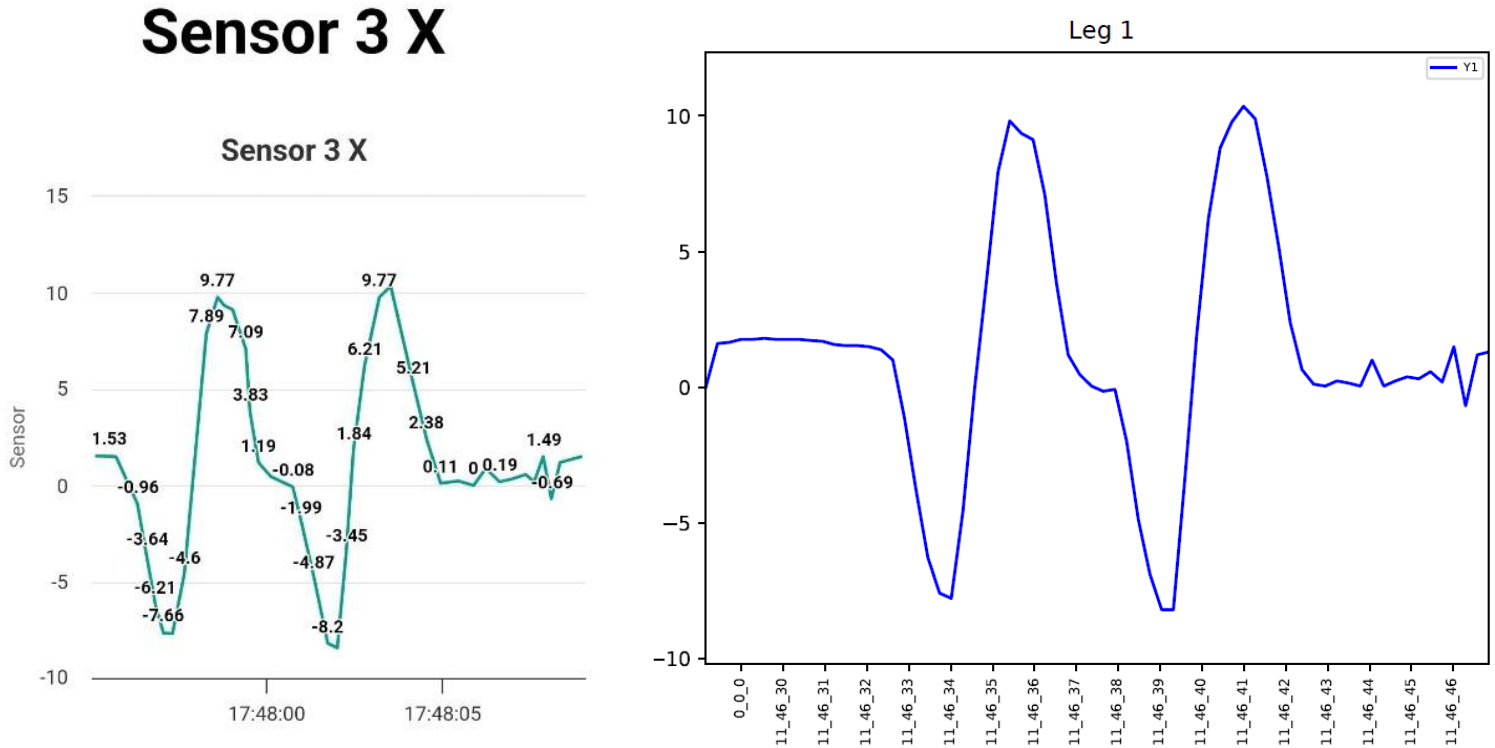


Fig. 4 *a) Real-time application graphic shown on the website (right leg) Vs b) Data storage in the microSD module.*

Results

- Python-based graphed data from microSD, comparing two legs

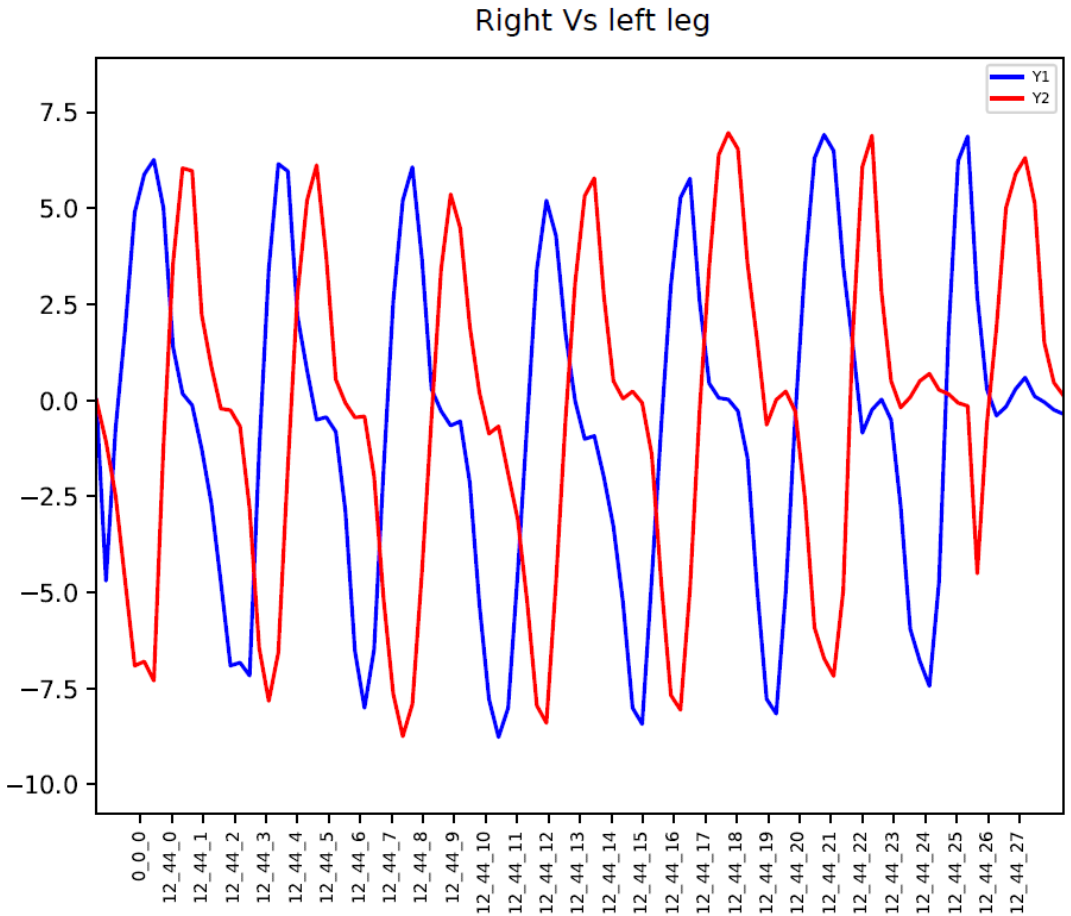


Fig. 5 *Right leg and left leg are moving with a diphase between both movements.*

Conclusions

- Data and graphics presented show the locomation of a person with no injuries, in a flat surface area
- Device’s operation is appropiate, communication is correctly done and data is stored and processed properly
- The project will continue, in order to be tested during rehabilitation practices, to check how useful it is to improbe health experts analysis
- With that, improvements will be done in the device design/process, to ensure a good behavior and operation

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