Gait Tracking and Analysis

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Project Summary:

Human gait analysis can be used to evaluate a person’s physical progress or current health. A person’s gait can be affected by either physical or neurological complications. The purpose of this project is to create a hardware and software platform, that will track, store and present gait analysis data to medical professionals and patients.

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# 1. Introduction

## 1.1 Problem Description

Human gait tracking is a measurement of human health and analysis of this can be beneficial to medical professionals and those who are experiencing physical or neurological conditions that could affect gait. These conditions range anywhere from spinal damage to Alzheimer’s. There exists a variety of physical tests and measurements that can be used to evaluate gait, however these use a scale system rather than a standard(Wrisley et al) and provide a limited approach to in the way of evaluation for improvement or degression. Systems also exist that track a gait through 3D imaging and video recording, However, these methods could be complicated for medical professionals to understand and would require highly specialized equipment. These also limits a patient’s understanding of their own condition and progress because these scales use medical terminology not often understood by the layman.

## 1.2 Significance

As stated above gait tracking and analysis can provide insight into various medical conditions. However current tests and scales, provide limited data to evaluate progress and can be complicated for those who suffer from an ailment that affects their gait. If progress is measured and presented in a more understandable way for a patient to see their progress which could help with mental health, and medical professionals are given more straight forward data and could personalize treatment to suit patient needs and progress. This also can provide an early warning to degrading condition which could mean life or death should a patient be suffering from a neurological condition.

## 1.3 Goals and Objectives

The purpose of this project is to accurately monitor, store, and evaluate inertial gait data. Using an IMU sensor, a lower body’s pitch, roll, yaw, and acceleration can be recorded. This data will be stored in an online database, which will then be evaluated by a neural network, and then using visualization software, be presented in a format that is user friendly and shows patient progress. In order to achieve these goals development of a hardware and software platform will need to be designed and implemented. The responsible team member is listed in the following objectives

* Design and implement hardware system that will read inertial data (Meshal Alobaid)
* Design and implement the PCB design and integrate with the software subsystem (Dominic Robbins)
* Design, implement, and manage database that will contain user and inertial data (Summer Poissonier)
* Design and implement neural network that will evaluate inertial data (Andy Cheng)
* Design and implement visualization dashboard to present data (Ania Schulz)

The above statement is the general description of the subsystems. In addition, we desired this system to be inexpensive (< $400 USD), as well as lightweight and not cumbersome to movement. Also, the device should be able to safely be attached to a human appendage.

## 1.4 Literature Survey

This section will contain research on other devices which perform the same general task, summary of their patents, and limitations, further research needs to be done for this section

# 2 Proposed Design

## 2.1 System Requirements

The proposed system will monitor the pitch, roll, and yaw of a human’s lower body to measure gait. This information will be fed to a pre-trained neural network and will make the decision whether the gait is within a certain tolerance.

Hardware Subsystem Summary

Gait Tracking or human gait analysis has become a popular area of research from the past few decades due to its applications in the fields of medicine, sports, and identification of people for security reasons. Here, the hardware used in this subsystem are: Raspberry Pi 0 WH, IMU sensor and Bluetooth. The IMU will be collect sensor data. Once the system detects a step, it will send the readings to an AI host device by the Bluetooth.

Software Subsystem Summary

Once the step is detected and is sent through Bluetooth, we will use MATLAB or Scikit-learn as the AI host. In MATLAB or Scikit-learn (the AI host) we will process the data and send it to MySQL; our database (where we will store the data). And the neural network would use the data stored in the database to optimize itself for future applications.

Functional Requirements

The following Table outlines the functionality requirements for this system design.

|  |  |
| --- | --- |
| Functionality Requirements |  |
| F.1. | This system shall monitor the pitch, roll, and yaw of a human lower body |
| F.2. | This system shall communicate with Bluetooth capable devices |
| F.3. | This system shall use a pre-trained neural network to classify data. |
| F.4. | This system shall track progress or regression of gait |

Usability Requirements

The following table outlines the usability requirements for this system design.

|  |  |
| --- | --- |
| Usability Requirements |  |
| U.1. | This system shall display current AI classifications |
| U.2. | This system shall display past classifications |
| U.3. | This system shall continuously monitor users gait |

Safety Requirements

The following table outlines the safety requirements for this system design.

|  |  |
| --- | --- |
| Safety Requirements |  |
| S.1. | This system shall not impede user’s movement |
| S.2. | This system shall have electrical systems isolated from the user |
| S.3. | This system shall meet or exceed all safety requirements as outlined by the FDA |

## 2.2 Product Design

Currently only prototype has been created using a raspberry pi 0. When final design choices are made this will be updated

## 2.3 System Diagrams

Diagram, schematic

Description automatically generated

## 2.4 State Diagram

Diagram

Description automatically generated

# 3 Implementation

## 3.1 Hardware

This section summarizes the potential hardware needed for the proposed system. The table below will list the component and the sub-system it is required for

|  |  |
| --- | --- |
| Microcontroller | Inertial measurement subsystem |
| IMU | Inertial measurement subsystem |
| Bluetooth module | Inertial measurement subsystem/database integration |

These components are subject to change as development continues. Hardware has not been chosen as this time

## 3.2 Software

Data will be stored in a online database form which the data can be pulled, this will either be utilized with SQL or JSON to python translation.

The neural network will be implemented with python and will pull data from the database using either JSON or SQL commands to test and classify.

The visualization dashboard will be implemented with an undecided programming language and will visualize and present the classification and the change in performance created by the neural network.

## 3.4 Testing

<<place holder>>

# 4 Development Plan and Schedule

## 4.1 Plan Outline

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## 4.2 Work Breakdown Schedule and Key Milestones

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## 4.3 Budget

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# References

Diane M Wrisley, Gregory F Marchetti, Diane K Kuharsky, Susan L Whitney, Reliability, Internal Consistency, and Validity of Data Obtained With the Functional Gait Assessment, Physical Therapy, Volume 84, Issue 10, 1 October 2004, Pages 906–918, <https://doi.org/10.1093/ptj/84.10.906>