Sit Monitor: IoT System to Track Sitting Patterns

Jasper Sang Ahn
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Abstract

As prolonged sitting is becoming more and more common which can lead to injuries, it is important to be able to monitor and manage the way that we sit. This report describes a modular system of IoT devices that monitor sitting patterns and provides feedback using a raspberry pi and a homemade pressure sensor, establishing a framework to allow for analysis on an individual's pattern of sitting as well as provide suggestions to reduce the amount of prolonged sitting done throughout their life.

Introduction

It is well known that prolonged sitting can cause injuries such as chronic back pain. This problem is even more apparent during the COVID-19 pandemic as people are forced to work and live their lives at home, giving people even more reason to want to spend time in front of their computers, sitting down. In my personal life, I find myself spending the majority of my time awake in front of a computer because i need to use it for work, school, as well as my leisure time.

There are a lot of solutions that people have when it comes to reducing the time spent sitting down. However, a lot of these solutions are often expensive or needed to be manually managed to work effectively. Standing desks, which has seen a rise in popularity, encourages the user to stand while working but can cost more than a hundred dollars, depending on which one you get. There are productivity apps on phones, but they need to be set, and they can't tell whether or not a person is actually sitting / doing work at the desk.

For this project, I have designed a sitting monitoring system which is cost effective as well as, for the most part, automatic. The basic components of the system are: a Raspberry Pi 3 model B, a customized seating sensor, and a centralized computing unit to receive and process data. The seating sensor collects data on whether or not the sensor is being utilized / being sat on. This information is given labels by the raspberry pi and transmits the information to the centralized computing unit using a TCP wireless connection. The computer, based on certain conditions, is able to save the data for further analysis. The system also features an automated notification system which uses Burnt Toast, a module which allows for customized Windows 10 notifications. This IoT system is designed to help the user to understand their sitting patterns as well as providing a tool to help with lifestyle changes.

Proposed System

Hardware
Overall, the goal of the hardware side was to make it as cheap as possible as well as accessible for people to make it themselves. All of the materials used for the project were materials that could be found in the home or can be bought for cheap.

Figure 1: sitting monitor system

Sitting Sensor (button)
This is a homemade sensor which uses copper wiring, aluminum tape, and plastic case which was made from a bottle. The design objectives of the bottle were that it needs to be simple and easy to recreate (if i wanted more sensors for more chairs), sturdy so that it can withstand continuous presses and long presses, and that it needs to be comfortable enough for continuous sitting. The rigid plastic that I used is really good for preventing accidental touches and for sturdiness, but it compromised comfort in a lot of ways. Typical pillows and seat cushions weren't a perfect solution, so I ended up using a seat cushion from Purple which seemed to be a good solution (Figure). However, it is a costly solution, so in order to meet the design goal of affordability, a new solution needs to be implemented in the future.
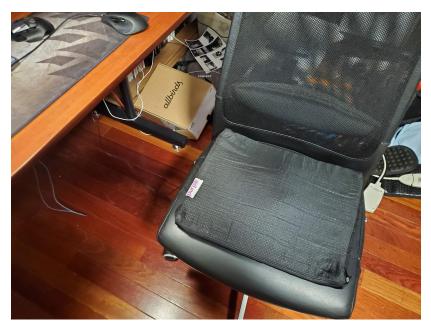
Figure 2: sitting sensor up close

Figure 3: sitting sensor under Purple cushion

Raspberry Pi 3 Model B
The main objective of the raspberry pi is to be able to read the data from the sitting sensor, organize the data, and send the data off. For the project, I used a Raspberry Pi 3 Model B because it was something that I already owned from a previous project, but a Raspberry Pi Zero should be enough for this application and will be something good costwise if the system is to be expanded. On the Raspberry Pi, the features that were used were the GPIO pins as well as WI-FI in order to establish a TCP connection with my main computer.

Central Computing Unit
For this part, I used my main PC. The requirements for this device are that it needs to have the ability to establish a TCP connection with multiple devices and the ability to store data that could be used for future analysis.

Software
For this project, I used Python3 as the language for all of the software. On every raspberry pi, there is a program which takes code from the GPIO pins once a minute. It compiles the data, giving the time, date, and the day of the week. It then establishes a TCP connection as the server with the central computing unit, and sends that data. The program which runs on the raspberry pi is server_checker.py

The main computing unit runs client.py which establishes the connections with the raspberry pi's as the client. It organizes the data, establishes various patterns, and features and saves it in csv files for further analysis. Additionally, it also determines the values and the messages that are sent to the user to help with monitoring the time that is spent sitting in a chair.

notification.ps1
A part of this sitting monitoring system, I wanted there to be some user feedback on their sitting habits. This is a Windows Powershell script that runs a module called Burnt Toast which allows for customized Windows 10 notifications. As mentioned above, the content for the notification is determined by client.py but this script is what runs the actual notification.

Figure 4: notification from notification.ps1
https://github.com/Windos/BurntToast

Results

3_2021.csv
This csv file contains all of the sitting data for the month of March. The data labels are :
        Date & Time : Day of the week (0 - 6) : Sitting (1) / Standing (0)
A new file is created automatically per month to keep file sizes smaller. If the program runs
continuously for a full month, there would be 43800 lines.

```
2021-03-15 20:41 : 0: 1
2021-03-15 20:42 : 0: 1
2021-03-15 20:43 : 0: 1
2021-03-15 20:44 : 0: 0
2021-03-15 20:45 : 0: 0
2021-03-15 20:46 : 0: 0
2021-03-15 20:47 : 0: 0
2021-03-15 20:48 : 0: 0
2021-03-15 20:49 : 0: 1
2021-03-15 20:50 : 0: 1
2021-03-15 20:51 : 0: 1
2021-03-15 20:52 : 0: 1
2021-03-15 20:53 : 0: 1
2021-03-15 20:54 : 0: 1
2021-03-15 20:55 : 0: 1
2021-03-15 20:56 : 0: 0
```

sessions.csv
This csv contains the length of each sitting session with the date.

```
2021-03-15 : 3
2021-03-15 : 8
2021-03-16 : 93
2021-03-17 : 60
```

Future Improvements
The system that I laid out can have four main improvements made to it.
   1. Expand modularly to create a network of sensors to be more than just my desk chair
   2. Permanent solution to increase comfort when sitting on the sensor
   3. Model the collected data to analyze and learn about my sitting habits.
   4. Improve the user interface for a more streamlined experience.

Conclusion
Throughout the project, it was more satisfying to see how accessible IoT can be. Nearly Everything that I've used in this project were things that I already owned. A lot of the infrastructure that is needed for the project were things that were built into the devices or easily downloadable. The Raspberry Pi's built in Wi-Fi connectivity made establishing a TCP connection between it and my main computer easy to do. Because of my inexperience with the subject, I wanted to keep the concept of the project simple and easy. However, by taking the time to learn it, and realizing all of the other things I can do, doing this project, gives me confidence that I can continue to make devices that can be useful and more complicated.

This project of creating a sitting monitor has been extremely helpful and effective. When I use it, I see myself becoming more aware of the amount of time that I spend sitting, and spending the time to get out of my seat and take a break from working or playing has become something that I do more often. Overall, I think the project has been successful in teaching me how to develop and create IoT devices and has helped me in fixing a habit of sitting too much throughout the day.

Link to all of the Code:

https://github.com/Firefwing999/seat_monitor