COMPUTER SCIENCE AQA

A-LEVEL NEA

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# ANALYSIS

In an age of an ever-increasing reliance on technology, with more and more people adopting a sedentary lifestyle, health and fitness has become an aspect that in many cases have become neglected. However, there is now an increasing pressure on governments and on society to change old habits of an unhealthy lifestyle, to a more active one.

Countless studies suggest that exercising not only improves physical health but also has significant impact on improving mental health and relieving stress. One study suggests that those who exercised had 43.2% fewer days of poor mental health in a month than those who did not. [1]. This shows to us the importance of exercise, especially as one of the leading causes of death in the US [2] and as well as for men in the UK [3] is heart disease, which can be preventable through exercise and a healthy diet.

Despite majority of the public knowing the great benefits of exercising, only 63.3% of people aged over 16 consider themselves physically active doing 150 minutes or more of moderate intensive activity in a week, according to a UK government survey. [4] There remains a large portion of the public which do not exercise, for many different and respective reasons. Various reasons may include not having enough time during the day to exercise, finding a gym that is affordable or simply not having enough motivation to work out.

Whilst a large chunk of the population remains unactive, the proportion of the population, especially within young adults, who have access mobile smart phone continues to increase. One study suggests, that for those aged 16-24 years old, roughly 99% of respondents say they have a smart phone, for those living in the UK [5]. This is a rather a stark contrast to society just 10-20 years ago, where smartphones had barely begun to break into the common consumer market. This really shows to us the commonality of smart phone nowadays and how much of the UK’s population use smart phones on a daily basis, especially younger people.

My objective in this NEA is to investigate how physical activities can be tracked and detected through a device’s on-board sensors. At the end of this project, I am to have a working app that gives users the interface to access exercise recognition software, to help more young people become active through their mobile phones.

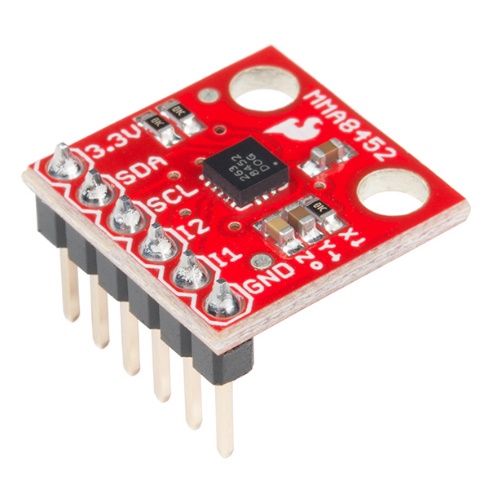
## Sensors Overview

Between devices, the physical hardware and sensors on a given device vary, depending on various factors. Over the past decade, the general progression of theses sensors tends to improve over time as computational power increases with more and more devices receiving more and more sensors.

Before motion sensors were widely adopted in mobile phones, they were often used for devices such as Wii remotes, airbag deployment, aircraft, missiles etc. During the period between about 2005-2012, adoption of on-board sensors started to breakthrough to mobile phones, most notably within Apple and Samsung phones. The very first phone with 3-dimensional movement recognition was the Samsung SCH-310 [6], with Apple’s first iPhone also using accelerometer technology [7]. Nowadays, it is expected of manufactures to have various sensors, including the gyroscope, accelerometer, and magnetometer.

As I am focusing my project on Android applications, I will mainly be discussing the sensors on a typical Android phone, rather than one on an IOS phone.

### Accelerometer:

As suggested by the title an accelerometer is a part of the phone which measures the acceleration on a device on three axis reflecting real-world movement. These axes are in the x, Y and Z direction.

The data provided by an event from an Android device is given in metres per second squared (unit for acceleration). This provides a force along the X, Y and Z vectors. [8]

The accelerometer is often used to detect motion within a given axis, especially to measure the translation of a device.

I am in this investigation, to research more on how I can use the accelerometer to track the distance of a given motion exercise, like walking or treadmilling.

Figure Sparkfun Triple Axis Accelerometer https://www.sparkfun.com/products/13926

### Gyroscope:

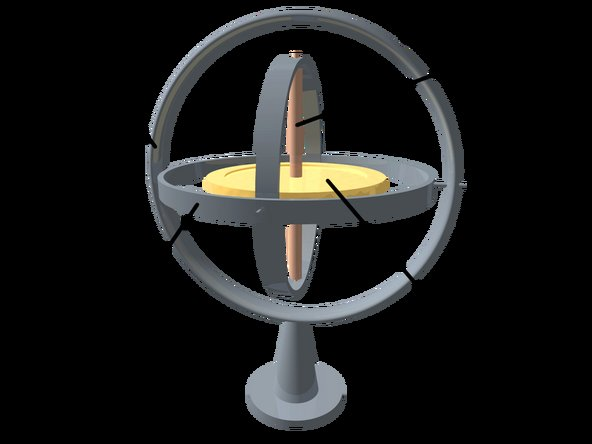
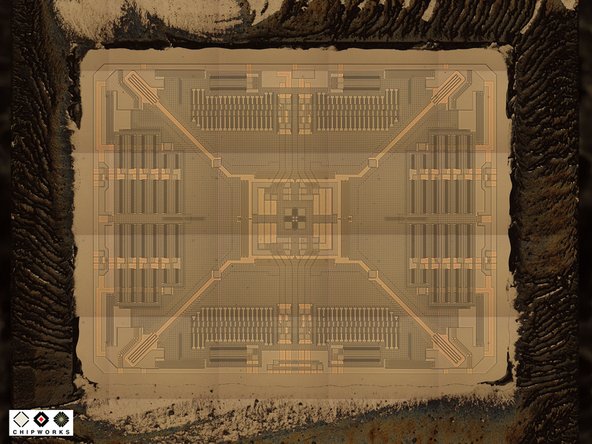


Figure 2 GK10A MEMS die (oscillating plate) https://www.ifixit.com/Teardown/iPhone+4+Gyroscope+Teardown/3156

Figure 3 A Mechanical Gyroscope https://guide-images.cdn.ifixit.com/igi/nmNv4u3uHqZ5VNIR.large

A gyroscope measures the rate of rotation around the three axes, often known as yaw, pitch and roll. [8] Early versions of a gyroscope included three spherical axis that span around a rotor, being able to rotate freely in three axes. The gyroscope nowadays in phones are much more compact and consist of a tiny vibrating plate in a chip which is pushed around and is detected by the device processor. [9] can be used for a variety of different applications for a mobile phone. The most common is determining the orientation of a phone, whether it is being held in landscape or portrait mode, which was first well utilized in Apple’s iPhone 4. [10]

To my investigation, I am more interested in how a gyroscope can be used to determine an exercise being done by a user. For example, when a user puts a mobile phone in their pocket and goes for a run, how can I use the data from the gyroscope sensor to determine whether the user is running, based on the rate at which the device rotates in a repeated pattern of harmonic motion.

### Magnetometer:

The magnetometer is responsible for measuring strength and direction of magnetic fields, often used to figure out the spatial position of a device in a given space. They utilize the Earth’s magnetic orientation to calibrate a given device to a specific position. [11]

It is often used as devices in spacecraft measuring magnetic fields and metal detectors. More specifically, in mobile phones, it is used to help judge a device’s position, relative to the north pole of the Earth. [10]

### Six degrees of freedom:

It is due to all these various sensors, that we can now use algorithms to track and trace various activities and I hope to be able to use them as part of my investigation in exercise detection.

## Current Market and Applications

Leap Fitness Group:

Currently, as of 2021, one of the most common and prominent companies producing fitness/health apps in Android and IOS platforms are the “Leap Fitness Group”. Their apps have a consistent design, UI and theming that makes them recognisable, especially amongst the Google Play Store. Furthermore, they do not have a niche market, but produce apps which are wide ranging with various different activities and demographics – there is always an app made by them that covers the wide appeal of the general public.

This incentive of producing as many apps as they can for fitness/health may be one of the reasons why they are so successful in the Google Play Store, because they can cover so many different aspects of fitness and exercise. From this, they use advertisements and monetization to gain profits

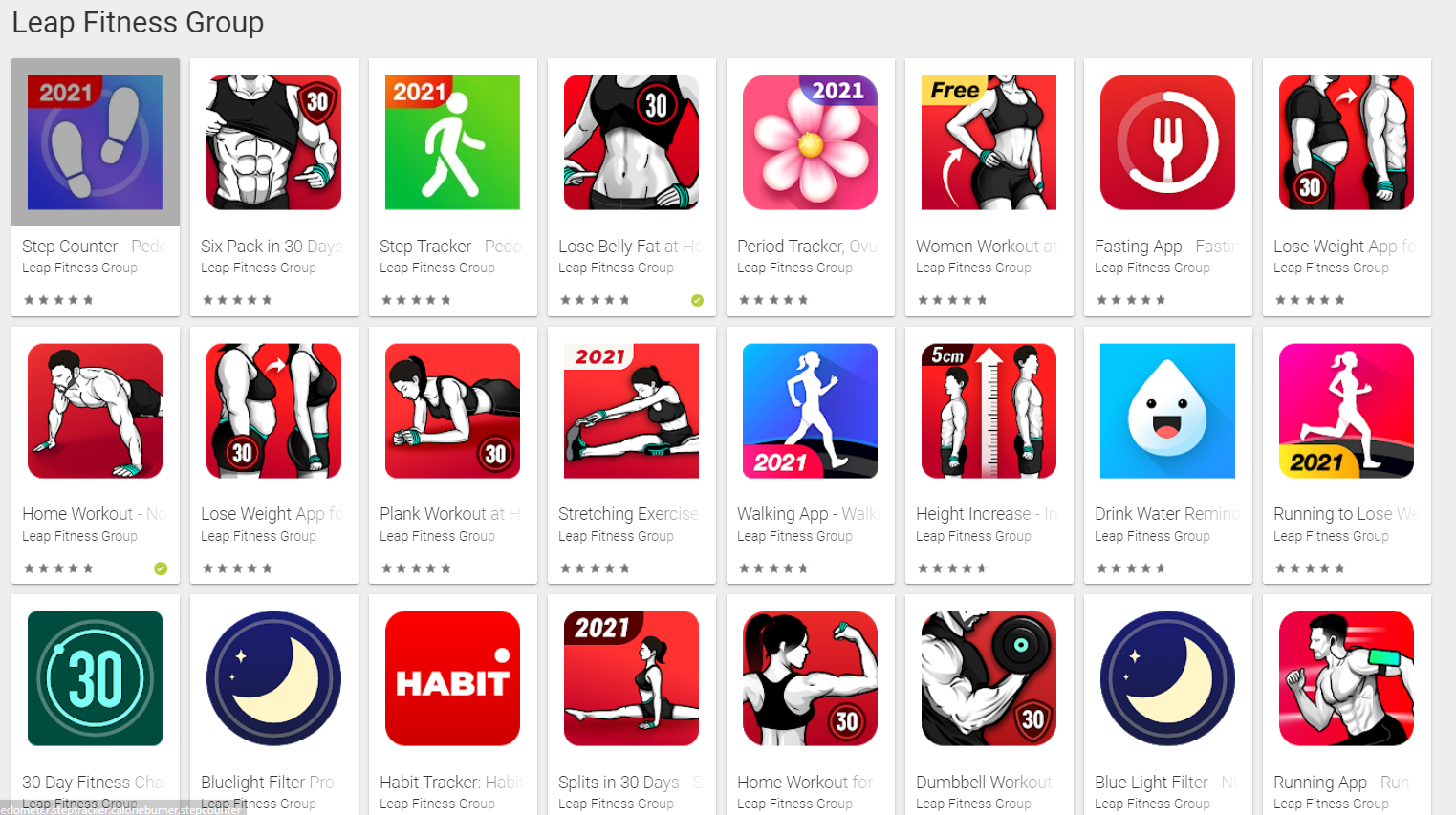


Figure Leap Fitness Group https://play.google.com/store/apps/developer?id=Leap+Fitness+Group&hl=en&gl=US

Google Fit

Google Fit is a widely used tracking app that mainly focuses on detecting what activity you may have done. The app displays to users their step count, their activity history, calorie burnt as well as data from other devices, such as smart watches. Google fit is very well integrated with Google Play Services, through Google’s Fitness API. This API is easily accessed by developers who also want to extract and use data from a person’s device for their android app, or for certain web applications.

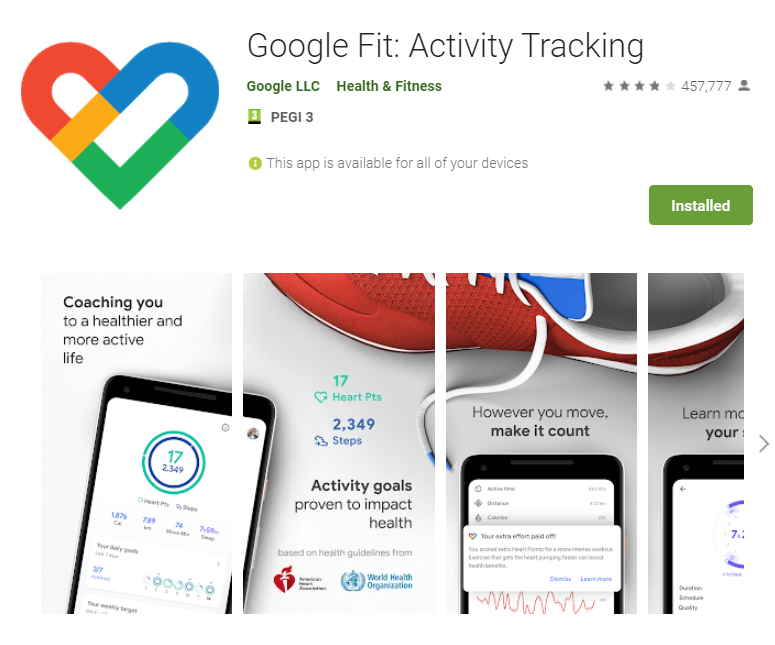


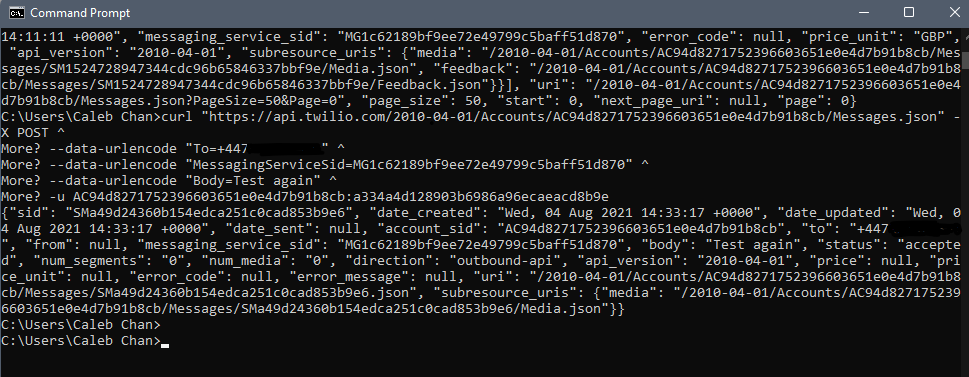
Figure Google Fit https://play.google.com/store/apps/details?id=com.google.android.apps.fitness

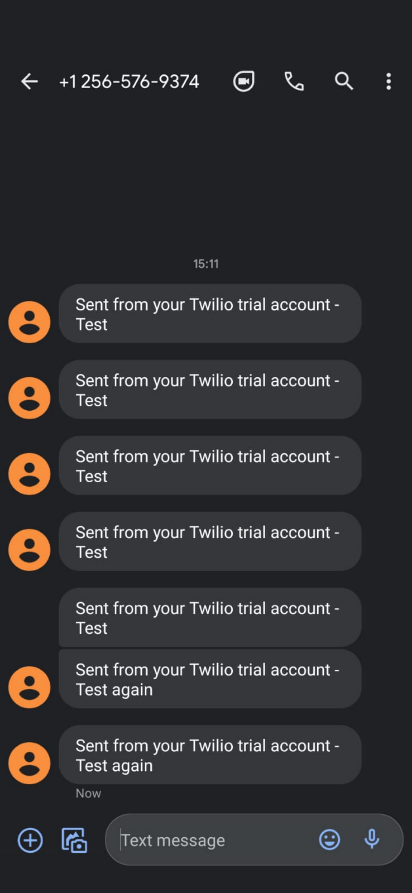
## Prototyping and Spiking

An API, stands for application programming interface, to allow a developer access to data without the need for a developer to necessarily know all how this data is formed etc. API gives way to abstraction of needing to program everything from scratch.

During my analysis of current fitness applications, Google Fit stood out to me, as they provided developers with their dedicated fitness API, specifically for app developers. As I have not dealt with API’s before, I wanted to learn more about APIs in general, so that I could test out their Fitness API so I could have a rough idea in how to approach developing a fitness app. Furthermore, the method of how Google detected steps and activities intrigued me, because of how easy it seemed for a developer to extract such information from the API.

<https://www.youtube.com/watch?v=GZvSYJDk-us&ab_channel=freeCodeCamp.org>

First use of API through command line, sending a text message from a phone to another phone via SMS, using Twilio.



By using the curl code provided by twilio, I was able to send a message from the twilio phone to my personal phone, via Twilio’s SMS API, as a POST request.

Creating my First Android application (through online course) <https://www.youtube.com/watch?v=fis26HvvDII&t=709s&ab_channel=freeCodeCamp.org>

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