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THE DESIGN OF A FITNESS TRACKER TO MONITOR & IMPROVE THE HEALTH OF INDIVIDUALS

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Abstract:-In our current age of more and more data being made available to us, accurate data about whether our body is functioning correctly is one of the most important information one must receive on regular basis. When it comes to getting fitter and healthier, the knowledge of your health is of paramount importance. There is good research proving that simply keeping track of what we do, can significantly improve our health. Self-tracking can actually make us follow a healthier diet, sleep better and exercise more– simply by letting us know the areas we need to improve. But there is plenty of room for human error in manual recordings. Per contra a Fitness Tracker provides this feedback in real time, capturing all the necessary details and then syncing up to deliver a clear picture of your health electronically at the touch of a finger.

Keywords: accurate data, self-tracking, real time, syncing up .

INTRODUCTION

Motivation

The most famous modern definition of health was created during a Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.
"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."
The Definition has not been amended since 1948.

Objectives

While no technology will ever replace diet and exercise, a new class of gadgets may provide key insights into your physical fitness. Known by a litany of terms—fitness trackers, health monitors, activity trackers and wearables —there's a growing cadre of tech toys that share a common goal: to get you into better shape.

The other most important thing is how you get at the information that's on the tracker. A fitness tracker has a screen. It won't give you the most granular info, but the built-in screen can at least tell you how many steps you've taken, floors you've climbed, and calories you've burned (estimated), so you know how you're doing in real time.

Many medical professionals believe that being aware of our current daily fitness levels may encourage us to make small, yet healthy changes in our lives. For instance, instead of vying for a front row parking spot at the grocery store, more people will park further away from the entrance and walk, or will take the stairs instead of opting for the elevator.

METHODOLOGY

A wearable device measuring the following is being constructed.

Pulse rate (Heart rate)
Steps taken
Normal walking
Hill/stairs climbing
Body temperature
Sleep quality
Haemoglobin levels

1. Heart Rate measurement

For a non-invasive method, we found three ways:

1) Optical method (Infrared LED and sensor)
2) Force Sensing Resistor (FSR)
3) Piezoelectric sensor

Among these the piezoelectric sensor(made up of pressure sensing ceramic material) was chosen because:

1) Piezoelectric material can sense the slightest pressure accurately and over a wide range, whereas FSR being very delicate, is useful only to measure very light pressure changes and it may get damaged easily
2) Piezoelectric material is handy, whereas attaching infrared LED and sensor is not comfortable (a fitness tracking device is intended for daily use)

Algorithm

1. Heart rate is measured by performing the following operations on the piezo output voltage:

a. Analog Filter and Amplifier:

Input signal is amplified using a 7th order low pass filter with a gain of 10^7.

b. Dynamic Threshold:

The system continuously updates the maximum and minimum values of the signal after every 50 samples. The average value, (Max + Min)/2, is called the dynamic threshold level. For the following 50 samples, this threshold level is used to calculate the heart beats. In addition to dynamic threshold, dynamic precision is also used for further filtering.

A heart beat is considered to be present, in case of a negative slope of the signal plot when the curve crosses below the dynamic threshold.

2. The heart rate is given by:

Heart rate (Beats/min) = (Beats /sec)*60

2. Pedometer

It is implemented using ADXL345. During natural walking, at least one axis of accelerometer will have relatively large periodic acceleration changes, no matter how the pedometer is worn, so peak detection and a dynamic threshold-decision algorithm for acceleration on all three axes are essential for detecting a unit cycle of walking or running.

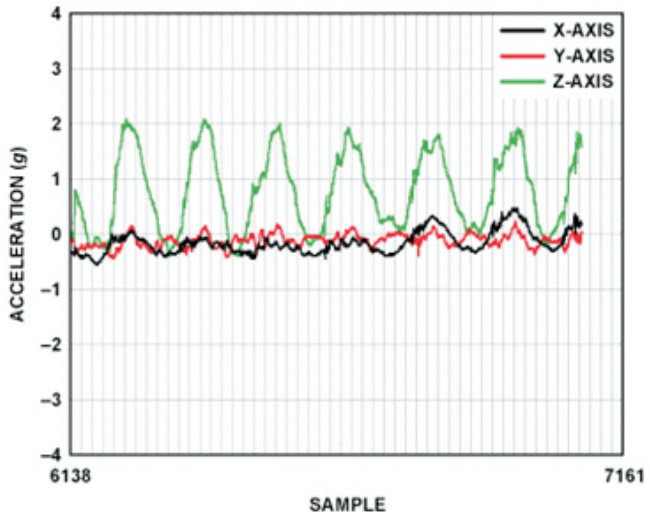

Figure 1: Typical pattern of x-, y-, and z accelerations measured on a running individual.

Algorithm

1. Steps taken are measured by performing the following operations on the accelerometer data:

a. Digital Filter:

Smoothens the signals using averaging

b. Dynamic Threshold:

The system continuously updates the maximum and minimum values of the 3-axis acceleration after every 50 samples. The average value, (Max + Min)/2, is called the dynamic threshold level. For the following 50 samples, this threshold level is used to decide whether steps have been taken. In addition to dynamic threshold, dynamic precision is also used for further filtering. A linear-shift-register and the dynamic threshold are used to decide whether an effective step has been taken. The linear shift-register contains two registers, a new sample register and an old sample register. The data in these are called new sample and old sample, respectively. When a new data sample comes, new sample is shifted to the old sample register unconditionally. However, whether the result will be shifted into the new sample register depends the changes in acceleration being greater than a predefined precision otherwise no shifting occurs. The shift register group can thus remove the high-frequency noise and make the decision more precise.

A step is considered to have occurred in case of negative slope of the acceleration plot (previous value greater than the current) when the acceleration curve crosses below the dynamic threshold.

c. Peak Detection:

The step counter calculates the steps from the x-axis, y-axis, or z-axis, depending on which axis's acceleration change is the largest one. If the changes in acceleration are too small, the step counter will discard them.

Time window is used to discard the invalid vibrations. We assume that people can run as rapidly as five steps per second and walk as slowly as one step every two seconds.

2.The distance is calculated by the formula:

Distance = number of steps × distance per step
Distance per step depends on the speed and the height of user. So, we use the steps counted in every two seconds to judge the current stride length.

3.The walking speed is given by:

Speed = steps per 2 s × stride/2 s

4.Calories are estimated using a conventional approximation as

Calories (C/kg/h) = 4.5 × speed (m/s)

3.Temperature measurement

Temperature is measured using IC LM35 whose analog output is proportional to the body temperature and needs no additional processing.

4.Sleep quality measurement

Actigraphy approach will be adopted using an accelerometer sensor. The same device will be used with accelerometers active but placed under one's pillow. Relevant data will be extracted and processed using a microcontroller.

The basic idea is to capture the intensity of user's activity throughout the night. As the user becomes more active, the intensity of activity increases, producing easily detectable peaks, indicating the lightest sleep throughout the night. Activity above a certain level indicates full awakening, such as getting out of bed.

Doubling it as a bio-sensor alarm, it will find the optimal time to wake you up during a 30 minute window that ends at your set alarm time. As you sleep you go through different phases, ranging from deep sleep to light sleep. The phase you are in when your alarm goes off is critical for how tired you will feel when you wake up. This product wakes you when you are in your lightest sleep phase.

5.Haemoglobin level measurement

Pulse oximetry is the non-invasive measurement of the oxygen saturation (SpO2). Oxygen saturation is defined as the measurement of the amount of oxygen dissolved in blood, based on the detection of Haemoglobin and Deoxyhaemoglobin. Two different light wavelengths are used to measure the actual difference in the absorption spectra of HbO2 and Hb. The bloodstream is affected by the concentration of HbO2 and Hb, and their absorption coefficients are measured using two wavelengths 660 nm (red light spectra) and 940 nm (infrared light spectra). Deoxygenated and oxygenated haemoglobin absorb different wavelengths. Deoxygenated haemoglobin (Hb) has a higher absorption at 660 nm and oxygenated haemoglobin (HbO2) has a higher absorption at 940 nm.

Integrated website

Wanting to know how far one has come in the fitness training efforts is natural as it helps to keep up the motivation levels. An exclusive website helps track progress like never before. It can help to keep a record of the stats, generate reports and info-graphics. Streaming of one's daily activities will be made possible by syncing the device's readings. Contextualized with pretty graphics and minute details about your body , it will break everything down to the minute and you can compare your heart rate versus calories burned, for instance, or any variation of the aforementioned and that too, over a period of time. This is facilitated by maintaining a log of your activities. A social twist can be added to the exercise routine. Get extra encouragement, cheer on your buddies or start a little friendly competition through the website.

CONCLUSIONS

When anyone starts an exercise routine, it is extremely important to set realistic goals that are achievable. Moving from a totally sedentary lifestyle to ultimate fitness in four weeks is not a realistic plan for most of us. A fitness tracker helps people set and achieve reasonable goals according to tested time frames, so that they don't get de-motivated or quit halfway. Using a Fitness Trackerisbeneficial as you can:

Create a plan that works for you
Make informed decisions
Visualize your progress
Stay motivated and energized
Look and feel your best
Lose weight and trim fat
Stay healthy and vibrant
Achieve your goals

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