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Fit Assist Step count and Calorie Estimator using Accelerometer

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Abstract: A key challenge for mobile fitness is to develop new expertise that can assist individuals in maintaining a healthy lifestyle by keeping track of their everyday behaviours. With the advancement in technology, mobile phones or smart phones are in a hurry becoming the central computer and communication device in people's lives. Mobile phones have got influence due to user friendly operating system Android with its wide range applications. Many instruments like Pedometers, Step count devices, Heart beat sensor's etc., are gaining much importance as they are related to physical activities of humans. The availability of these sensors will revolutionize many sectors of our economy including healthcare, social networks, environmental monitoring and other sectors. Totally there are 14 sensors available in today's Smartphone, and newly other sensors like finger print access and Heart monitoring sensors are also available in market. An accelerometer is a device that measures force resulting from movement. In research, these can be placed fairly unobtrusively on research participants to record the duration, frequency, and intensity of their motion. Accelerometer-based measures seem potentially more useful than other measures such as pedometers that can only count steps or other devices like video cameras or motion sensors that can only record motion in a specific area. The main objective of this paper is to develop an android application to track the user physical activity and estimate his energy expenditure using an inbuilt accelerometer and GPS in a smart phone within android device. To execute this arrangement, an android app has been developed to collect accelerometer data and calorie estimation in android SDK. It is an application implemented for smart phone with android operating system, which is open-source, easy to implement and expected to become dominant OS in the smart phone market. The need of this project is mounting now a day because today's way of life involves less physically activity.

Keywords: Accelerometer, Smart Phone, Android, Calorie, Physical activity, Fitness.

I. INTRODUCTION

To calculate calories burned or energy expenditure a human body needs to perform some or the other physical activities. Physical activity may be any movement of a human body by skeletal muscles which require energy. Physical activity is a form of behaviour, where Energy expenditure is an outcome of that behaviour [1]. Physical activities don't include only sports it also include household works, exercises, aerobics etc., Smart phones have got advancement due to sensors such as GPS sensors, vision sensors (i.e., cameras), audio sensors (i.e., microphones), light sensors, temperature sensors, barometer sensors, Touch screen sensors, proximity sensors, direction sensors (i.e., magnetic compasses), and acceleration sensors (i.e., accelerometers).[6] As shown below are the 14 sensors noticed till in mobile phones up to 2013, Later other sensors like finger print and heart monitors are also available in many mobiles.

The availability of these sensors in mass-marketed communication devices creates exciting new opportunities for data mining and data mining applications. As complexities in work are reduced everyone got habituated to travel in cars, buses, some or the other ways rather than spending their energy by walking. Hence workload has been reduced and in all sector, people got habituated to sit and work all the day the calories they consume are not getting scalded off as energy. The extra calories thus are stored as fat and are causing severe health problems. Moreover due to excess fat content in body people are facing many obese problems. So by monitoring their energy consumption per day or hour they can balance their weight against food intake. The main importance of this application or paper is tracking user activity using the inbuilt sensors without any additional costs thereby applicable in all smart phones. Hence we can get useful information of our daily activities and energy expenditure, all the user need to do is to have an android Smartphone in their pockets. With smart phones becoming ubiquitous devices, we assert that they are the most convenient devices for estimating the amount of energy spent, rather than introducing dedicated wristbands, heart rate monitors or other tracking devices. Keeping track of one's fitness in their busy life schedule is a difficult task. The objective of FitAssist is to provide a user a comprehensive fitness tracker application. FitAssist uses your android phone's sensor capabilities to achieve this goal. Our work makes several contributions. One contribution is the data that we have collected and continue to collect, which we plan to make public in the future. The below Fig: 1 gives us an idea about the availability and location of various sensors.

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Fig: 1 Accelerometer Sensor X, Y, Z axis and all Sensors in Mobiles

This data can serve as a resource to other researchers, since we were unable to find such publically available data ourselves. We also demonstrate how raw time series accelerometer data can be transformed into examples that can be used by conventional classification algorithms. [6]

Terminologies used:

1. BMI –Body Mass Index
2. BMR- Basal metabolic rate, Lean Mass
3. Calorie – A unit of energy.

The body mass index (BMI) is a measure of relative weight based on an individual's mass and height. BMI provides a simple numeric measure of a person's thickness or thinness, allowing health professionals to discuss overweight and underweight problems more objectively with their patients. For a given height, BMI is proportional to mass. However, for a given mass, BMI is inversely proportional to the square of the height. A BMI of 18.5 to 25 may indicate optimal weight, a BMI lower than 18.5 suggests the person is underweight, a number above 25 may indicate the person is overweight, a number above 30 suggests the person is obese [5].

Basal metabolic rate (BMR) is the rate of energy expenditure by humans at rest, and is measured in kJ per hour per kg body mass. Lean Body Mass is a component of body composition, calculated by subtracting body fat weight from total body weight: total body weight is lean plus fat. In equations:
Lean Mass = BW – BF
BW- Body weight, BF- Body fat Weight. [5]

II. RELATED WORK

Heart Beat Sensor: As the number of patients suffering from heart strokes is increasing due to the blockage of coronary artery, the heartbeat count can be now known easily using developed sensors. A new sensor namely Heart beat sensor is designed to give digital output of heat beat count when a finger is placed on a device as shown in Fig: 2.The main principle involved in heart beat sensor is light modulation across blood flow by checking the pulse through finger [3]. The heartbeat detector works simultaneously the beat Light emitting device produces a flash accordingly with the heartbeat. To measure the Beats per minute rate the digital output obtained is connected to a micro controller directly. Its applications include:

- Digital Heart Rate monitor
- Patient Monitoring System
- Bio-Feedback control of robotics and applications

Working:

The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse [3]. This signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heartbeat.

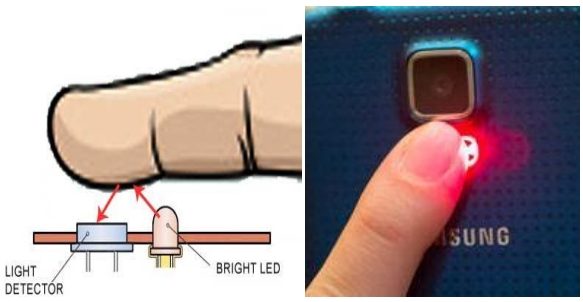

Fig: 2 Sensor principles, Fig: 2.1 Sensor in new Devices

This picture has been taken from [3]
As shown in Fig: 2.1 Samsung devices like Google Nexus 5, Google Nexus 4, Samsung Galaxy S4 and Moto G has already launched Heart rate monitoring devices, we will quickly see other such health monitoring devices in market.

There are many other sensor applications in Android platform as shown which are previously applied:

1. GPS Tracking Application

The GPS tracking application is used for measuring the distance of the client's exercise. An example of Android GPS tracking application is Runstar (Runstar, 2013), which can track distance and time of user's exercise [4]. However, the flaw of this application is the GPS network that has limited range and the lack of abilities to pierce through barriers (Otsason, Varshavsky, LaMarca, & Lara, 2005). Thus, it does not work well indoor.

2. Pedometer Application

The pedometer application generally mimics the functions of the pedometer device. Therefore, this application can count user steps, show the approximate distance, speed and the number of calories burned. Accupedo-Pro Pedometer (LLC, 2013) is an example of this kind of application. Because this application measures the approximate distance calculated from user's paces, it cannot measure user's speed accurately, thereby affecting the precision of calorie calculation [4].

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3. Calorie Counting Application

This application is used to help an user to keep track of Android calorie counting application is an application that helps users to keep track of their meals, exercise and weight. An example of Android calorie counting application is Calorie Counter by FatSecret (FatSecret, 2013). This application works by providing necessary information such as nutrition facts on foods and number of calories burned in each exercise mode [4]. The number of calories burned by user's activities will be counted and recorded in the application. Since the calorie counting process does not come from the real practice, the result may be incorrect.

Barometer sensor and its application:

Traditionally, the barometer sensor is used in meteorology to measure atmospheric pressure. It is also used as pressure sensor which measures relative and absolute altitude through the analysis of changing atmospheric pressure. The barometer sensor can be used for motion detection, but it is mostly used by location-based applications to evaluate elevation. Ohtaki et al. have first introduced the concept of combining barometer with accelerometer for detecting ambulatory movements, where authors embed a barometer sensor into a portable device to evaluate daily physical activity and classify the activity type [2].

Architecture:

The below Fig: 3 represent the high level architecture of FitAssist.

Android platform is an open source complete software stack that includes operating system, A Kernel, Middleware with many User applications for mobile platforms. Android platform has its own virtual machine namely DALVIK (DVM), which is similar to Java virtual machine.

Support services for executing applications are

- Core Libraries
- Dalvik Virtual Machine

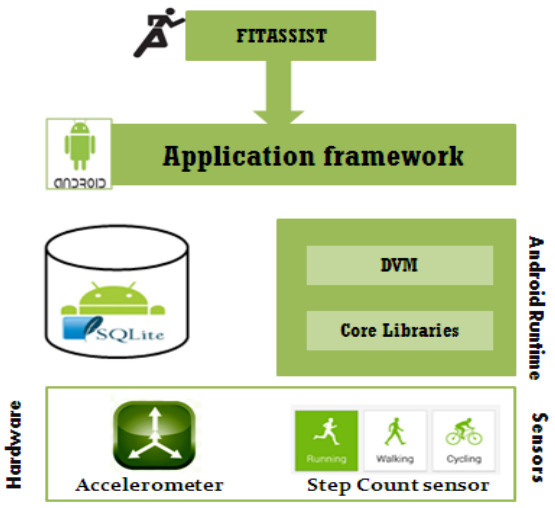

Fig: 3 High level Architecture

DVM:

Every android application runs on its own process, with its own instance of the Dalvik Virtual Machine.

Dalvik has been written so that a device can run multiple instances of VM efficiently. Dalvik is a virtual machine that is designed specifically for the Android platform. Named after the fishing village of Dalvik in Iceland, it was originally written by Dan Bornstein [8]. Unlike most of virtual machines that are stack based, Dalvik architecture is register based. It is optimized to use less space. The interpreter is simplified for faster execution. The Dalvik VM executes its files in the Dalvik executable (.dex) format which is optimized for minimal memory footprint [7]. The Dalvik machine is register based and runs classes compiled by a Java language compiler that have been transferred into the .dex format by the included dx tool. The DVM relies on the Linux kernel for underlying functionalities such as threading and low-level management. The Android Core Libraries also referred to as the Dalvik Libraries. These are classified into three types:

i) Dalvik VM Specific Libraries
ii) Java Interoperability Libraries
iii) Android Libraries

III. ANDROID TECHNIQUES USED

1. The application is primarily designed to work with Android 4.4 device featuring a Step Counter sensor.
2. Due to the lack of devices with inbuilt Step Counter sensor, an algorithm is designed in order to detect and record the steps using the Accelerometer sensor present in the device.
3. In order to run the application in an uninterrupted manner, PowerManager and Wakelock have been used. A wake lock is a mechanism to indicate that your application needs to have the device stay on.
4. SensorManager has been used for getting and working with the device's sensors.
5. To store the user specific information, SQLite Database has been used.
6. A class extending Application has been used to store the globally accessible values for the application.
7. Java's Scheduler is used to provide scheduled operational functionalities for the application.
8. Android's inbuilt UI elements are used to provide a seamlessly easy and simple user experience.
9. Android's PendingIntent and NotificationManager are used to provide Notifications to the user.
10. Android's Toasts are used to provide simple and elegant notifications for the user.

Calculating BMI:

Bmi = wt/(ht*ht);
Lean mass =wt-bf*wt/100;

Calculating BMR:

In order to suggest the appropriate number of calories expended per day for each person, we use the BMR (Basal

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Metabolic Rate) equation (Wikipedia, 2014) to find the number of calories the client body needs at rest for each day. The BMR equation for male and female consists of components described below:

Case 1: If sex == 0
bmr = 66+13.7*(leanmass)+5*(ht*100)-6.8*(age));
Case 2: If sex!= 0
bmr = (655+9.6*(leanmass)+1.8*(ht-4.7*age));

Algorithm:

Step I:

Calculating calories burned after connecting to database:

float ht=(float)val.get(0)/100;
wt=(float) ((float)val.get(1)/2.20462);
age=(float)val.get(2);
bf=(float)val.get(3);

Step: 2

To Calculate BMI//

cbmi = wt/(ht*ht);
leanmass=wt-bf*wt/100;
Initialise cbmr;

Step: 3

To Calculate BMR//

cbmr = (float)(66+13.7*(leanmass)+5*(ht*100)-6.8*(age));
cbmr = (float) (655+9.6*(leanmass)+1.8*ht-4.7*age));

Step: 4

To Find Calories Burned:

if(calburned<100)
x=(float) 1.2;
if(calburned>=100&&calburned<250)
x=(float) 1.3;
if(calburned >= 250 && calburned <425)
x=(float) 1.4
if(calburned>=425&&calburned <700)
x=(float) 1.5;
if(calburned>=700)
x=(float) 1.6;

IV. TESTING

1. Functional Testing is performed to ensure that the applications functionalities are working as per requirements.
2. Usability Testing is performed to ensure that the application receives a favourable response from the group of users who tested the application.
3. Installation Testing and Compatibility testing are performed by installing the application on Few devices like Google Nexus 5, Google Nexus 4, Samsung Galaxy S4 and Moto G
4. Interface testing is performed to ensure the seamless navigations and validations of workflows

V. RESULTS

The below results are obtained when this app is successfully installed and run on your Smartphone. Make sure that the Accelerometer is ON so that it can calculate the results.

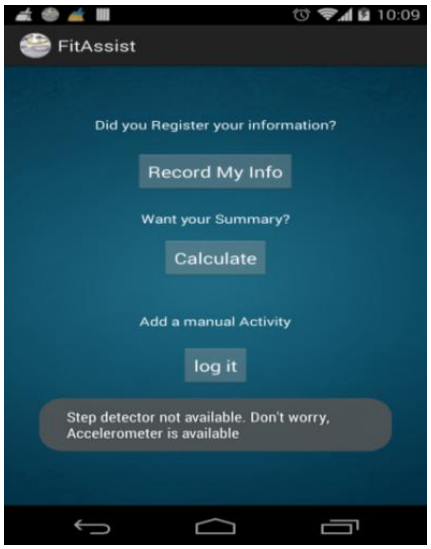

Fig:4 The home page to register

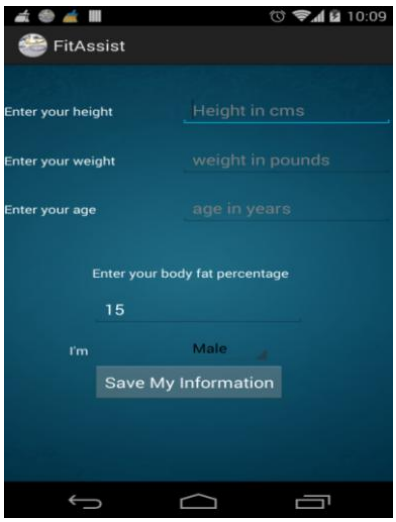

Fig:5 Recording details

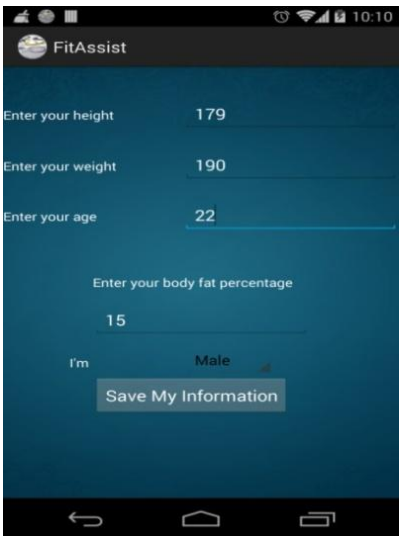

Fig:6 Saving Information

Fig: 4,5,6 gives us information regarding how to register and how to save our personal information and thus saving is done.

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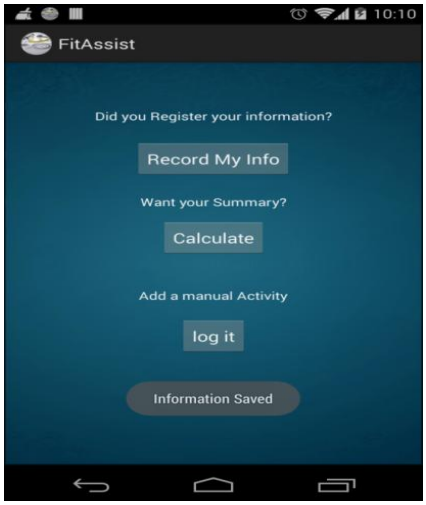

Fig:7 Information Saved

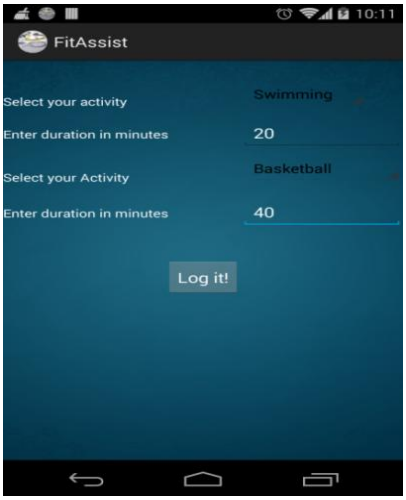

Fig:10 Manual activity and Time

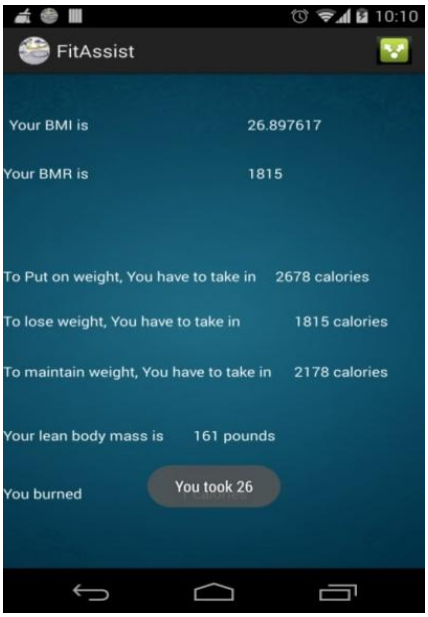

Fig:8 Obtained results details

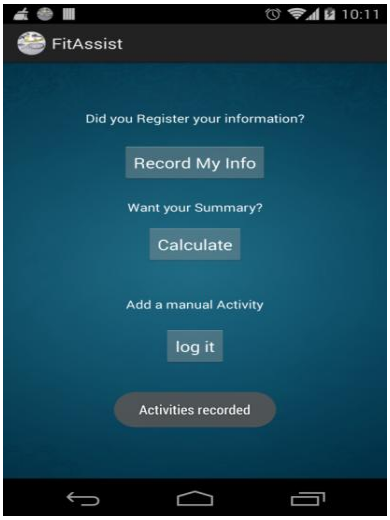

Fig:11 Activities recorded

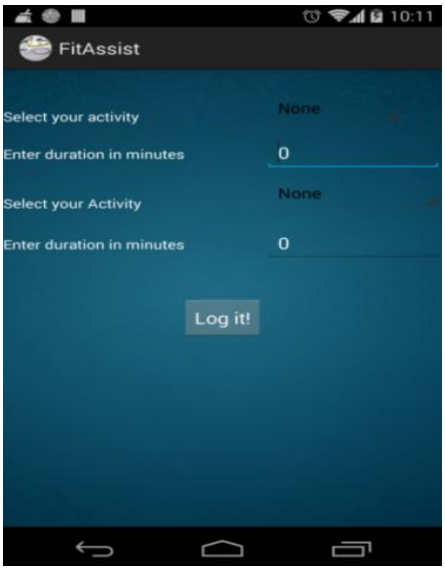

Fig:9 Selection of activity

Fig: 7,8,9 Shows us a sequence of steps after registering and gives the result, and to select an activity.

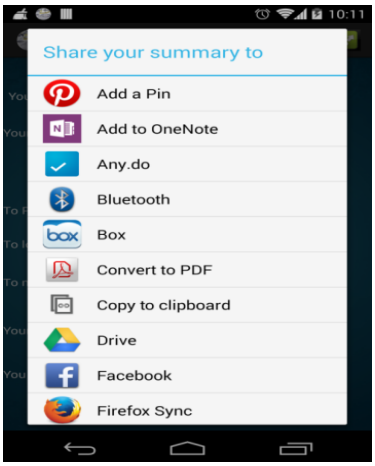

Fig: 12 Sharing Information

Fig: 10, 11 represents us to select an activity and the time estimated to perform the activity and to record them.

After getting the results these can be shared and stored as shown in Fig:12.. As sharing can allow us to store everyday details and thus we can easily observe the variations of our calories expentidure. We used all the trending applications to store and share data thus it provides flexibility to an user.

VI. CONCLUSION

Here a real world application has been designed for mobile users as it is very useful for people who are suffering from severe health problems like excess weight, underweight, etc., Hope this application is useful to all age groups. It costs nothing to download this application in android devices just all you have to do is to install an APK and keep your smart phone in your pockets or anywhere near on your body. If you use any other device specifically for a purpose everyone will come to know that you are suffering from something or other, so instead if we use a mobile no one can identify our weakness, and we can check all the problems easily. As generation is improvising gradually development of applications like this can save us a lot of money and time, instead of meeting a doctor regularly. Many applications like these have been developed in Android for computing our fitness or health. Let's hope many as such applications which will be very useful to us can render a faster progress in all aspects.

FUTURE WORK

As per my concern the developer of an application can never be carried out to the fullest extend in a fixed time, the main reason why revisions of the application are always introduced in course of time. As android is in a chase of quicker development of varied applications, researchers are also acquiring knowledge about all the tools. As android provides easy tools for designing such applications it's not so complicated to implement a new technique. Many software developers are in a thirst of developing new mobile applications, so android provides a better platform in terms of research equally with development. This application can further be extended in Windows Platform, etc., so that all the mobile users other than android also can access to this application. Step counter is not fully fledged in this paper so researches are in progress to solve some of the errors regarding step count.

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BIOGRAPHY

Saiprasad Kashi is an M.Tech student and Research scholar in Computer science and engineering with a wide interest towards new technologies and also interest in research field of computer and data mining applications. He has previously published two papers on knowledge and data engineering and interested in attending national conferences.