The Design of an Intelligent Pedometer using Android

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***Abstract*—Google's Android has become the leading platform in smart phone market. Android has also integrated various sensors including gyroscope, orientation and accelerometer, so it is quite suitable to design mobile sensor applications.**

Pedometer is a common auxiliary device used for maintaining health and fitness. In this paper, an intelligent pedometer is developed using Android. The user's walking motion was detected via android sensor and pedometer application then analyzes the signal, calculates the walking distance and calories burned, and provides real time feedback to user via Bluetooth. The system provides three action modes: time-based mode, distance-based mode and count-based mode. All the tracking data are saved in SQLite database, and automatic threshold detection is used to improve the accuracy.

Keywords-Android; pedometer

I. INTRODUCTION

According to the Canalys's Q4 2010 global country-level smart phone market report, Google's Android has become the most popular mobile platform [1].

Android consists of a kernel based on the Linux kernel, with middleware, libraries and APIs written in C and application software running on an application framework which includes Java-compatible libraries based on Apache Harmony [2]. Android uses the Dalvik virtual machine with just-in-time compilation to run compiled Java code. Besides, Android has a large community of developers writing applications ("apps") that extend the functionality of the devices.

One of the attractive features of Android is that Android devices have multiple different types of hardware that are built in and accessible to developers. Android can use video/still cameras, touchscreens, GPS, accelerometers, gyroscopes, magnetometers, proximity and pressure sensors, thermometers, etc. Because of additional hardware support, Android is more suitable for creating creative applications than other smart phones [3]

This study applied Android to develop an intelligent pedometer. The user's walking motion was detected via Android sensor. Pedometer application will analyze the signal, calculates the walking distance and calories burned, and then provides real time feedback to user via Bluetooth. The system provides three action modes: time-based mode, distance-based mode and count-based mode. All the tracking data are saved in SQLite database, and automatic threshold control is used to improve the accuracy.

II. RELATIVE TECHONOLGIES

A. Bluetooth

The Bluetooth (IEEE 802.15) is a proprietary open wireless technology standard designed for short-range, low-bandwidth peer-to-peer communications. It has been widely used in cellphone. Android provides classes that manage Bluetooth functionality and let applications [4]:

- Scan for other Bluetooth devices
- Query the local Bluetooth adapter for paired Bluetooth devices
- Establish RFCOMM channels/sockets
- Connect to specified sockets on other devices
- Transfer data to and from other devices

B. Android Sensor

Smartphones are becoming sensor hubs in a way, opening a rich experience for users. Android devices have multiple different types of hardware that are built in and accessible to developers. Sensors, such as a camera, accelerometer, magnetometer, orientation sensor, and proximity sensor, are available on most devices. Android abstracts the sensor implementations of each device. The Sensor class is used to describe the properties of each hardware sensor, including its type, name, manufacturer, and details on its accuracy and range. The SensorManager class is used to manage the sensor hardware available on Android devices [5].

C. SQLite

SQLite, one of the built-in data persistence technologies included in the Android platform and supported by the Dalvik virtual machine, is a tiny yet powerful relational database engine created by Dr. Richard Hipp in 2000. It is arguably the most widely deployed SQL database engine in the world [6]. A SQLite database is just a file. Android stores the file in the /data/data/packagename/databases directory. Instead of calling Java I/O routines to access this file from your program, you run Structured Query Language (SQL) statements using the helper classes and convenience methods.

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III. SYSTEM DESIGN

A. Getting a Device's acceleration & Rotational Attitude

The pedometer application uses acceleration sensor and orientation sensor to detect user's walking motion, and infer the walking steps, walking distance and calories burned form the sensor data

Figure 1 shows the coordinate system of Android. The coordinate system of the device frame is defined as:

x-axis in the direction of the short side of the screen (along the menu keys)

y-axis in the direction of the long side of the screen

z-axis pointing out of the screen

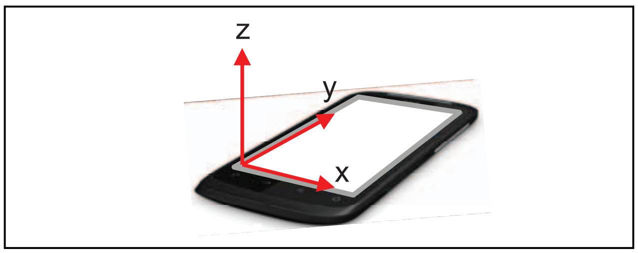

Figure 1. The values of acceleration sensor

In addition to acceleration, we also need to detect the device's orientation. We can invoke the SensorManager.getOrientation() method to retrieve a rotation attitude vector attitude[] which represents the :

- attitude[0]—Azimuth (in radians) is the rotation angle around the world-frame z-axis required to have the device facing north. It takes values between -PI and PI, with 0 representing north and PI/2 representing east.
- attitude[1]—Pitch (in radians) is the rotation angle around the world-frame x axis required to have the device face straight up along the long dimension of the screen. It takes values between -PI and PI with 0 representing device face up, and PI/2 means it points toward the ground.
- attitude[2]—Roll (in radians) is the rotation angle around the world-frame y axis required to have the device face straight up along the short dimension of the screen. It takes values between -PI and PI with 0 representing device face up, and PI/2 means it points toward the right.

For a pedometer application, there are two cases when a user is walking with an Android device hanging on waist. As shown in Fig.2, when the device is horizontal, the acceleration value of x axis represents the up-down vibration, and the acceleration value of y axis represents the forward-backward vibration.

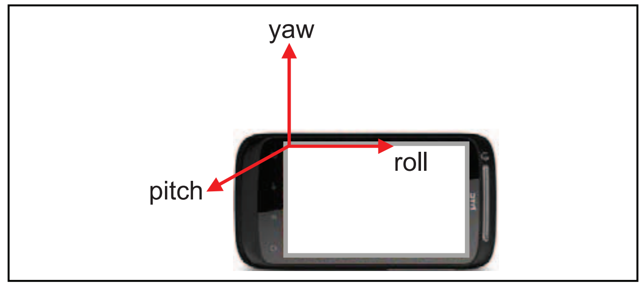

Figure 2. Device orientation when yaw=90, roll=0 and pitch=0

In case of the device is vertical (as shown in Fig. 3), the acceleration value of x axis represents the forward-backward vibration, and the acceleration value of y axis represents the vibration.

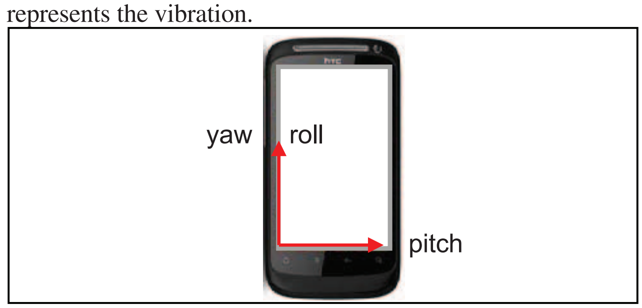

Figure 3. Device orientation when yaw=0, roll=0 and pitch=90

Figure 4 shows a snap of acceleration values when the Android device is horizontal.

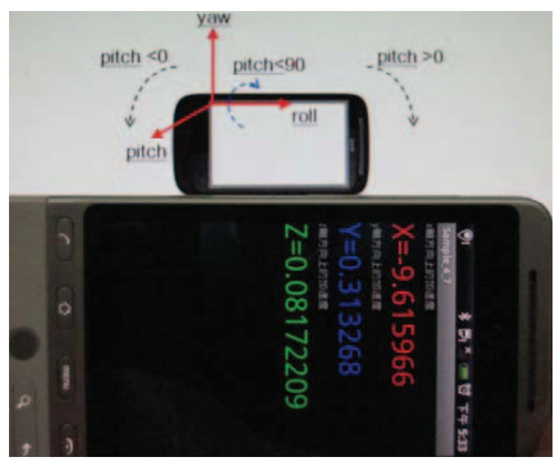

Figure 4. Device accelertion when yaw=90, roll=0 and pitch=0

B. Action Modes

The system provides three action modes: time-based mode, distance-based mode and count-based mode.

- time-based
  User sets up the walking time, system will notify user via Bluetooth when the exercise time is out.
- distance-based
  User sets up the walking distance, system will notify user via Bluetooth when walking distance is achieved.

- count-based
  User sets up the walking steps, system will notify user via Bluetooth when walking steps is achieved.

As shown in Fig.5, each mode will also calculate the calories burned by the following formula [7]:

$$\text{kca} = 0.7768 \times \text{distance (km)} \times \text{weight (kg)} \qquad (1)$$

Figure 5. A snap of pedometer application

C. *Operation flow*

Figure 6 shows the sequence diagram of the pedometer application.

1) User selects action mode and setup parameters.
2) Pedometer activity retrieves the sensors' values.
3) Pedometer activity anaiyzes the user's walking motion.
4) Pedometer activity checkup goal.
5) Pedometer activity sends feedback information to user via Bluetooth
6) Pedometer activity persists walking data in SQLite data base
7) Pedometer activity notify user when preset goal is achieved.

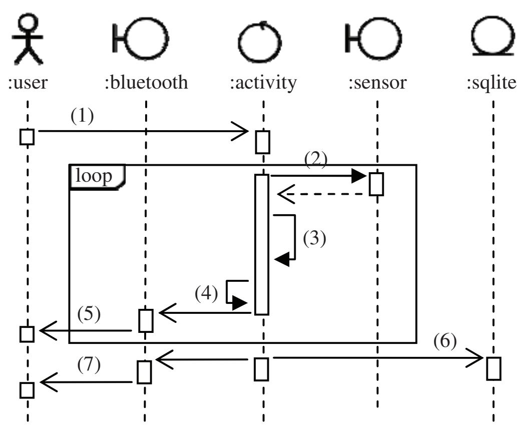

Figure 6. The sequence diagram of the pedometer application

D. *automatic threshold control*

Firgure 7 shows the pedometer application's sensoring data when a user hung the Android device at the waist and walked for fifteen steps. There is notable noise at the begin and the end of walking. Besides, the virabtion amplitude of sensoring signals of each user is different. So the pedometer application should calculate the counting threshold according to the sensoring data at the sampling phase for each user.

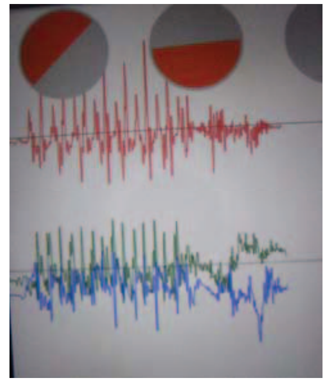

Figure 7. Sensoring data of pedometer application

IV. Conclusion

Android is becoming sensor hubs in a way. In this study, Android is used to develop an intelligent pedometer application. User's walking motion was detect by acceleration sensor and orientation sensor, and voice feedback was provide via Bluetooth. All the tracking data are saved in SQLite database, and automatic threshold control is used to improve the accuracy.

Our future work includes the following issues.

- Integrate *with GPS information to record the user's walking track*
- Integrate *with WiFi communication to provide group walking interactions.*

References

[1] Canalys, "Google's Android becomes the world's leading smart phone platform," http://www.canalys.com/pr/2011/r2011013.pdf, 2011

[2] Android Developer, http://developer.android.com

[3] Google, Android Developer Challenge, http://code.google.com/intl/zh-TW/android/adc/

[4] W. Frank Ableson, et al., Android in Action 2nd Edition, Manning 2011

[5] Reto Meier, Professional Android 2 Application Development, Wiley 2010

[6] SQLite, http://www.sqlite.org

[7] Williams & Wilkins, "ACSM's Guidelines for Exercise Testing and Prescription," 1995