The design of network pedometer based on Bluetooth 4.0

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***Abstract*—The pedometer combined with Bluetooth 4.0 can effectively implement the communication with the laptops, PAD， and mobile phones. it can more accurately calculate the number of pace through the method of real-time digital filter smoothing data curve, the design not only can enhance people's enthusiasm of taking exercise but also can effectively save communication resource. Because of the Bluetooth technology is in the 2.4 GHz band which is free spectrum [1], Bluetooth technology is bound to get more widely applications and more recognition, it can effectively put the data recorded by pedometer sent to the mobile phone and other modern terminal devices through Bluetooth technology, and then the data is uploaded to the cloud server to be saved through the terminal. This can increase people's interest in the pedometer, because the relevant data can be visible saved for a long time, it tracks more convenient for people to exercise and reach the effect of physical fitness. So it is convenient for people to track and compare the physical activity to reach the effect of physical fitness.**

Keywords- Bluetooth 4.0; pedometer; Real-time digital filtering; Cloud server

I. INTRODUCTION

In recent years, the pedometer is becoming more and more popular, it not only can inspire people to challenge themselves, but also can help people to enhance physique and thin body.

Bluetooth as a kind of short-range wireless communication technology can effectively achieve the communication between the pedometer and notebook computer, PAD, mobile phones and other mobile communications terminal equipment [2] [3], this makes the data transmission between modern communication equipment and the Internet becoming more efficiently, it also widens the road in the field of wireless communication and reduces the burden of the countries in the aspect of communication [4].

The effective combination of pedometer and of Bluetooth technology conforms to the development trends of the electronic market, through the Bluetooth technology can effectively put the recorded by pedometer sent to the mobile phone and other modern terminal devices, the terminal transmits the data to the cloud, so it can not only increase the peoples' interest in pedometer, but also the relevant data can be visible preserved for a long time which is convenient for people to follow to exercise.

II. OVERALL ARCHITECTURE OF SYSTEM

In the pedometer module, acquiring acceleration data as a parameter is calculated by acceleration sensor, and the data includes three kinds of acceleration values in three directions, which are the front and rear components, the left and right components, and the upper and lower components, the values are defined as the X-axis, the Y-axis and the z-axis in the algorithm.

The principle diagram of the system is as follows.

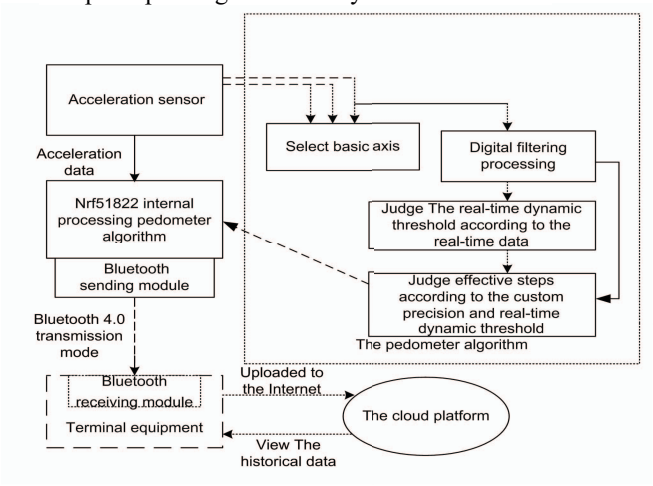

Figure 1. The principle diagram of the system

III. ALGORITHM OF SYSTEM

A. *Algorithm of pedometer*

The pedometer algorithm mainly includes the algorithms of choosing XYZ axis direction, real-time digital filtering algorithms, real-time dynamic threshold calculation method and the algorithms of judging to take the step which is determined by the custom precision and real-time dynamic threshold.

1. Using the algorithms of choosing XYZ axis direction to determine datum axis. In the calculation of the whole algorithm, only one axis data is calculated, the algorithm not only simplifies the calculation process but also ensures the accuracy of the calculation.

2. All the data collected is processed by digital filtering, which prevents the data collected by the sensor from being abnormal and ensures the smoothness and accuracy of the data.

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3. To calculate the real-time dynamic threshold is prepared for determining the pace.

4. The algorithm defines the acceleration accuracy and combines the dynamic threshold from the step 3 to determine whether an effective step is taken.

Because of the difference between the individual and the difference of the pedometer carried [6], the acceleration change of the X-axis, Y-axis, and z-axis is also different, But there's always a change highlighting in one direction, which is the selected base axis. The acceleration change curve of XYZ axis in the actual running individual instance is shown in Fig. 2.

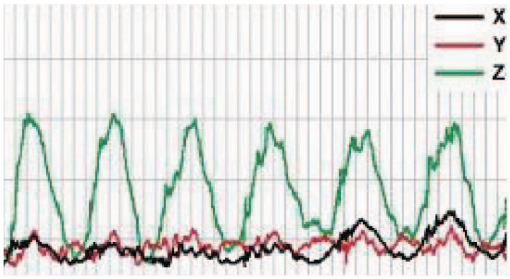

Figure 2. The acceleration change curve of the individual XYZ axis

The specific selection algorithm is as follows:

Collect 100-150 data respectively from the X-axis, Y-axis, and z-axis, and calculate the average value of each axis data, find the maximum average in the mean of X, Y, and Z axes, then select this axis as the base axis and only operate the data in this direction.

B. Method of real-time digital filter smoothing data curve

The body signals collected by the sensor in the motion always fluctuate, the signals jump is larger, and although the sensor is sensitive, there still is some deviation in the actual. For this defect, the real-time digital filter is designed to smooth data curve.

The filter uses five registers and an average unit, usually the more registers are used, the more stable and accurate the resulting data curve is, But using too many registers is bound to affect the response speed, after testing, the method of five registers can give a good balance of data stability and response speed. The model is shown in figure 3.

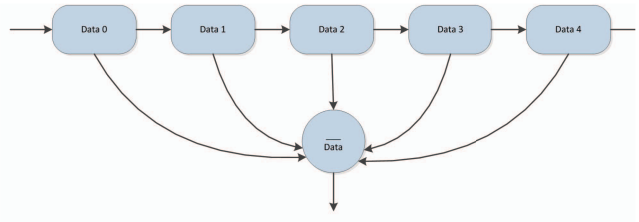

Figure 3. The model of digital filter

C. Algorithm of judging steps

The output data of digital filter is dynamically stored in the 30 registers. Each time calculating a real-time dynamic threshold (dyn_threshold) when a data is coming. Find out the maximum value (max) and the minimum value (min) from the data of 30 registers. The real-time dynamic threshold value is dyn_threshold = (max+min)/2.

Use dynamic threshold and a linear shift register to judge whether an individual has an effective step in this paper. A linear shift register contains two registers which are data_new register and data_old register, the data in the two register is respectively called data_new and data_old. When the new sampling data is coming, the data of sample_new register always moves into the sample_old register.

Users can predefine the precision according to their own condition, by default precision = 0.01, through experimental test it can accurately judge steps when the precision is 0.01. If the change of acceleration is larger than the predefined precision, the latest sampling data (data_out) which is processed through digital filter moves into the data_new register, otherwise, the data of data_new register is invariant. When the acceleration curve is above the dynamic threshold, at the same time data_new is larger than data_old, we judge it to be an effective step. The specific process is shown in figure 4.

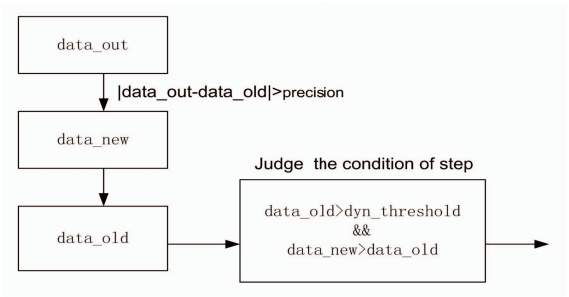

Figure 4. The model of judging steps

IV. TRANSMISSION MODE OF BLUETOOTH 4.0

The bottom protocol of Bluetooth 4.0 is basically similar to the bottom protocol of basic Bluetooth. The difference is the host side, low-power Bluetooth 4.0 protocol for sensor network applications push out property protocol ATT and general attributes profile GATT [6] [7], specific protocol hierarchy is shown in figure 5.

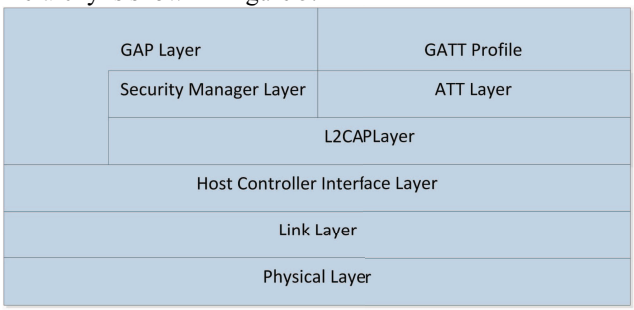

Figure 5. The chart of protocol hierarchy

The Bluetooth module of pedometer in the normal working state mainly contains standby, initiate, scanning, connection and broadcast, the relationship between each other as shown in figure 6.

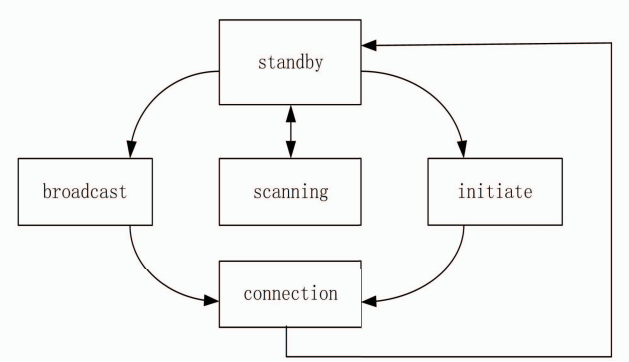

Figure 6. The working state transition diagram of Bluetooth module

V. CONCLUSIONS

In this paper, we design a network pedometer based on Bluetooth 4.0 combining movement hotspot and Bluetooth 4.0 technology which is the latest short-range wireless communication technology [8]. The algorithm of the pedometer is precise, and the data is accurate after digital filtering, the dynamic threshold obtained through a lot of samples values can guarantee the accuracy of the algorithm in real time. The merits of Bluetooth 4.0 technology are high transmission rate, far transmission distance and low power consumption, mostly terminal equipment are imported the module of Bluetooth 4.0 now [9], pedometer carriers can easily see the condition of exercise timely through the terminal, and it can upload data to the network and cloud platform through the terminal, the user can view the recent movement history, pedometer has a very good market prospect by using this technology.

Acknowdgements

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