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# Design and Application of Intelligent Running Shoes Based on the Internet of Things

**James Anderson**

Xavier University, Cincinnati, USA

Jameso098@xavier.edu

**Abstract:**The Internet of Things (IoT) represents the third significant phase in the evolution of the global information industry, following the advent of personal computers, the Internet, and mobile communication. A notable area of focus within IoT research and application is intelligent wearable devices. This paper introduces the design of an IoT-based intelligent running shoe, which incorporates capabilities for data sensing and collection, motion tracking, information transmission, data analysis, and user interaction. By employing a well-structured hardware architecture and software system, the proposed design offers a practical approach for the development and implementation of wearable technology, exemplified by intelligent running shoes.

**Keywords:**Intelligent running shoes, Internet of Things , sensors, GPS, wearable equipment.

## 1. Introduction

In 2016, the global wearable equipment retail market has reached 96 million units, an increase of 178% over the same period last year. This trend continued to grow in 2019. Developed markets such as America, Europe, Japan and South Korea account for 65% of the global market share, while in China, regardless of the population base or purchasing power, the potential capacity of the market is huge, and it will become the focus of the layout of major manufacturers. With the improvement of living standard and quality, wearable equipment is becoming more and more popular among consumers. With the development of science and technology, the cost of technological innovation and investment has been continuously reduced, and wearable equipment will become a common commodity in our daily life. Under the general trend of AI development, wearable intelligent devices will become a part of people's life. Intelligent running shoes of Internet of Things combined with healthy sports function will also become an indispensable intelligent wearable product in people's life.

In foreign markets, Under Armour (Andema) launched its second series of smart running shoes, UA Record Equipped, in April 2017.The smart running shoes have sensors embedded in the shoes and UA Run to transmit information from the shoes to the smart phone. The sensors can also record the physical state of the athletes. There are similar products in China, such as Li Ning and Anta's intelligent running shoes, which can record multiple data items and complete data analysis in the background. However, from the actual use, the accuracy and stability of the data are not high, and it cannot well reflect the real movement state of the athletes.

## 2. Development of Internet of Things

The Internet of Things is the third wave of global information industry after the development of personal computers, Internet and mobile communication. Internet of Things (IOT) is a network that intelligently identifies, locates, tracks, monitors and manages information by means of radio

frequency identification, infrared sensors, global positioning system, laser scanner and other information sensing devices, linking any item to the Internet according to the agreement, exchanging and communicating information. The structure of Internet of Things can be divided into perception layer, transmission layer and application layer. The intelligent running shoes discussed in this paper are the Internet of Things for ordinary running shoes.

## 3. Design of Hardware System for Intelligent Running Shoes

The hardware system of intelligent running shoes is mainly composed of three parts: core processing module, sensing module and communication positioning module.

(1) Core processing module. This module is the core part of the whole system, using STM32 chip and redesigned PCB circuit board. STM32 is a powerful 32-bit microcontroller, which integrates CPU, RAM, ROM, I/O ports, interrupt system, timer/counter functions with data processing capability into a single silicon chip by using VLSI technology. STM32 integrates high performance, real-time, digital signal processing, low power consumption and low voltage, while maintaining the characteristics of high integration and simple development. The smallest system based on STM32 chip retains only some basic input, output and control functions, fully meets the requirements of signal processing and data transmission of intelligent running shoes, and can also adapt to the actual application environment of intelligent running shoes to the greatest extent.

(2) Sensor module. Sensors are devices that convert non-electric physical signals, chemical signals and biological signals into electrical signals. The requirements of this design for sensors are as follows: high sensitivity, high sensitivity, high sensitivity, high precision; wide linear range, the more effective range of sensors; high stability. After long-term using, they can still maintain high output characteristics and output accuracy. The basic components of the sensor include power supply, sensitive elements, converter and signal conditioning circuit.

The main sensors used in this design are pressure sensor and gyroscope sensor. Pressure sensors are distributed in many places on intelligent running shoes insoles according to certain rules. The average contact time, landing ratio and gait ratio of the athletes are collected. From these three dimensions, combined with large data modeling and analysis, it can be concluded whether the movement posture and habits of the athletes are scientific and reasonable.

The gyroscope sensor can accurately acquire the motion state of the intelligent running shoes. It works based on the acceleration principle. The acceleration of the intelligent running shoes can be regarded as the component superposition on three coordinate axes. The gyroscope sensor can realize the conversion and debugging of the positive and negative 90 degrees of the two axes and the inclination angle from zero to 360 degrees of the two axes. It can be used to record the athletes in the intelligent running shoes. Running steps, stride length and stride frequency, etc.

After the sensor in the smart running shoes is connected with the mobile phone, it can also send out voice prompts synchronously, correct the inappropriate walking posture and excessive fluctuation of stride frequency of the athletes in real time, supervise and adjust them in place. In addition, intelligent running shoes are equipped with photosensitive sensors, which can control the switch of LED lights on running shoes, realize the function of night running warning, and increase the safety of sports.

(3) Communication positioning module. It mainly consists of Bluetooth unit and GPS unit. Bluetooth unit uses the latest Bluetooth 5 chip. Bluetooth 5 chips have wider signal coverage ( which are four times the old standard v4.2; effective working distance between transmitting and receiving devices can reach 300 meters); faster transmission rate (twice the old standard);larger data capacity (broadcasting packet data carrying capacity is eight times the old standard).

Bluetooth 5 also supports indoor navigation; positioning accuracy can reach 1 meter. It can provide more stable, fast and wide range of connection and communication functions for Internet of Things and wearable devices. Smart running shoes communicate with the outside world through Bluetooth. After connecting with smart phones, the data of athletes can be transmitted to smart phones in real time. Through the gateway function of smart phones, the data can be transmitted to the cloud through the network.

GPS (Global Position System), which is based on satellite radio navigation technology, can realize the positioning and navigation of space intersection and fixed-point of time-service and ranging, and provide users with continuous, real-time, high-precision three-dimensional position, three-dimensional velocity and time related information. The GPS unit records the motion trajectory of the mover, and locates the specific geographical position of the mover in real time by using the data package of the German map.

## 4. Design of Software System for Intelligent Running Shoes

Intelligent running shoes software system is mainly based on Wechat and cloud computing. The small program development based on Wechat does not need to install APP on the smartphone. Users can open the application by scanning the QR code or searching it, which greatly reduces the difficulty of development and the threshold of use, and is conducive to the promotion and use of smart running shoes. The development of Wechat widget includes prototype design, server information collection and mobile program debugging. Wechat applet is the interface between the system and users. In UI design, the functions of pressure sensor, positioning information, gyroscope sensor, Bluetooth and other parts need to be reflected, as well as the statistics of user data, recording pages, etc. In order to achieve convenience and beauty in the overall design and layout, and to maximize the user's needs.

Cloud computing is cloud service, which is a pay-per-use mode. This mode provides usable, convenient and on-demand network access, with virtualization, high reliability, high scalability, low cost and other characteristics. After the data of smart running shoes is transmitted to the cloud, it is analyzed, processed and stored through the program, and finally the information is displayed to users through the smart phone feedback.

## 5. The Improvement Direction of the Design

In the aspect of hardware system, we need to further improve the layout of PCB circuit board, sensors and components, and strive to design the whole hardware system more compact, more integrated, and reduce the volume of hardware system: pressure sensors, gyroscope sensors, photosensitive sensors and other components with higher accuracy can be selected, so as to improve the stability of the whole system and data accuracy. In the aspect of energy consumption control of the system, special devices should be designed in the aspect of water- proof and seismic resistance of intelligent running shoes.

On the software side, on the one hand, it is necessary to continuously optimize the algorithm of user step frequency, step width and other data; on the other hand, the software interface design also needs to constantly summarize user feedback, and optimize the software interface and the running speed of the program from the actual needs of users.

## 6. Conclusion

Intelligent running shoes provide abundant reference information for athletes and provide new methods and means for scientific and quantitative sports. They have the following obvious advantages: real-time and continuous monitoring of the state and process of sports; intelligent data processing without manual intervention; friendly human-computer interaction, simple and intuitive.

On the one hand, the design of intelligent running shoes based on the Internet of Things overcomes the shortcomings of intelligent running shoes in the current market, and puts forward a convenient, stable and feasible real-time positioning and data monitoring solution based on running shoes. On the other hand, it also provides some ideas and references for the research and development of intelligent Wearable products by adopting new technologies and implementation methods.

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