

Design of Intelligent Personalized Nutrition Supplement Machine

Xinpeng Yang², Sidan Liu¹, Lirui¹, Junhui Yin^{1*}, Yizhun Peng^{2*}

¹*School of Economics and Management, Tianjin University of Science and Technology, Tianjin, China*

²*School of Electronic Information and Automation, Tianjin University of Science and Technology, Tianjin, China*

*E-mail: *junhuiyin@126.com, *pengyizhun@tust.edu.cn*

www.tust.edu.cn

Abstract

Reasonable nutritional supplement is the necessity for growth and development of living organisms. Residents need various nutrients daily to maintain bodies. However, in the post-epidemic era, people's physical and mental pressure has increased due to the fast life pace, and most Chinese residents are sub-healthy. To improve the current incomplete and untimely citizen nutrition supplement mode, this work uses big data, artificial intelligence and Internet of things to design an unmanned intelligent personalized nutrition supplement machine. Combining individual body data automatically, the machine can prepare exclusive nutritional supplement drinks timely, avoid crowd contact and support the citizen health quality improvement with effective software and hardware.

Keywords: Nutritional supplement; The Internet of things; Embedded system; Mini-program

1. Introduction

National health is related to the development of national quality and the promotion of economic level. Under the impact of COVID-19, society has a deeper understanding of health and healthcare, and people's awareness of their own physical fitness has been significantly improved¹. More and more people have realized the importance of reasonable nutritional supplements. In the field of health care, the health care industry combining big data analysis², Internet of things³, human-computer interaction and other new technologies⁴ has become a research hotspot. This research has greatly improved the competitiveness of products, opened up a new mode of reasonable nutrition supplement, and helped epidemic prevention and health security. It has laid a practical foundation for the national and local governments in China to improve the health quality of residents.

2. Nutritional design

We aim to customize recipes for each user scientifically and reasonably according to the Dietary Guidelines for Chinese Residents (2016) from the original unilateral nutrition supplement to the dietitian at home!

2.1. select (suitable) material

Kiwi :(can be used as A supplement for vitamins A, C and E, it is rich in vitamins C, A and E. The contents of Vc, Mg and trace elements in kiwi fruit were the highest. At the same time, Ve and Vk contents in Kiwifruit were determined as excellent)⁵. Mulberry: can be used as iron and calcium supplement, containing calcium, iron, zinc, selenium and other minerals lacking in human body, which can enhance immunity, promote the growth of hematopoietic cells and promote metabolism, etc.)⁶; Tomato :(can be used as vitamin B supplement, tomato is rich in vitamin A, vitamin C, vitamin B1, vitamin B2)⁷; Apples :(as a zinc supplement) apples are not only rich in essential nutrients for the brain

such as sugar, vitamins and minerals, but more importantly, they are rich in zinc.

2.2. Principle of nutrition scheme ratio

First, calculate the user's body mass index (BMI) : BMI= weight (kg)÷ (height * height) (meter)

Second, according to the relevant requirements of users to complete the plan

Basis for plan making According to Mifflin St. Jeor Calculator, the formula included height, weight and age, and the calculated results were more suitable for Chinese people's physique. The formula is as follows: Static energy consumption (REE) calculation formula (unit: Kcal) : Male: 10* weight (kg)+6.25* height (cm) - 5* age (Y)+5; Female: 10* weight (kg) + 6.25* height (cm) - 5* Age (Y) - 161

Third, daily total energy consumption (TDEE) calculation formula (unit: Kcal) : REE*1.2: sedentary; Little or no exercise throughout the day; REE*1.375: Light exercise (1-3 days per week); REE*1.55: Moderate physical activity (3-5 days per week); REE*1.725: Strenuous exercise (6-7 days per week); REE*1.9: Overweight activities (extremely heavy activities/sports, heavy physical work or training twice a day such as marathons, races, etc.).

Program development (e.g., fat reduction)

The formula is as follows: Your current weight is: __ kg; Your target weight is: __ kg; The weight you want to lose: Current weight - Target weight = __ kg; Total calories that must be reduced during weight loss: (current weight - target weight) *7700 = __kcal Daily calories that must be reduced: (current weight - target weight) *7700 ÷ weight loss period (days) = __kcal Daily calories that must be absorbed during weight loss: TDEE- [(current weight - target weight) *7700÷ weight loss period (days)] = __kcal⁸.

Formulated recipes

According to the Dietary pagoda of Chinese Residents (2016) combined with the food exchange method (taking the diet arrangement of healthy elderly people as an example)

Table 1 Daily diet for adult women (diet provides energy of 2000kcall, suitable for light physical activity level over 18 years old)

Name	Recipe
------	--------

Breakfast	One bowl of purple rice porridge(35g), egg (50g), milk(300g), stir-fried cabbage with garlic (100g), cashew nuts (10g)
Lunch	Steamed rice (30g), steamed chicken (50g chicken, 50g pumpkin, 20g sweet potato), shredded potato (100g) mapo Tofu(100g), tomato and shrimp soup (50g tomato, 5g shrimp), banana (100g)
Supper	Rice (90g rice, 30g sweet potato), braised crucian carp (50g crucian carp), stir-fried asparagus (100g bamboo shoot), stir-fried spinach (100g spinach) laver soup (5g laver), apple (100g)
Breakfast	Drink plenty of water, 1500-1700ml a day, For added sugar, less than 25g is best . If drinking alcohol, do not exceed 15g. Eat and exercise balance, at least 6000steps per day or 30 minutes of moderate intensity exercise, exercise consumption at least 270kcal.

3. Integrated system design

3.1. Overall functional framework

The system consists of embedded equipment, mobile phone client and background server, which integrates TWO-DIMENSIONAL code scanning, network communication technology and asynchronous parallel communication technology, as shown in Figure 1. In the three components, the client can realize two-way data exchange and two-dimensional code scanning one-way data transmission with the embedded system through Bluetooth, two-way data exchange between the client and the background through wireless data network, and embedded devices can send information to the background through GPRS.

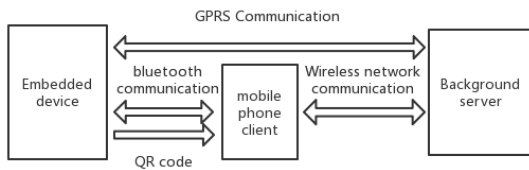


Fig.1 The overall functional framework diagram

When a user queries using machines when the ratio of health, through the mobile phone client posted some qr code scanning machine, machine number, cell phone a client and its synchronization, and then by the user on the embedded system provide the physical data acquisition device, at the same time embedded systems provide data to mobile client hint whether it is right. If the data is not provided correctly, the mobile client will continuously prompt the user until the user provides the data correctly. Then the mobile phone client sends information to the background server for the background server to calculate and process the user's information, calculate the nutrition ratio suitable for the user, and update the user's body data. Finally, the background server will send the user's body data and recommended ratio data to the mobile client for customers to check.

When the user receives the configuration supplement drink, click the "Query" button on the mobile client, the mobile client sends information to the background server, and the background server determines and sends the client identity, body data and proportion information to the client according to the received information. User to confirm the information you have supplied before clicking the "confirm" button, the client ratio for sending information to the embedded devices, embedded devices by accepting information ratio of drinks, wait for after the ratio, the user can be gotten in retrieving the drinks, at the same time, the mobile client will send information to the backend server to update the user insist on drinking nutrition matching the number of drinks and other information.

3.2. Embedded device design scheme

Bluetooth technology is a wireless technology standard with radio frequency characteristics. It applies frequency hopping technology and wireless technology, etc., with advantages of high transmission efficiency and high security, it has been applied by all walks of life ⁹.

Photoelectric sensor is generally composed of two parts: processing path and processing element. Its basic principle is based on the photoelectric effect, the change of the measured into the change of the optical signal, and then with the help of photoelectric elements to further convert non-electrical signals into electrical signals. The Beidou Navigation Satellite System is a global navigation satellite system independently developed and operated by China. Beidou navigation system is an active bidirectional ranging two - dimensional navigation system. The ground central control system is calculated to provide users with 3D positioning data. Beidou is the world's first satellite navigation system to provide three-frequency signal service. Three-frequency signals can better eliminate the influence of high-order ionospheric delay and improve positioning reliability. In addition, Beidou also has its own unique short message communication function¹⁰.

GPRS is the abbreviation of general packet wireless service technology, it is a mobile data service available to GSM mobile phone users, GPRS and the previous continuous channel transmission way is different, it is packet type to transmit, using packet switching technology, compatible with GSM network and more effective transmission of high-speed data and signaling on the network. Users are allowed to send and receive data in end-to-end packet transfer mode without the need for network resources in circuit switch mode¹¹.

Drive module adopts L298N, L298N is a motor driver that accepts high voltage, dc motor and stepper motor can drive.

Stepper motor controller can send uniform pulse signal of electronic products, it sends the signal into the stepper motor driver, will be converted by the driver into the stepper motor required by the strong current signal, driving the stepper motor operation. The stepper motor controller can accurately control each Angle of the stepper motor.

OpenMV is an open source, low cost, powerful machine vision module. Machine vision algorithms on OpenMV include color block search, face detection, eye tracking, edge detection, marker tracking, etc.

Relay, also known as relay, is an electronic component that controls the circuit. It is composed of two subsystems, the control system and the controlled system. It automatically controls the circuit on and off by induction of the size of the access current. Since relays can control

large current through small current, they have been well applied in electrical engineering and automation of low-voltage appliances¹².

LCD touch screen, also known as touch panel, is an inductive LCD display device that can receive the input signal of touch head.

Solar cell, is a kind of photoelectric semiconductor chip that uses sunlight to generate electricity directly, also known as "solar chip" or "photocell", it can output voltage and produce current in a loop as long as it is satisfied with a certain illuminance condition. Solar cells reduce energy consumption.

The embedded end uses stm32F103 series MCU produced by STMICROELECTRONICS as the microcontroller. In addition, Outside the microcontroller, bluetooth communication module, photoelectric detection module, Beidou positioning module, OpenMV module, GPRS module, drive module, stepper motor, LCD touch screen and relay used to control the switch of storage unit are also integrated. The power supply uses solar cells, as shown in Figure 2. Among them, Bluetooth is used to communicate with the mobile phone client, photoelectric detection is used to detect the status of cups, GPRS module and Beidou module are combined for machine positioning, OpenMV is used to identify the TWO-DIMENSIONAL code of the mobile phone client, the drive module is used to drive the stepper motor, and the LCD touch screen is used for better human-machine interaction.

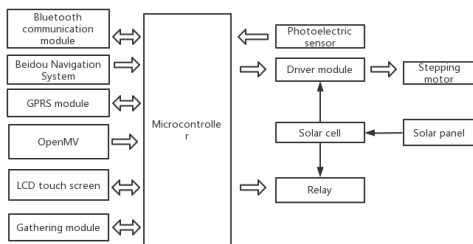


Fig.2 The overall design scheme of embedded equipment

3.3. Mobile phone client design scheme

Mobile phone client uses wechat small program, integrated with scanning code, Bluetooth communication, network communication and so on. Among them, Bluetooth is used to communicate with embedded devices, and network communication is used to

communicate with the backend server. Users can check their identity information, body data, nutritional ratio recommended by the background server and the number of days they adhere to through the mobile phone client. At the same time, they can also scan the code to confirm their identity information, upload body data and receive drinks.

3.4. Background server design scheme

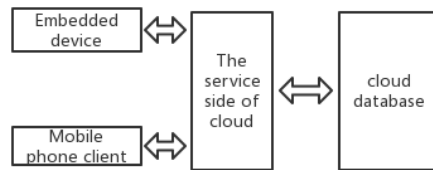


Fig.3 The overall framework of background server

The data processing part of the background server takes Ali Cloud server as the carrier, and the data storage part takes Ali Cloud database as the carrier, as shown in Figure 3. After the user finishes providing body data and receiving drinks, the mobile phone client sends information to the background server through the network, and the background server analyzes the received information and updates the database. At the same time, the background server can also provide the mobile client with the current user identity data, recommended ratio and the number of days to adhere to the ratio plan.

4. System software design

4.1. Embedded device software design

The software design of the embedded device (see Figure 4) includes three parts: communication between the embedded device and the mobile phone client, body data collection and detection by the embedded device, and configuration of the embedded device with drinks.

The working process can be divided into two steps: data detection and beverage configuration.

4.1.1. data detection

When the machine performs data detection, the mobile phone client sends instructions to the embedded device

through Bluetooth in the format of frame header + command. Wherein, the frame header is 0xFF 0xFF two consecutive data, which is used to prompt the embedded processor to enter the data detection mode. The command is an 8-bit data, which represents the specific steps of data detection. There are two steps of data detection, namely, measuring body weight and measuring human resistivity. For example, 0xFF 0xFF 0x01 indicates to remind the embedded device to carry out weight measurement. When the embedded processor receives the instruction, it sends 0x21 to the mobile phone client and 0x22 when it is finished. When the mobile client receives 0x22, it sends 0xFF 0x02, and the embedded device enters the human body resistivity measurement. Similarly, the embedded device sends 0x03 when receiving, and sends 0x04 when completing, and updates various body data of the user to the background server. After receiving 0x04, the mobile client stops sending instructions to the embedded system.

4.1.2. Configuration drinks

When the mobile client receives the nutrition ratio data from the background server and the user agrees to transmit it to the embedded device, the mobile client sends instructions to the embedded device in the form of frame header + command. The frame header is 0x05 0x05, which is used to prompt the embedded processor to enter the beverage configuration mode. The command is 4 8-bit data, which is used to represent the amount of dropping of 4 nutritional supplements, such as 0x05 0x05 0x22 0x5F 0xFF 0x26. When the embedded device receives the data, it sends 0x01 to the mobile phone client, which is used to prompt the mobile phone client to receive the current status of the embedded device. When the configuration is complete, send 0x02 to remind the user that the beverage configuration is complete through the mobile client. At this time to detect whether the drink is removed, if not removed every 5s to the mobile phone customer user sends 0x03 once, sends 0x04 when it detects that the drink is taken away, and sends the number of times that the background server and the new user insist on drinking the drink with nutritional ratio, and then restores the initial setting.

4.2. Mobile phone client design

WeChat small program referred to as "small program, is a kind of don't need to download and install the use of application, it implements the application" within reach "of the dream, the user through a sweep or search can open the application, it embodies the concept of" used up ", users no longer care about too much installation application will lead to problems such as mobile phone

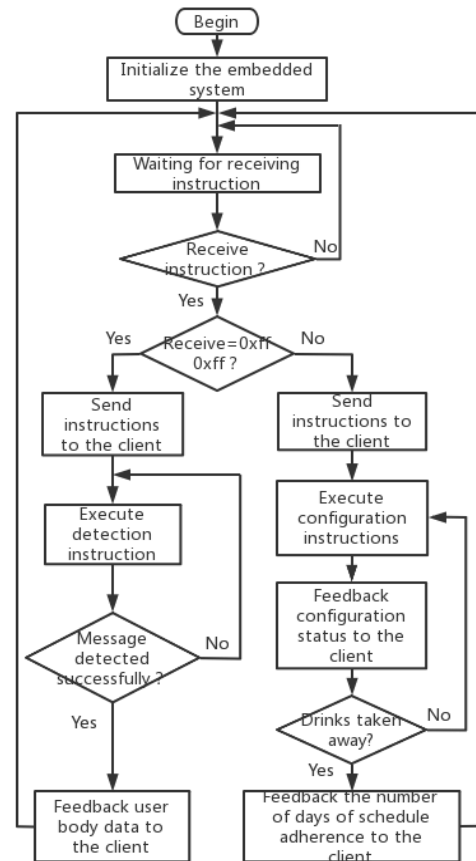


Fig.4 The software block diagram of embedded system

memory, can use at any time, do not need to install the program. For the developers of wechat, the development difficulty of wechat applets is far less than that of APPS. Ordinary users can develop simple and practical applets through simple learning¹³.

The mobile phone client mainly provides users with operations such as body data collection, nutrition data query, and self-fetching of drinks. The working process can be divided into two modules of nutrition data query and self-fetching of drinks, as shown in Figure 5.

Before using drinks, users must scan the two-dimensional code on the box of the machine to confirm the current machine number. The two-dimensional code contains the 48-bit MAC address of the Bluetooth module of the machine, which is globally unique and can be used as the number of different machines.

4.2.1. Nutrition Data Query

First click on the "nutrition data query" button, enter the authentication interface, the interface has two

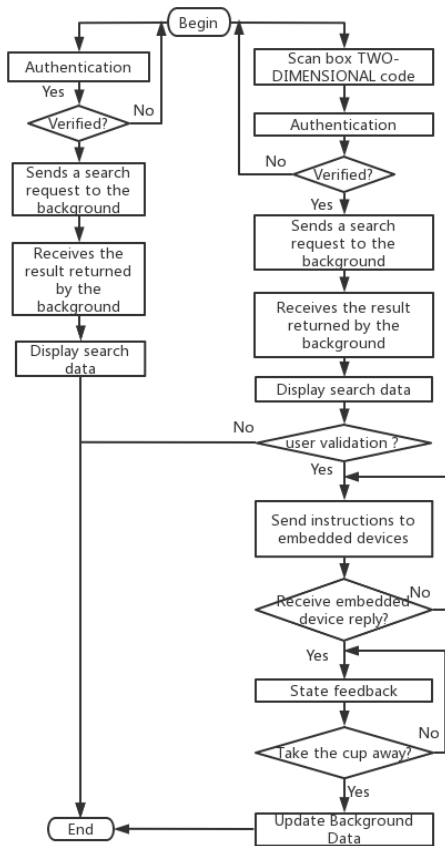


Fig.5 Client program flow chart

input boxes, require the user to enter the name and id number, click on the "validate" button, mobile phone client sends the information to the backend server, if the verification through the access backend server again, for users' personal data body, nutrition matching results and adhere to the matching results the number of drinking, And jump to the next interface, the interface will display the requested information; If the

authentication fails, the system returns to the page and prompts the user that the user name or ID number is incorrect.

4.2.2. Drinks come undone

Click drinks come undone, just like the above identification process, only when the authentication is successful to back-end server for the number of users insist on drinking drinks and remnant data such as number, and into the drink must display interface, at the bottom of the interface through the "+" and "-" select number of thyself, confirmed, click on the "confirm" button, The mobile client sends configuration instructions to the embedded device. When the configuration is complete, the user is reminded that the configuration is complete and the back-end server data is updated.

4.3. Background server design

In the process of Internet application, network server is a very key tool to provide services through computer network system. In the application process, the network server can effectively classify, sort out and save the network information, and also process it according to the needs of users¹⁴.

The background server includes two parts, server and database, which are respectively used to realize data interaction with the client and record the user's body data, recommended ratio data and drinking days. Its program flow chart is shown in Figure 6, which can be divided into two parts: data query and maintenance days query.

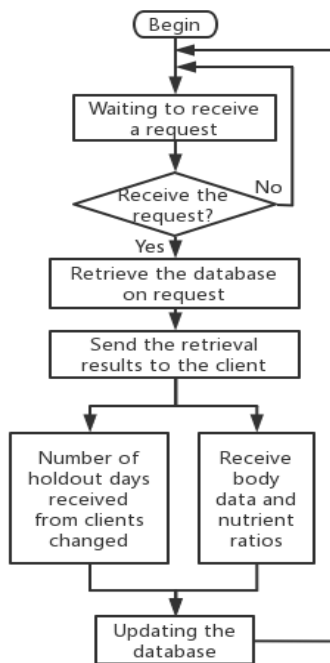


Fig.6 Background server process flow chart

4.3.1.query and pivot

When data query, the background first receives the identity information sent from the mobile terminal to start the request, and the server retrieves the corresponding user's body data and provides the relative nutritional ratio in the database according to the identity information, and sends it to the mobile terminal. When the user re-provides the physical data, the background will update the database data in real time according to the information sent by the mobile terminal.

4.3.2.Maintenance days Query

Maintenance days are proposed as a way to promote enhanced efficacy, and the specific query process is the same as data query.

5. Conclusion

Intelligent personalized nutrition supplement machine based on big data analysis, through the Internet of things technology, software production, intelligent machine operation and other practical operations, to achieve timely and reasonable nutrition supplement, to provide exclusive health drinks for sub-health people, changed the traditional mode of production and sales, to ensure

the quality and function of reasonable nutrition. The machine has a wide range of applications, which can be placed in schools, communities, gyms and other areas. With the continuous promotion of the machine, more and more people can experience the convenience of real-time nutrition supplement. The machine will be "invisible to everywhere", making a contribution to the comprehensive nutrition and health promotion.

Acknowledgements


This research was supported by Student's Platform for Innovation and Entrepreneur Training Program, the Ministry of education of China (202110057034).

References

1. Sui Yue-jiao, Ji Tian-yi, BIAN Di, WANG Ying. Exploration and application of the curriculum construction of Diet and Health conservation in Traditional Chinese Medicine under the background of "Great Health" Era [J]. Modern Vocational Education,2021(50)
2. Shi Yufei. Thinking on the development and application of health care big data [J]. Wireless Internet Technology, 201,18(19):94-95.
3. Wang Y, Wang Y, Wang Y, et al. The development of the Internet of Things [J].
4. Jiang Liming, Tian Xuetao, Ren Ping, Luo Fang. Artificial intelligence aided by the mental health of new assessment [J/OL]. Psychological science progress: 1-11 [2021-12-13].
5. Heben. Eating kiwifruit benefits more [J]. China Fruit Industry Information, 2021(03):51
6. Nutritional value of Cherry tomatoes [J]. Northern Horticulture, 2019(16):176
7. Han Songlin, ZHAO Dongsheng. Nutritional value of Mulberry and fermentation wine production technology [J]. Food Safety Guide.2021(03):135-136 DOI:10.16043/j.cnki.cfs.2021.03.076.
8. Kou Wenxin. Research on Intelligent Nutrition Catering System and Its Core Algorithm [D]. Beijing University of Technology.2015(03)
9. QIN Qinglei.- Design of an ultra-low power consumption infrared obstacle detection module [J]. Electronic Manufacturing, 2017. (7): 15-16.]
10. Shen L X, PANG J Y, ZHANG Q Y, et al. Design and implementation of location service Platform based on Beidou Navigation [J]. Computer Technology and Development, 2019(1):1-4.
11. Chen K X, XIE H T, GPRS principle and application [J]. Railway Communication Signal, 2003, 39 (7): 7-8. (in Chinese)

12. BI Jialin. Application research of Relay in Electrical Engineering and Its Automatic low-voltage Apparatus [J]. Heilongjiang Science, 2016, 7 (20): 12-13.
13. Tan Yongping, Basic Characteristics and Implementation Strategies of Blended Teaching Mode []. China Vocational and Technical Education, 2018 (32): 5-9.
14. Zhao Chunxia. Research on Security Management and Maintenance Strategy of Network Server [J] computer Programming Skills and Maintenance, 2019 (4): 149-150,172.
15. “ RoboCup Federation official website, ” , <https://www.robocup.org/>
16. Y. Yasohara, H. Suzuki, “ Development of Omni-directional Mobile Mechanism for RoboCup MSL ” , Proceedings of 31st Fuzzy System Symposium, pp. 151-152, 2015. (In Japanese)
17. FLIR, “Flea3(USB3 Vision Camera)”, <https://www.flir.com/products/flea3-usb3/>
18. T. Yoshida, H. Suzuki, “Real-Time Self-Localization for RoboCup Middle-Size-League”, Proceedings 32nd Fuzzy System Symposium, pp. 397-398, 2016. (In Japanese)
19. D.E.Goldberg, “ Genetic Algorithms in Search, Optimization and Machine Learning ”, Addison-Wesley, 1989.
20. H. Suzuki, M. Minami, “Visual Servoing to Catch Fish Using Global/Local GA Search ” , IEEE/ASME Transactions on Mechatronics, Vol. 10, No. 3, pp. 352-357, June, 2005.

Ms. Rui Li




She is an undergraduate of Tianjin University of science and technology, she research field is nutrition supplement program and nutrition

Ms. Junhui Yin



She is an Professor in Tianjin University of Science &Technology. Tianjin first batch of management accounting consulting experts. Her research field is financial management and management accounting theory and practice research.


Dr. Yizhun Peng



He is an Associate Professor in Tianjin University of Science &Technology. He received a doctor’s degree in control theory and control engineering from the Institute of Automation,Chinese Academy of Science,in 2006.His research field is intelligent robot and intelligent control


Authors Introduction

Mr. Xinpeng Yang



He is an undergraduate of Tianjin University of science and technology, his research field is embedded system.

Ms. Sidan Liu



Sidan Liu, She is an undergraduate of Tianjin University of science and technology, she research field software design.