Mathematical Biosciences and Engineering

MBE, 20(3): 4798–4815.
DOI: 10.3934/mbe.2023222
Received: 05 November 2022
Revised: 04 December 2022
Accepted: 08 December 2022
Published: 03 January 2023

http://www.aimspress.com/journal/MBE

Research article

Design of intelligent robots for tourism management service based on green computing

Tingting Yang[1,*] and Yi He[2]

[1] Department of Tourism Management, Chongqing City Vocational College, Chongqing 402160, China
[2] Chongqing City Vocational College, Chongqing 402160, China

* **Correspondence:** E-mail: 2016122146@jou.edu.cn.

Abstract: The modular intelligent robot platform has important application prospects in the field of tourism management services. Based on the intelligent robot in the scenic area, this paper constructs a partial differential analysis system for tourism management services, and adopts the modular design method to complete the hardware design of the intelligent robot system. Through system analysis, the whole system is divided into 5 major modules, including core control module, power supply module, motor control module, sensor measurement module, wireless sensor network module, to solve the problem of quantification of tourism management services. In the simulation process, the hardware development of wireless sensor network node is carried out based on MSP430F169 microcontroller and CC2420 radio frequency wireless communication chip, and the corresponding physical layer and MAC (Media Access Control) layer data definition and data definition of IEEE802.15.4 protocol are completed for software implementation, and data transmission and networking verification. The experimental results show that the encoder resolution is 1024P/R, the power supply voltage is DC5V5%, and the maximum response frequency is 100 kHz. The algorithm designed by MATLAB software can avoid the existing shortcomings and meet the real-time requirements of the system, which significantly improves the sensitivity and robustness of the intelligent robot.

Keywords: scenic spot management; intelligent robot; tourism service; partial differential analysis; green computing

1. Introduction

With the development of the mobile Internet, the rapid rise and intelligence of mobile devices [1], people's daily life, entertainment activities, travel and social interaction are inseparable from the participation of the mobile terminal [2], people's access to information and services are transferred from the PC to the mobile phone side, software from all walks of life is also emerging one after another [3]. With the rapid development of the economy and the improvement of people's living standards [4–6], tourism has become a popular entertainment item for people, and more and more trips are made when they want to go [7].

Intelligent robots are an important branch in the field of robotics, spanning multiple disciplines such as computer, automatic control, machinery, and electronics [8–10]. As a frontier field of information technology development [11], intelligent robot is a highly comprehensive, prospective, innovative and practical discipline, and contains extremely rich tourism resources [12]. The multi-threading technology widely used in the agent system is the best way to realize the parallel processing of the system [13], but the implementation of multi-threading may require system resources, especially adding network compression transmission threads when performing partial differential processing, the memory and processor requirements may impose certain requirements on the implementation of embedded systems [14]. In this paper, the instantaneous balance compensation of multi-person cooperation is introduced to ensure the overall rationality, individual rationality and time consistency of the alliance payment, to ensure the continuous effectiveness of the income distribution scheme under the optimal criteria, so that the regional tourism service supply chain alliance can be maintained until the success of cooperative tourism business activities.

Based on the intelligent robot in the scenic area, this paper constructs a partial differential analysis system for tourism management services. By mining user needs and synthesizing the software on the market, a platform-based travel intelligent management robot is designed and developed. Users can not only initiate invitations to travel together anytime, anywhere, the tedious process of searching for travel information on the computer is omitted. Considering the modularity and expansibility of intelligent robots, this paper proposes an interface expansion scheme based on the combination of FPGA (Field Programmable Gate Array) logic expansion and bus. On the one hand, the use of FPGA to expand the logic interface improves the scalability of the enhanced system and enables preliminary data processing; on the other hand, the use of bus as the expansion bus improves the efficiency and speed of bus communication for rapid expansion. After a lot of market research and comparison of the travel social software on the market, the demand analysis of the system is finally determined, and the travel client is divided into modules such as user management, travel information release, friendship and travel management robots, which better meet the needs of users. The coding work of the project has been completed, and the functions and performance requirements of the project have been realized after being tested by professionals.

2. Related works

In recent years, with the development of domestic big data and artificial intelligence, more and more robot technology has been applied in the field of life services. Many domestic robot manufacturers have developed and developed service robots, many of which are equipped with function, we also classify these robots as a kind of guide robot [15].

Reis [16] expressed information in the form of probability distribution. When fusing multi-sensor information, it expressed the environmental information collected by each sensor in the form of probability, and regarded independent decisions as the division of a sample space, and then used Bayes probability algorithms process them, ensuring that the measured quantities represent the same entity by checking the sensor measurements for consistency. Kervenoael [17] classified according to the similarity of the accepted samples, mainly in the weight distribution of the network. The variety of materials purchased is rich and the quality can be guaranteed. By sorting out the supply chain theory and competition theory, the connotation and formation mechanism of the core competitiveness of the service supply chain are clearly defined. However, only simple fuzzy processing of the information will reduce the system control accuracy. Fan [18] designed the obstacle avoidance function of the mobile chassis through the fuzzy control simulation and analysis method. According to the derivation process of the method, the input and output fuzzy sets were established, the fuzzy inference rules were established, and the membership function was selected. The essence of the supply chain is the integration of services, the key is the degree of synergy, the purpose is to provide tourists with services to meet their own needs, so as to generate superior happiness. The model of tourism service supply chain is constructed and the operation mechanism of tourism service supply chain is explored. In view of the tourism service supply chain and its characteristics, the author analyzes the evolution process of the cooperative relationship between the member enterprises of the tourism service supply chain, and discusses the governance framework of the cooperative relationship on this basis. Finally, Chuah [19] conducted a simulation test through the Fuzzy program package of Matlab software, obtained the membership function diagram of each output variable, and created rules to obtain the control output method.

If the accuracy is improved by increasing the number of quantization stages, the search range will be expanded and the processing speed will be reduced. For future upgrades and subsequent development, the upper body and legs of the robot are divided into two distinct wholes [20]. The advantages of such an organization method are obvious: each hierarchical processor is only responsible for the motion state of one axis, and the data processing is small [21]. It does not require the use of high-processing chips, and the speed and precision indicators of the comparison quotient can be obtained [22]. In terms of application, the implementation of embedded system programming requires a certain understanding of the embedded system and the transplanted operating system, and the available function libraries are relatively limited; some components of Matlab can be packaged and applied, which is more convenient to implement [23].

3. Construction of a partial differential analysis model for tourism management services based on intelligent robots in scenic spots

3.1. Partial differential equation solution

The first step in establishing the partial differential equation of the robot manipulator is to analyze the partial differential of the manipulator, which will require solving the positive and inverse solutions of the manipulator partial differential, and then calculate the Jacobian matrix of the manipulator joints through the obtained positive and inverse solutions [24]. Among them, the kinematics forward and inverse solutions study the relationship between the joint variable space and the position and posture of the end of the manipulator, and the Jacobian matrix F(a, b, c) is established by the movement of the

end effector r(a, b) of the manipulator along a specific trajectory u(n), which can determine whether the motion trajectory of the manipulator is reasonable, whether the flexibility and performance meet the standard, and finally establish the partial differential model of the manipulator [25,26].

$$F(a,b,c) = (a-b-c)(\sim a)(\sim b)(\sim c) - (a \,\&\, b)(b \,\&\, c) \tag{1}$$

$$u(a,b,n) = \begin{cases} a*b-1, a > b \\ a*b-n-1, a = b \\ a*b-n, a < b \end{cases} \tag{2}$$

After finding the optimal features for classification, the dataset is divided into several data subsets according to these features, and these data are distributed across all branches of that decision point. According to the functions to be realized by the system, we subdivide each function into each task, and the main program is to carry out reasonable division and scheduling among the tasks. If the data under one of the branches does not belong to the same type, it is necessary to continue to divide the data set x(i), repeat the above process deci(x) of dividing the original data set to determine the optimal features of the data set deci(y), and continue to classify the data set until all feature points and data in all sub-data sets are found to belong to the same category p(x)v(x).

$$A = \{x(1) / deci(x), y(i) / deci(y)\} \tag{3}$$

$$p(x)v(x) = 1 - nr(x)t(x) \tag{4}$$

In a broad sense, according to the industry field, influence degree and way involved in tourism development, tourism development stakeholders are divided into three levels: core layer, support layer and edge layer. Secondly, it classifies the core stakeholders of the regional tourism service supply chain and expounds the demands of each core stakeholders. Then, the main interest conflicts between them are introduced and the data are used to analyze the reasons. Finally, the reasons are classified as the supply and demand contradiction mainly caused by tourism information and profit distribution [27,28]. Since the wireless communication mode nr(x) of the system design is two-way communication t(x), the coordinator node needs to communicate with multiple terminal nodes at the same time, and must process the data information sent by the terminal nodes in time. When the amount of information transmitted by the system is large, communication congestion c(i)c(i-1) will occur. In the process of program design y(x, t), according to the specific situation x(a)x(b), the time interval of data transmission is adjusted, and the start timer function is used to set the time x(t).

$$\sum_{n}^{i=1,2,\ldots,n} c(i)c(i-1) - (i-1)^{i-1} = 1 - c(i) \tag{5}$$

$$y(x(a,b),t) = sim[x(a)x(b), x(t), t] \tag{6}$$

With the support of modern information and communication technology, the tourism service

supply chain is developing in the direction of depth and depth. Since the above function parameters involve the event of the calling task, and in the process of data information transmission between the coordinator node and multiple terminal nodes, it needs to be realized through the serial port, so the serial port application can be added to the protocol stack as a new event, that is, the user defines the serial port event g(x) by himself. When the time set by the timer i(a, b) expires, the serial port event is triggered, and the communication function involved in the event s(x, t) is executed.

$$g(x) = \lambda(x-1)^2 + \lambda(x-2)^2 + \lambda(x-3)^2 \tag{7}$$

$$\frac{i(a,b) - i'(a,b)}{a-b} \int s(x,t)s'(t,t-1)dsdt = 1-x \tag{8}$$

The most important thing in the lower computer system is the acquisition process of the signal. Combined with the interference of this system mainly comes from random interference signals or occasional pulse interference, the median average filtering algorithm is selected to effectively process the collected tactile signals.

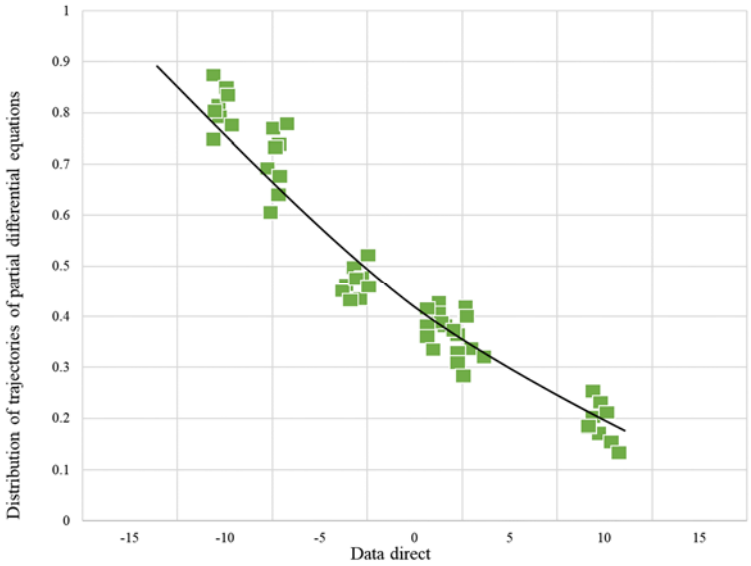

Figure 1. Partial differential equation trajectory distribution.

According to the program analysis in Figure 1, before using the serial port communication, the parameters of the serial port must be configured accordingly to meet the requirements of different communication speeds of the serial port. The uncertain factors in the tourism service supply chain are increasing, and the convergence and segmentation of interests between the tourism industry and related industries have become an important issue in the research. In the intelligent small robot management and control system, the serial port parameters of the system are set to the baud rate of 38,400, no parity bit, 8 data bits and 1 stop bit. When debugging the system, in order to ensure the normal communication of the serial port between the coordinator node and the host computer travel management system, the serial port debugging assistant can be used for inspection. When the data transmission is normal, other functions of the travel management system can be designed and debugged.

3.2. Intelligent robot module

In the travel service supply chain, the agent must have a full grasp of its own situation, but the entrusting party may not be very clear about the actual situation of the agent. In this case, adverse selection should be mainly considered. When receiving the information released by the agent, the entrusting party can speculate on the relevant products of the agent according to the information, and put forward the intention of cooperation when it thinks the enterprise is suitable for its own development. According to the functions of the three parts, the model is mainly responsible for encapsulating, storing and processing data, and performing operations on the data f(x-1); the function of the view is to display data and monitor user operations k(x, x-1); the controller s(x) is responsible for processing business logic and responding to event execution, data processing, etc.

$$f(x-1)=1-k(x,x-1)-l(x)-s(x-1) \tag{9}$$

$$\frac{k(x)-k(x-1)}{1-k(x-1)}=l(x,x-1)-l(x) \tag{10}$$

The Controller is an intermediate class l(x, x-1) to coordinate the Model and the View. When the View changes, this class should tell the Model, and the data processed by the Model should also be fed back to the View by this class, so as to realize the changes on the View. Same as the calculation method of the non-cooperative management model, the present value of tourism alliance profits under the optimal state trajectory, namely the value function, and the optimal reception trajectory of the two regions under the optimal state can be obtained by combining the equation. If the program requires multiple serial ports, an equal number of MSComm controls must be added. When a certain byte of characters is stored in the serial port receiving buffer, the corresponding communication event will be triggered, and the MSComm control can use the OnComm event attribute c(x)-s(x) to detect and respond to the corresponding communication events involved in the application v(x)-s(x).

$$\frac{c(x)-s(x)}{v(x)[v(x)-s(x)-1]}=1-s(x) \tag{11}$$

$$1=\frac{(a-b-c)(\sim x)}{x(x-a)}-\frac{(\sim b)(\sim c)}{x-b}-c \tag{12}$$

In most MVC architectures, changes to the data layer x(x-a) will directly notify the view layer to perform corresponding operations, so that the view layer can interact directly with the data layer x-v(x). However, in development, direct interaction between models and views is prohibited, and the controller layer must be used as an intermediate layer to handle changes in models and data 1-n.

$$\frac{\pi(x)(x-\Delta x)}{\pi(x-1)v(x)}=1-r(x) \tag{13}$$

$$\frac{1-n}{\pi(x)v(x)^2}(1-2x-\Delta x)=1-\frac{1-\Delta r(x)^2}{\pi(x-1)\Delta r(x)^2} \tag{14}$$

The specific operation process 1-r(x) of the host computer software is: first initialize the window, adjust the initial position of the actuator, set the connection serial port between the PC and Arduino, and initialize the flag bits of each process to the next step. At the same time, you can press the production curve button, and the corresponding tactile curve graph block shows the change of the tactile representative quantity in the form of real-time curve; stop collecting and saving the data, and the collected data will be saved in the hard disk where the software is located in format, which is convenient for subsequent processing of tactile data; finally, close the serial port and exit.

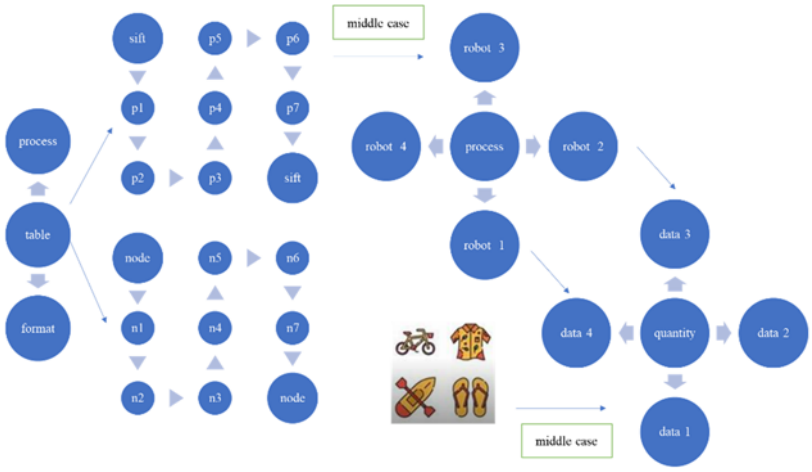

Figure 2. Distribution of intelligent robot modules.

Almost all the members in the structure of Figure 2 are function pointers, so it is essentially a function jump table. The operation of each ingress process to the device will be converted into access to file-operations according to the major and minor device numbers, and then into the access to the corresponding function in the structure. It can read the function pointer corresponding to this data structure, and then pass control to the function.

3.3. Tourism management mechanism

The specific functions of the tourism management main queue and main thread can be obtained by calling the dispatch get_main-queue function. Because the main queue is associated with the main thread, it is also a serial queue by default. Since SPCE061A does not have bit operation instructions, and it is necessary to operate a certain bit frequently when the program controls the motor, in order to facilitate the writing of the program and enhance the readability, a bit operation module is written. In order not to affect the state of other bits during bit operation, the method of "read-modify-write" can be used, that is, first read the value of a certain bit, and then write it back to the current byte after logical AND and logical OR operations. That is, the state of the I/O port is changed. Global queues are all concurrent queues shared by the entire process. According to the functions to be realized by the

system, we subdivide each function into each task, and the main program is to carry out reasonable division and scheduling among the tasks. The queues described in Figure 3 are all serial, so they can be used to complete the synchronization mechanism.

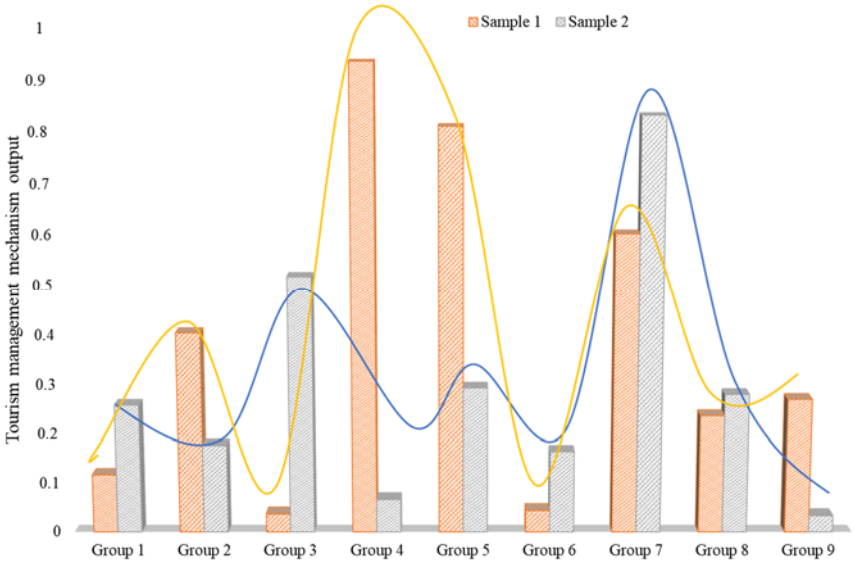

Figure 3. Tourism management mechanism output.

The method of measuring the working frequency of the sensor: use TimeB as the timer and TimeA as the counter; within the time period of TimeB, the counter TimeA uses the external interrupt source (falling edge trigger) as the clock source, starts counting from 0x0000, and uses the timed interrupt, and the time is up. After executing the interrupt program, stop the timer timing and counter counting. According to the algorithm of the above model, the calculation of the present value of profits in both non-alliance and alliance involves the calculation of many differential equations, and it is difficult to give the analytical solution of the present value of profits. In order to reduce the error and ensure the correctness of the measurement, measure four times, remove the highest value and the lowest value, if the difference between the two middle numbers is not greater than 10, the average of the middle two numbers is the final measured data, in the program this data is the count value of TimerA. Before each measurement, turn off the fast interrupt FIQ (Fast Interrupt Request), because the timer/counter TimerA is used in the measurement process, and the FIQ interrupt is turned on when managing playback.

3.4. Scenic service design

Setting the scenic service proxy object between the tourism client and the target object can play an intermediary role for it, which also solves the problem that one object cannot directly refer to another object. The proxy model consists of protocols, proxies, and delegations. The agreement is used to specify the tasks to be achieved by the two sides of the agent. The agent should be based on the agreement, accept the agreement specified by the entrusting party, and complete the tasks delivered by the agent. In the process of wireless data transmission, in order to ensure that the intelligent robot and the tourism management system platform can easily identify the received data information, the system has carried out corresponding coding design for different transmission contents, so that it can be used

in the intelligent robot and tourism management system. The management system platform can be transmitted accurately and without error, and the control command is composed of the recipient's address and the information content.

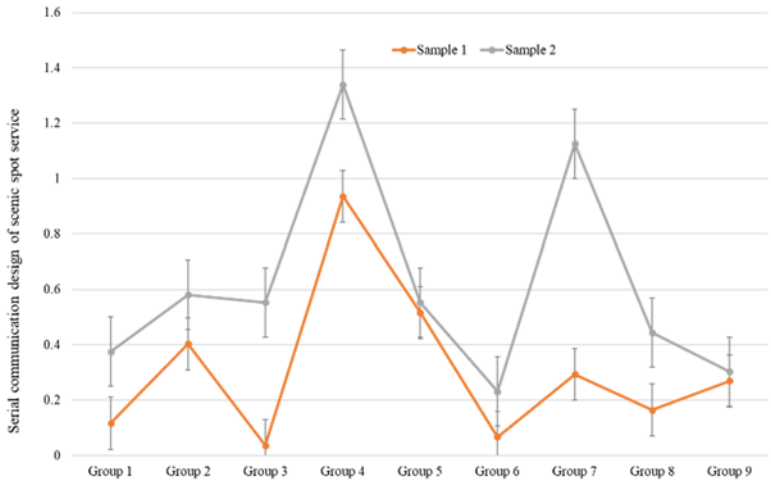

Figure 4. Scenic spot service serial communication design.

Figure 4 uses serial port for communication, and provides a set of standards for programmers, which can make it more convenient for operators to write serial port programs. According to the benefit distribution formula of dynamic Shapley value, the benefit distribution value of the participant's tourism management system under the alliance state can be calculated. The MSComm (serial communication) control can communicate with the serial port of the host computer, and can connect with other peripheral devices through the serial port. It has the function of issuing control commands, transmitting data with the port, and detecting and checking the errors generated in the serial communication. Therefore, MSComm control is used to design the monitoring interface of the upper computer of the system, and Visual Basic software is used to control the communication port of the upper computer. The way modules are loaded is very different from previous application development. The module is loaded when the insmod command is called, and the entry point at this time is the init_module function, where the device registration is usually done.

4. Application and analysis of partial differential analysis model of tourism management service based on intelligent robot in scenic area

4.1. Intelligent robot data processing

The system platform can divide the robot system into main control module, motor control module, battery power supply module, sensor detection module and wireless communication module according to the goals to be achieved. With the passage of time, the instantaneous reception of both shows a decreasing trend, which is consistent with the behavior characteristic that most people choose to travel in the morning. In the research process of intelligent small robot management and control system, ZigBee wireless communication module is installed on each intelligent small robot, and the host computer travel management system uses ZigBee wireless communication network to transmit data

with several intelligent small robots in the system. The host computer travel management system is connected to the coordinator node of the ZigBee wireless module through UART (Universal Asynchronous Receiver/Transmitter), and the coordinator node is connected to the terminal node. Wireless communication is carried out, and the transmitted data includes the start command issued by the host computer travel management system to the intelligent small robot and the information such as its own robot vehicle ID number and motion speed uploaded by the intelligent small robot, so that the intelligent small robot can be monitored in real time.

Table 1. Intelligent robot data monitoring.

Intelligent unit	Reset 1	Reset 2	Reset 3
Sensor and response	0.022	0.241	0.657
	0.594	0.267	0.317
Pulse and signal	0.375	0.602	0.220
	0.382	0.009	0.735
Prediction and result	0.128	0.557	0.329
	0.013	0.097	0.963

The operation of DS18B20 in Table 1 is that the single-chip microcomputer sends it a reset pulse through the bus. If the timing is correct, DS18B20 will send back a response pulse to indicate that the communication between them is normal and can work. After the temperature measurement program successfully initializes the device, the microcontroller will issue a temperature conversion command (the reading and writing of the temperature sensor and the temperature conversion use its own function commands). After the temperature conversion is completed, DS18B20 will collect the data. The 16-bit temperature value is stored in the lowest two bytes of its ROM (Read Only Memory) in signed 18-bit complement. After the conversion, the DS18B20 must be initialized, and then write the command word to the DS18B20 to read the ROM to obtain the actual temperature value.

4.2. Tourism management information release

Travel management information classes defined in Interface Builder can directly generate source code skeletons, such as superclasses, actions and socket variables. User interface information created in Interface Builder is stored in a file with the extension. Nib files are actually packages of objects that appear in the user interface in the form of archives (package directories). Through software simulation and simulation, with the existing hardware platform, complete the system debugging work, and verify the feasibility of the scheme. The experimental results show that the system achieves the intended design purpose, and realizes the system functions such as target tracking, path planning and autonomous navigation, and provides a good basic experimental platform for the realization of complex algorithms. It has a reference circuit inside, which generates a reference signal with a period of 20 ms and a width of 1.5 ms, and compares the obtained DC bias voltage with the voltage of the potentiometer to obtain the voltage difference output. Finally, the positive and negative voltage difference is output to the motor driver chip to determine the forward and reverse rotation of the motor. When the motor speed is constant, the potentiometer is driven to rotate through the cascade reduction gear, so that the voltage difference is 0, and the motor stops rotating.

Table 2. Description of data management information.

Tourism Index	Input Voltage /V	Output Voltage /V
Control Signal	0.089	1.007
Input Signal	0.781	0.032
Wireless Data	1.442	0.878
Operating Type	1.096	0.579
Double-chip Case	0.635	0.665
Operating Set	1.380	0.026
Single-chip Case	1.391	1.270
Output Signal	0.636	1.339

The upper-layer control system in Table 2 is composed of ARM (Advanced RISC Machine) and FPGA. Through the analysis and processing of the environmental information perceived by the sensor and the operating state information of the robot, the lower-layer control is effectively implemented. The bottom layer is composed of independent single-chip functional modules, which adopts a vertical architecture that can be executed in parallel, and completes the functions of ultrasonic sensor, proximity switch, infrared sensor signal processing, motion control, positioning, obstacle avoidance, and wireless communication. SBC84710 embedded motherboard is based on VIAC7CPU with a main frequency of 10 GHZ and a bus of 533 MHZ. The average power consumption of the C7-M mobile processor is less than 1W, and the minimum standby power consumption is even only 0.1W. Even if it is running at full speed, the power consumption of the c7-M mobile processor is 20 W (20 GHz) and 12 W (1.6 GHz) respectively. The industrial-grade SBC84710 series can operate normally under industrial requirements and has strong reliability.

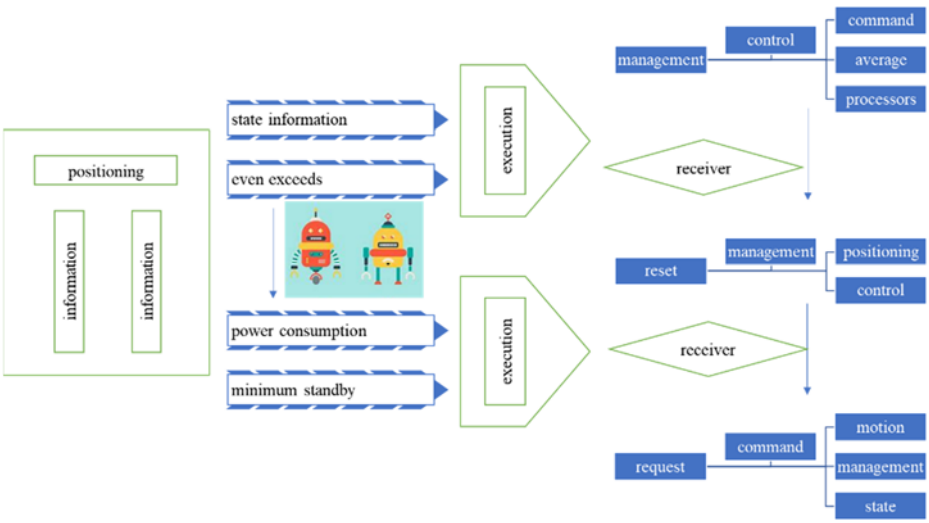

Figure 5. Tourism management information collection topology.

When the task execution function processes the task in Figure 5, a timer task is added by the following code, using the interrupt resource of Timer_A, the channel scan is completed by sending a

beacon request command, because a request may fail, so set each channel to send the beacon request command 4 times. The main processing system mainly completes the functions of system scheduling, partial differential acquisition and processing and network communication. After all channels are scanned, the upper layer chooses to join a program or start a program according to the saved program information.

4.3. Partial differential analysis simulation

To interact with the network in this project, the connection between the travel client and the server must be established first, and then the travel client needs to use a complete connection to obtain partial differential data or send data from the server. It establishes the connection between the travel client and the server, and the interactive data transfer between the two can use the get or post method. Second, when the server receives the travel client's request, it must respond to the travel client's request and process the travel client's request. The third is to return to the travel client after the processing is completed. Finally, after the interaction between the travel client and the server is completed, the connection should be disconnected, which is convenient for other travel clients to request to establish a connection with the server.

The modular design of intelligent robot hardware is completed, including the center control module, motor drive module, obstacle detection module, ambient temperature and humidity detection module, embedded voice recognition and response module. Speed adjustment is achieved through duty cycle control of PWM (Pulse-Width Modulation). By controlling the corresponding pins in Table 3, movements such as inverting the robot, forwarding, and differential turning are realized.

Table 3. Partial differential analysis algorithms.

Analysis algorithm codes	Partial differential texts
Parr.v[j] = (int)(w*parr.v[j])	The travel code $deci(x)$
(Parr[gbindex].xbest[j]-parr.x[j]));	The client needs to $a*b-n$
(Int)(c1*rand()/(double)rand_max	The server must be established
If (parr.fit >= parr.fitbest)	The connection between $1-c(i)$
C2*rand()/(double)rand_max*	The network in this project $\pi(x-1)$
(Parr.xbest[j]-parr.x[j])	To obtain partial differential data
Calculatefit();parr.fitbest = parr.fit;	To interact with $a*b-n-1$
For (int j = 0; j < dim; j++)	From the server $(\sim b)(\sim c)$
For (int i = 0; i)	Connection or send data $y(i)$
W=wmax-k*(wmax-wmin)/kmax;	Then use a complete $c(i)c(i-1)$

The initialization function is called when Linux is initialized or the driver is dynamically loaded. The initialization module is responsible for initializing the FPGA device when the kernel is started. Using the moudule-1 and moudule_exit macros to document the driver module's initialization and exit function names. The initialization work is mainly completed: 1) Initialize the data structure of the FPGA, including the get-stats/open/stop function mapping, and call f_setup0 to initialize some functions by default; 2) In the open() function, initialize the FPGA, the physical address of the exchange module is initialized and assigned; 3) The address remapping in the device driver is

completed; 4) The register_chrdev() function is called to register the initialized drive device. After registering the FPGA driver with the kernel device file system, the file structure of the device driver must also be implemented.

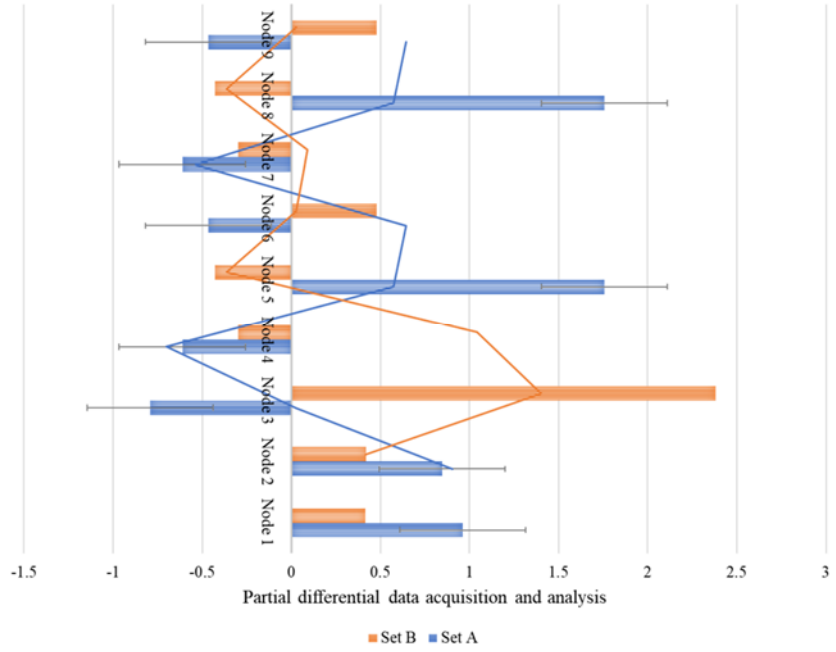

Figure 6. Partial differential data acquisition and analysis.

According to a certain arrangement, the photographed object is "decomposed" into pixel points one by one. Figure 6 collects the points on the partial differential in an interlaced scanning manner. The partial differential grayscale is converted into a voltage value corresponding to the grayscale one-to-one, and then the voltage value is output through the video signal terminal. When one line is scanned, the video signal terminal will output a level lower than the lowest video signal voltage (such as 0.3V), and keep it for a period of time. The important part of partial differential data acquisition is to obtain partial differential data through the interface provided by the USB (Universal Serial Bus) camera driver function, so to access the underlying device interface from the system, you need to call the capDriverConnect function, connect the capture window and the MSVIDEO device driver, and then use the capDriverDisconnect macro or also use a macro to connect the MSVEDEO driver. It can disconnect the video capture driver by calling the capDriverDisconnect macro after the capture process is complete.

4.4. Example application and analysis

In this project, the travel client interacts with the server through the network transmission protocol, mainly using get and post requests. Software advantage part is mainly through the IDE integrated development environment to complete, the establishment of robot.spj project file, using single step debugging and breakpoint debugging with debugging program code, the program uses C language coding. After the server receives the information, it will be saved in the database table, which is

convenient for the travel client to visit next time. In practice, the partial differential original data is cached by the partial differential acquisition program in the server-side system. After that, the application of H-264 encoding function compresses and encodes the data, which is convenient for the transmission of the next-level robot network. In order to ensure the effect after decoding, a monitoring window is set up in the server program, and the monitoring window displays the restored data after decoding, which is mainly used for the comparison and testing of the decoded partial differential data. In the design of the travel client software, Figure 7 decodes the encoded partial differential data and displays it in the travel client window.

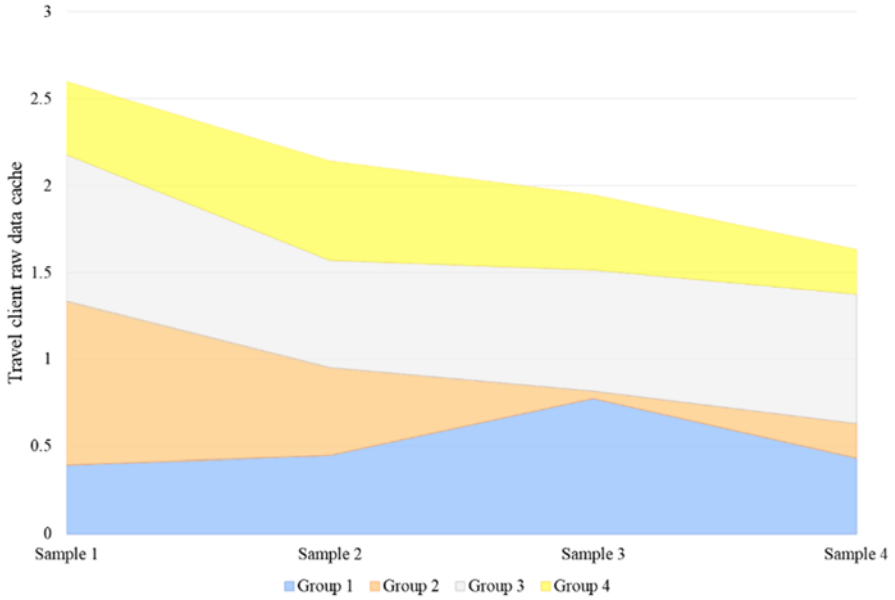

Figure 7. Travel client raw data cache.

The PWM timer of $3C2410 adopts a double buffer mechanism, which can reset the load value of the next round of timing operation without stopping the current timer operation. This value can be written into TCNTBn (Timer Count Buffer Register), and the count value of the current timing can be obtained from TCNTOn. That is, what is obtained from TCNTBn is not the current value but the initial value of the next count. After the automatic loading function is turned on, when the value of TCNTn decreases to 0, the chip automatically copies the value of TCNTBn to TCNTn, and starts the next cycle. If the TCNTn value becomes 0 and the autoload value is also 0, then there will be no further operation of TCNTn.

Based on the in-depth study of the image compression protocol, the design of the codecing software of the image acquisition data is completed, and the streaming media transmission of the network image is realized. The design of ultrasonic obstacle detection device and obstacle avoidance strategy during movement is completed, and the combination of map information lays a foundation for the realization of autonomous navigation. In the Linux system, the set of entry points provided by the device driver is explained to the system by a file operation structure filo perations, and the entry points in Figure 8 are associated with their respective functions, which are mainly responsible for the implementation of system calls.

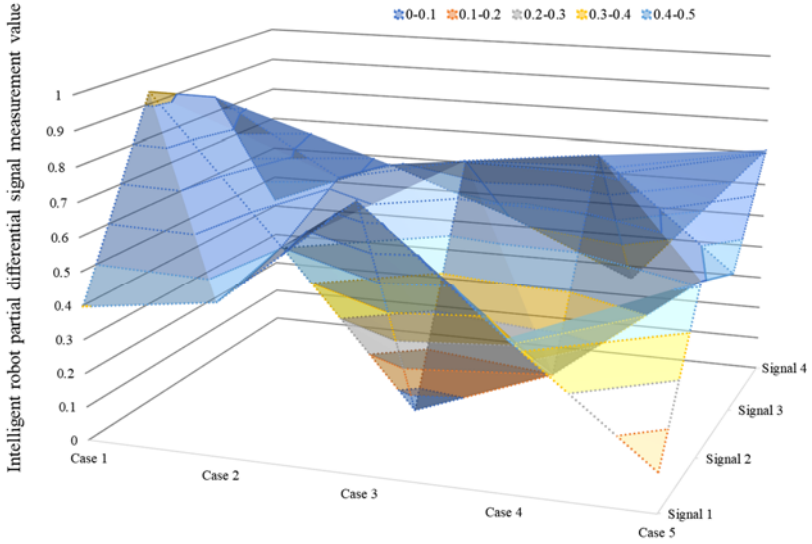

Figure 8. Partial differential signal measurement of intelligent robot.

The distance measurement in the program adopts the classical pulse measurement method. The pulse signal sent by the SPCE061A controller is 40 KHz, and such a waveform output can only last for 0.5 milliseconds, so in actual measurement, it is necessary to transmit at least 12 complete pulses continuously to complete a measurement. At the same time, the whole process needs to be timed by the counter. It should be noted that the counter needs to be turned on before transmitting the signal, and a threshold value is set for the counter. When the counter reaches the threshold value, the echo signal can be checked, which will reduce the residual wave to the signal. Since the echo signal is sent to the single-chip microcomputer in the form of square wave pulse, the external interrupt is used to detect the signal. When the single-chip microcomputer receives the echo signal, it immediately samples the data in the counter. The actual meaning of the data is to measure the time difference. In order to reduce the measurement error as much as possible, the system divides 4 times as the unit of distance measurement and counts it as a distance measurement. Before the smart robot plays the game, click the start button, and the system starts a 5-second countdown. When the countdown is 0 seconds, the initialization information is sent to the smart robot through the wireless communication between the coordinator node and the terminal node. At the same time, the ID numbers of each intelligent robot and the speed of the traveling robot entering the field are also uploaded to the tourism management system interface in real time through the wireless communication network for display.

5. Conclusions

In this paper, ultrasonic ranging sensor, temperature sensor, humidity sensor and other sensors are used to design the multi-sensor hardware system of the robot; the software and hardware are coordinated to debug, and the error of the measurement results is reduced through software design, and the system accuracy and stability are improved. The interface is mainly designed in combination with the ZigBee wireless communication network and the monitoring functions required by the system, including MSComm control design, display area, communication port selection area, and time area. In

addition, the system has designed 16 different communication ports COM1-COM16 for convenient selection of the communication port of the host computer to ensure the normal transmission of data. We analyze and design the hardware circuit and software program of the intelligent small robot management control system: the hardware circuit uses the ARM7 series chip LPC2103 chip as the main controller, and the peripheral circuits use the power supply module, motor drive module, sensors with different functions and wireless transmission modules respectively. The software program design is mainly based on the management algorithm, and the ranging program, the intelligent small robot direction and robot speed control program, the wireless two-way communication program and the graph segmentation algorithm program design are designed respectively. Therefore, this paper believes that the central location of the core enterprises should be as close to the downstream as possible, so as to reduce the number of level levels and participants at all levels, so as to simplify the tourism service supply chain. The experimental results verify the effectiveness of the above robot control function implementation scheme. Different sensors can obtain data information of different attributes or multiple data of the same attribute. Therefore, in further research, we will focus on multi data fusion technology to obtain more accurate information.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Z. Guo, K. Yu, A. K. Bashir, D. Zhang, Y. D. Al-Otaibi, M. Guizani, Deep information fusion-driven POI scheduling for mobile social networks, *IEEE Network*, **36** (2022), 210–216. https://doi.org/10.1109/MNET.102.2100394
2. Y. Li, H. Ma, L. Wang, S. Mao, G. Wang, Optimized content caching and user association for edge computing in densely deployed heterogeneous networks, *IEEE Trans. Mob. Comput.*, **21** (2022), 2130–2142. https://doi.org/10.1109/TMC.2020.3033563
3. Q. Zhang, K. Yu, Z. Guo, S. Garg, J. J. P. C. Rodrigues, M. M. Hassan, et al., Graph neural networks-driven traffic forecasting for connected internet of vehicles, *IEEE Trans. Network Sci. Eng.*, **9** (2022), 3015–3027. https://doi.org/10.1109/TNSE.2021.3126830
4. S. Xia, Z. Yao, Y. Li, S. Mao, Online distributed offloading and computing resource management with energy harvesting for heterogeneous MEC-enabled IoT, *IEEE Trans. Wireless Commun.*, **20** (2022), 6743–6757.https://doi.org/10.1109/TWC.2021.3076201
5. Z. Guo, K. Yu, Z. Lv, K. K. R. Choo, P. Shi, J. J. P. C. Rodrigues, Deep federated learning enhanced secure POI microservices for cyber-physical systems, *IEEE Wireless Commun.*, **29** (2022), 22–29. https://doi.org/10.1109/MWC.002.210027
6. L. Zhao, Z. Yin, K. Yu, X. Tang, L. Xu, Z. Guo, et al., A fuzzy logic based intelligent multi-attribute routing scheme for two-layered SDVNs, *IEEE Trans. Network Serv. Manage.*, 2022, early access, https://doi.org/10.1109/TNSM.2022.3202741
7. D. Peng, D. He, Y. Li, Z. Wang, Integrating terrestrial and satellite multibeam systems toward 6G: Techniques and challenges for interference mitigation, *IEEE Wireless Commun.*, **29** (2022), 24–31. https://doi.org/10.1109/MWC.002.00293

8. L. Huang, R. Nan, K. Chi, Q. Hua, K. Yu, N. Kumar, et al., Throughput guarantees for multi-cell wireless powered communication networks with non-orthogonal multiple access, *IEEE Trans. Veh. Technol.*, **71** (2022), 12104–12116. https://doi.org/10.1109/TVT.2022.3189699
9. Z. Cai, X. Zheng, J. Yu, A Differential-private framework for urban traffic flows estimation via taxi companies, *IEEE Trans. Ind. Inf.*, **15** (2019), 6492–6499. https://doi.org/10.1109/TII.2019.2911697
10. Z. Zhou, X. Dong, Z. Li, K. Yu, C. Ding, Y. Yang, Spatio-temporal feature encoding for traffic accident detection in VANET environment, *IEEE Trans. Intell. Transp. Syst.*, **23** (2022), 19772–19781. https://doi.org/10.1109/TITS.2022.3147826
11. X. Zheng, Z. Cai, Privacy-preserved data sharing towards multiple parties in industrial IoTs, *IEEE J. Sel. Areas Commun.*, **38** (2020), 968–979. https://doi.org/10.1109/JSAC.2020.2980802
12. S. H. Ivanov, C. Webster, E. Stoilova, D. Slobodskoy, Biosecurity, crisis management, automation technologies and economic performance of travel, tourism and hospitality companies—A conceptual framework, *Tourism Econ.*, **28** (2022), 3–26. https://doi.org/10.1177/13548166209465
13. B. Hysa, A. Karasek, I. Zdonek, Social media usage by different generations as a tool for sustainable tourism marketing in society 5.0 idea, *Sustainability*, **13** (2021), 1018. https://doi.org/10.3390/su13031018
14. H. E. Arici, M. A. Köseoglu, A. Sökmen, The intellectual structure of customer experience research in service scholarship: a bibliometric analysis, *Serv. Ind. J.*, **42** (2022), 514–550. https://doi.org/10.1080/02642069.2022.2043286
15. Y. Wu, Z. Huo, W. Xing, Z, Ma, H. M. A. Aldeeb, Application of experience economy and recommendation algorithm in tourism reuse of industrial wasteland, *Appl. Math. Nonlinear Sci.*, **6** (2021), 227–238. https://doi.org/10.2478/amns.2021.2.00039
16. J. Reis, N. Melão, J. Salvadorinho, B. Soares, A. Rosetea, Service robots in the hospitality industry: The case of Henn-na hotel, *Technol. Soc.*, **63** (2020), 101423. https://doi.org/10.1016/j.techsoc.2020.101423
17. R. Kervenoael, R. Hasan, A. Schwob, E. Goh, Leveraging human-robot interaction in hospitality services: Incorporating the role of perceived value, empathy, and information sharing into visitors' intentions to use social robots, *Tourism Manage.*, **78** (2020), 104042. https://doi.org/10.1016/j.tourman.2019.104042
18. H. Fan, W. Gao, B. Han, How does (im) balanced acceptance of robots between customers and frontline employees affect hotels' service quality, *Comput. Human Behav.*, **133** (2022), 107287. https://doi.org/10.1016/j.chb.2022.107287
19. S. H. W. Chuah, E. C. X. Aw, C. F. Cheng, A silver lining in the COVID-19 cloud: Examining customers' value perceptions, willingness to use and pay more for robotic restaurants, *J. Hosp. Market. Manage.*, **31** (2022), 49–76. https://doi.org/10.1080/19368623.2021.1926038
20. S. Ivanov, C. Webster, Willingness-to-pay for robot-delivered tourism and hospitality services–an exploratory study, *Int. J. Contemp. Hosp. Manage.*, **33** (2021), 3926–3955. https://doi.org/10.1108/IJCHM-09-2020-1078
21. A. Tuomi, I. P. Tussyadiah, J. Stienmetz, Applications and implications of service robots in hospitality, *Cornell Hosp. Q.*, **62** (2021), 232–247. https://doi.org/10.1177/193896552092396

22. S. M. C. Loureiro, R. G. Bilro, The role of commitment amongst tourists and intelligent virtual assistants, *J. Promot. Manage.*, **28** (2022), 175–188. https://doi.org/10.1080/10496491.2021.1987979
23. S. Kabadayi, F. Ali, H. Choi, H. Joosten, C. Lu, Smart service experience in hospitality and tourism services: A conceptualization and future research agenda, *J. Serv. Manage.*, **30** (2019), 326–348. https://doi.org/10.1108/JOSM-11-2018-0377
24. C. T. Zhang, L. P. Liu, Research on coordination mechanism in three-level green supply chain under non-cooperative game, *Appl. Math. Modell.*, **37** (2013), 3369–3379. https://doi.org/10.1016/j.apm.2012.08.006
25. F. Ruggiero, V. Lippiello, B.Siciliano, Nonprehensile dynamic manipulation: A survey, *IEEE Robot. Autom. Let.*, **3** (2018), 1711–1718. https://doi.org/10.1109/LRA.2018.2801939
26. X. Zhang, T. Feng, Q. Niu, X. Deng, A novel swarm optimisation algorithm based on a mixed-distribution model, *Appl. Sci.*, **8** (2018), 632. https://doi.org/10.3390/app8040632
27. X. Yuan, J. Shi, L. Gu, A review of deep learning methods for semantic segmentation of remote sensing imagery, *Exp. Syst. Appl.*, **169** (2021), 114417. https://doi.org/10.1016/j.eswa.2020.114417
28. V. Q. Trinh, N. Seetaram, Top-management compensation and survival likelihood: the case of tourism and leisure firms in the US, *Ann. Tourism Res.*, **92** (2022), 103323. https://doi.org/10.1016/j.annals.2021.103323

AIMS Press