Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2023.29439

290 (2023) 247–254
April

Application of large amount of data in real-time tracking system of marine organisms

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Received 11 June 2022; Accepted 12 August 2022

ABSTRACT

During the real-time tracking of marine organisms, due to the huge amount of data, the problem of not being able to upload data in time will occur. Therefore, the application of massive data in the real-time tracking system of marine organisms is studied. According to the overall design requirements of the system, the overall framework of the system is established. Based on the system construction, the hardware part of the design system is composed of multiple serial port MCU, sim808 module and camera module. The host of the marine biological positioning and tracking system is designed using the STC15W4K32S4 multi-serial single-chip microcomputer. The real-time positioning data is uploaded to the network through the host control program design, and the whole system is designed based on GPS module and GPRS module. The experimental results show that: The similarity between the proposed method and the actual trajectory is very high with and without interference. And the data transmission time of the method in this paper is up to 6 min, which shows that the method in this paper can upload data in time, with small error and good performance.

Keywords: Big data; Motion of marine organism; Trajectory tracking; System design

1. Introduction

The ocean, which accounts for about 71% of the earth's surface, is an important part of the earth's biosphere, nurturing a wide variety of marine organisms and a treasure house of biodiversity. Marine biodiversity is one of the important material basis and realization conditions for human survival and sustainable development [1]. Due to the variety of marine organisms, the closely range action is subtle and difficult to observe, so it is difficult to track their trajectories. Therefore, big data technology can be added to mobile devices, which can track the target in real-time space.

Li et al. [2] studied the detection and tracking system of sea moving targets. Based on the dual digital signal processor (dual DSP) control system, the lifting morphological wavelet method is used for image preprocessing, and the combination of GA algorithm and Otsu algorithm is used to extract the characteristics of moving targets, realizing the detection and tracking of moving targets on the sea. Zou et al. [3] studied the dynamic target tracking system based on SSC-Siam Mask. Aiming at the problem that the target is partially occluded, interfered, deformed or lost, which is easy to lead to tracking failure, a dynamic target tracking system was implemented based on SSC-Siam Mask algorithm. However, when the above methods are used to track the process, there will be a problem that the amount of information is too large to upload data in time.

On the basis of the above, this paper studies the application of massive data in marine biological real-time tracking system. The research path is as follows: According to the overall design requirements of the system, the overall framework of the system is established. Based on the system construction, the hardware part of the design system is composed of multiple serial port MCU, sim808 module and

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camera module The host of the marine biological positioning and tracking system is designed using the STC15W4K32S4 multi-serial single-chip microcomputer. The real-time positioning data is uploaded to the network through the host control program design. The whole system is designed based on the GPS module and GPRS module. The similarity between the proposed method and the actual trajectory is very high with and without interference. And the data transmission time of the method in this paper is up to 6 min, which shows that the method in this paper can upload data in time, with small error and good performance.

2. Overall design of the system

2.1. Demand analysis of system overall design

This paper studies the application of massive data in the real-time tracking system of marine organisms. Therefore, when designing the system, it must have mobile devices that can meet the needs of real-time positioning, and save and reflect the real-time positioning data of mobile devices, so that the system can respond to some emergencies quickly. By completing the design of this positioning mobile device, the stability and speed of the system are enhanced. In addition, the positioning of the control system design should also meet the following requirements:

- This design can receive the signal sent from the satellite in time through the GPS positioning module in 24 h without interruption. Then, when calculating the accurate positioning information for these mobile devices, the error range can be controlled within the acceptable range [4].
- Underwater radio frequency has (1) high communication rate. (2) Strong anti-noise capability. (3) The underwater electromagnetic wave has fast propagation speed and low transmission delay. (4) The system structure is simple without accurate alignment. (5) Low power consumption and convenient power supply. In this regard, in order to make mobile devices have better prompt information function, underwater wireless radio frequency is used for communication. If the information connection is interrupted, the system can send an alarm message to remind the user.
- In order to make the mobile device have better prompt information function, the system uses Underwater radio frequency transmission terminal to communicate at any time. If the information connection is interrupted, the system can send an alarm message to remind the user.
- The monitoring program needs to establish a contact between the location information transmitted by GPRS and the mobile device in time, call the map API to describe the track of the mobile device, and make emergency treatment for the information uploaded in case of alarm.

2.2. Overall framework construction of the system

The overall design of the system is composed of hardware mobile tracking device and software in the system. The hardware of the system consists of multi-serial port single chip microcomputer, camera, power module, data receiver and so on.

STC microcontroller is used as the full power controller in the system, and the positioning information received by GPS is analyzed by serial method and communication module. GPRS is used to connect with the underwater radio frequency transmission terminal to transmit data to the remote server. If the time connection is interrupted, the alarm can be activated in time to prevent the loss of equipment [5,6]. The main idea of server software design in the system is to receive data through TCP stream, then store the location information in the server, and describe the track of mobile device on the map API according to the server data. When the mobile device is lost, it alarms, save the received image, and support the in-depth development, matching, assistance and positioning of the image. User behavior analysis of technology and data analysis and integration in the system, the perception system of mobile devices is realized (Fig. 1).

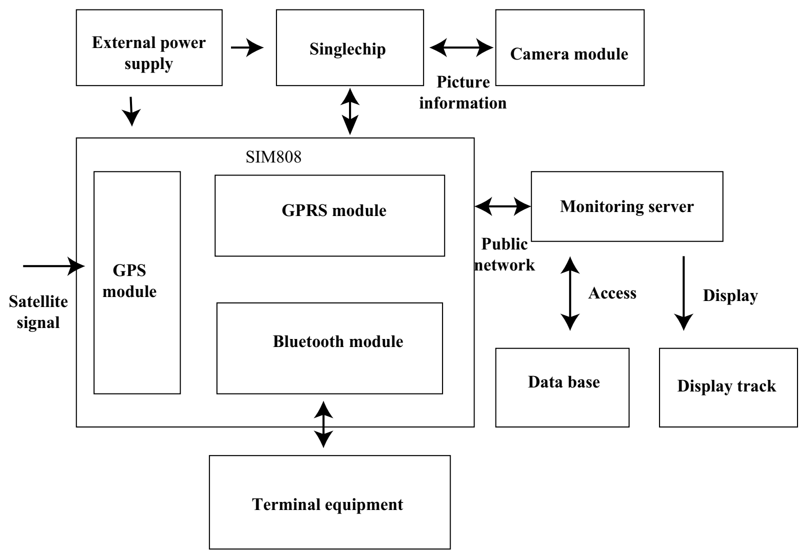

Fig. 1. Tracking system framework of mobile device for marine organism monitoring.

3. Hardware design of mobile tracking of marine organisms

The system design in this paper is applied to mobile devices, which requires second level real-time and high stability. On this basis, it should be minimized and lightest to facilitate the installation on various mobile devices. Therefore, in the design of control system, the composition of hardware should be compared and demonstrated to meet the design requirements. Then the hardware resources are programmed to make the results of hardware cooperative condition execution more in line with the theory and practical application.

3.1. Multi-serial port single chip microcomputer

In the selection of MCU, this paper considers the requirements of the biological mobile tracking device and the basic requirements of the realization of the function, and chooses the single chip microcomputer with low power consumption and advanced (Fig. 2). Most modules control startup and operation by means of serial port instructions [7,8]. The control core system SCM has rich serial port resources, which integrates 4K bytes SRAM and 7 timers. When the chip of the single chip is powered on, the program will run, and can fully perform all system functions in the tracking application of the real-time positioning platform. In the design of the system, the single-chip microcomputer is the key, and there should be less power consumption in the selection, so that the performance of the whole system can be greatly improved.

3.2. SIM808 module

The SIM808 module is the four in one module developed by SIMCOM, including GSM, GPRS, GPS and Underwater radio frequency transmission terminal. The combination structure is tightly designed and integrated with GPRS and GPS SMT package, which significantly saves time and reduces the cost of customer development and support of GPS Applications [9]. Through the combination of industry standard interface and GPS function, its variable assets can be tracked at any time (Fig. 3).

The traditional GSM wireless communication module SIM900A is replaced by the SIM808 in this paper, which makes it more suitable for the changeable environment of the seabed. The system mainly communicates with SIM808 through the serial port of single chip microcomputer, uses at command to carry out data positioning and data transmission, and also uses at command to manage the initialization of module, control function, timing transmission of Underwater radio frequency transmission terminal, etc.

3.3. Camera module

Through the camera module to collect the individual image of the target, it can provide more high-quality visual information for positioning. The information is huge and intuitive, which can greatly improve the overall management efficiency of the multi-perception track system. At the same time, the pictures reflected by the biological monitoring mobile device can bring greater help to the subsequent processing [10]. This system uses PTC06 small camera to combine image acquisition, data compression and serial port transmission into an industrial image acquisition micro processing module, which makes the communication between PTC06 and MCU more convenient and quicker (Fig. 4).

4. Design of control program of main unit

STC15W4K32S4 multi-serial port single chip microcomputer is used to design the main unit of positioning and tracking system for marine organism. The main control chip can receive and preprocess the positioning data of GPS module, read and identify the RF tag data. Through the above programming and data transmission of GPRS wireless network software, the power consumption of hardware system can be reduced. The system flow chart is shown in Fig. 5.

4.1. GPS module data processing

The system is designed to receive the GPS data through multiple serial ports. The receiving of the program only needs to identify the field to provide effective data. The most original serial port of the system is to read and judge the data sent by the variable control GPS module.

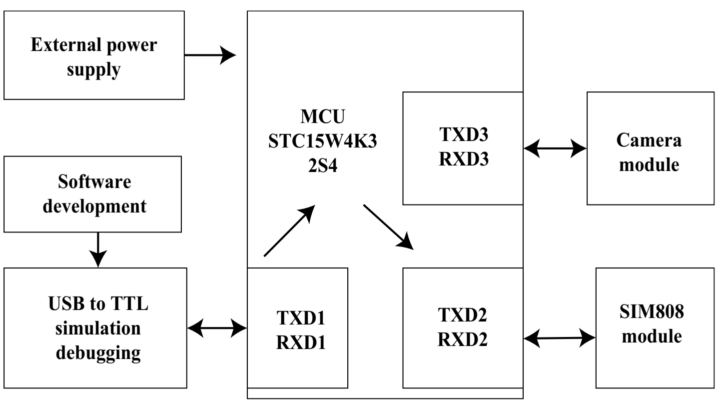

Fig. 2. Main working principle of single chip microcomputer.

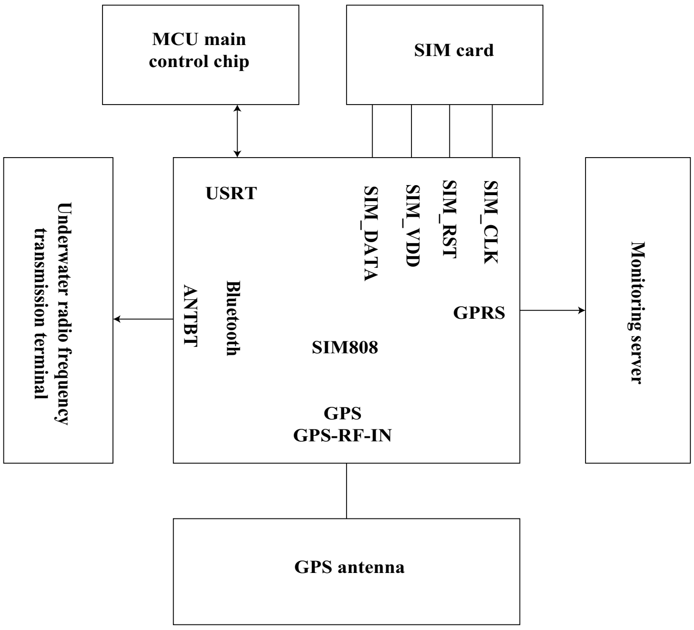

Fig. 3. Main working principle of SIM808 module.

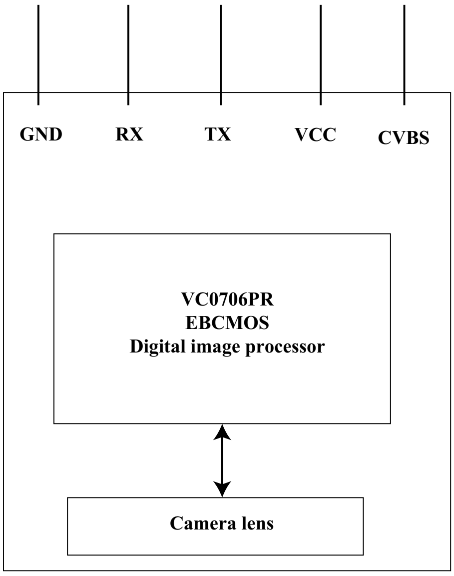

Fig. 4. Main working principle of camera module.

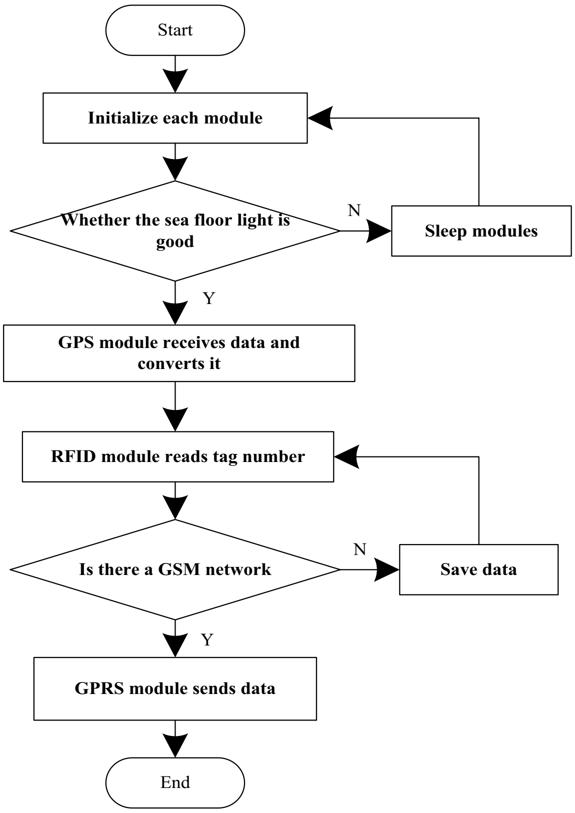

Fig. 5. Overall flow chart of control procedure.

In practical application, RMC data format is the most widely used, and its information volume is also the most perfect one, so this paper chooses RMC data format [11]. From the received symbol "$", it is counted, and then "G", "P", "R", "M" and "C" are received in sequence. After receiving the five leading symbols, the system program will transform itself into positioning data; when the air program feels the carriage return or line feed, the data will complete the receiving process. If the data generates wrong leading characters in the reception, the system will clear the data and restore it to the original state, and then wait for the data to be received. After receiving, the data significant bit in the field is used to judge the GPS data in this section. If the valid data is obtained by extracting the Greenwich time and latitude and longitude information in the database, the data variable will be stored, and the time is set as the international standard time [12]. After the time setting is completed, the invalid data will be cleared and re received. Finally, the re-received data will be transmitted to the mobile device to complete the real-time positioning, and the flow chart is shown as Fig. 6.

4.2. Data transmission of GPS network

The designed system program sends AT instruction to SIM808, monitors the network status, starts the packet data connection of GPRS module, and completes the packet encapsulation through the TCP/IP protocol stack inside the

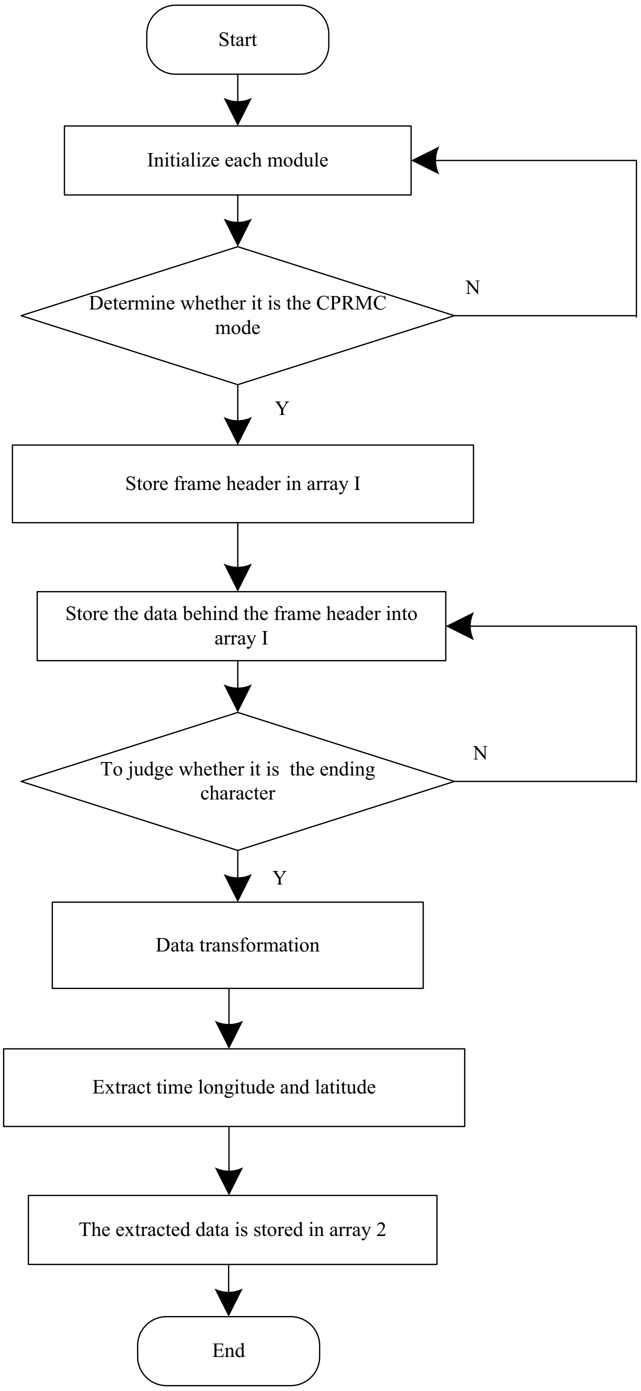

Fig. 6. Receiving process of GPS data.

data [13–15]. Then AT database is called to send the control command and send the data to IP control center, so as to realize the data transmission and collection process. The sending process is shown in Fig. 7.

Common AT instruction set for SIM808 networking is shown in Table 1.

The real-time tracking system for marine organisms designed above can select different types of marine organisms to wear mobile devices for positioning and tracking, use underwater radio frequency to transmit signals to the tracking equipment, and the tracking system can locate and track marine organisms according to the received signals.

5. Experiment and simulation

5.1. Experimental environment

In order to facilitate the collection of sample data needed for learning when building a motion primitive database, this paper constructs a Microsoft Foundation Classes (MFC) interface in Visual Studio 2013 software to simulate the robot's motion in two-dimensional plane, and then obtain the motion data of the robot and human, simulate the environment with the actual size of 10 m × 10 m. A circle simulation robot with a radius of 5 cm is adopted, and the robot's current motion position and speed of four data windows in the

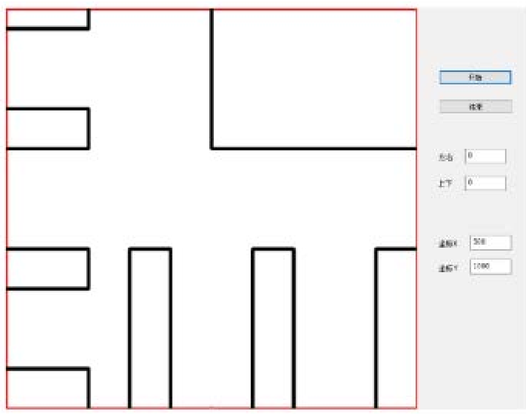

Fig. 7. Environment interface imitating robot movement.

Table 1
AT instruction set

AT instruction	Detailed annotations
AT+CREG?	Query the registration information of the network
AT+CGATT?	See if GPRS network is attached
AT+CGATT=CMNET	Setting of access point APN
AT+CIISR	Activate mobile scene and initiate GPRS wireless connection
AT+CIFSR	Get local IP address
AT+CIPSTART=TCP 172.21.57.72,1231	Establish a TCP connection
AT+CIPSEND	Transmit data

interface are displayed in real-time. After the static environment is built, open source computer vision library (openCV) is used to realize the manipulation of SM600 simulator and the record of motion data. The environment interface of robot motion is shown in Fig. 7.

The collected seabed image is shown in Fig. 8.

5.2. Analysis of experimental results

In order to verify the reliability and stability of the designed system, after the successful design, different types of marine organisms will be selected to wear mobile devices in different waters for testing. Through the detailed testing of longitude and latitude, signal and system power consumption of the area where the experimental organisms are located, the real-time positioning data will be sent to the system server through SIM808, and the real-time location route is displayed on the software interface of the server by means of transmission loading. After the actual test, the data of different sea floor light and various occlusions are recorded, and the energy consumption of the system is recorded (Table 2).

From the above experiments, we can see that GPRS module consumes the most energy in the system, especially in the process of communication with TCP/IP. The energy consumption of RFID module is only less than that of GPRS module in the transceiver mode, corresponding to the fact that the energy consumption of GPS module is not large when it is working, and the energy consumption of MCU is the smallest. If all modules are working uninterruptedly, the system will be at 2,232.5 mw. Compared with the operation of the system, 2,500 mA lithium battery is required, and the discharge capacity can reach 83%. If the working time is too short, it cannot maintain the actual work requirements of mobile devices. For all systems in the sleep state, the energy consumption of the system will be very low, so when designing the system, GPRS, REID module and multi-serial port single-chip microcomputer should be switched between sleep and work to complete reasonable control, and GPS data can also be received through a short time or longer time. When the module in the system is closed, the main control single-chip microcomputer will enter the sleep mode type. Therefore, it can improve the tracking performance of closely range motion trajectory of seabed organisms.

In order to verify the effectiveness of the method in this paper, the similarity between the expected trajectory and the tracking trajectory is taken as the experimental index. Based on the absence of external interference and the presence of external interference, the method in this paper, the method in literature [2] and the method in literature [3] are used for the experimental test. The test results are as follows.

It can be seen from Figs. 9 and 10 that whether there is external interference or not, the similarity between this method and the actual trajectory is very high. The main

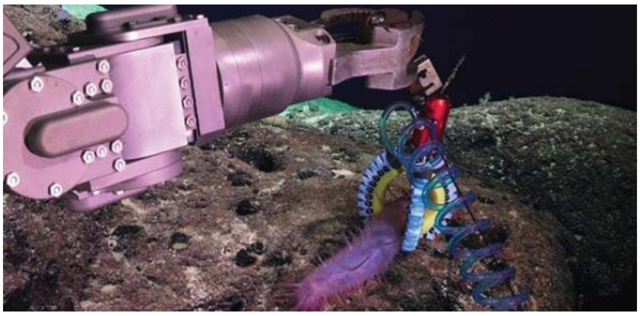

Fig. 8. Seabed image.

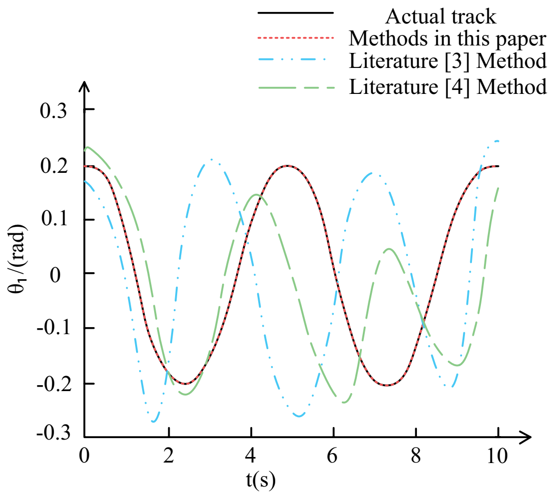

Fig. 9. Simulation results without external interference.

Table 2
Specific data of each module

Modular	Work pattern	Working voltage (V)	Working current (MA)	Power consumption (MW)
GPS	Normal operation mode	3.3~4.09	48	151~196.3
GPRS	GPRS communication	3.1~4.19	280	874~1,215.1
GPRS	Standby mode	3.1~4.19	25	74.1~92.45
GPRS	Sleep mode	3.1~4.19	1	3.4~4.26
RFID	Transceiver mode	5.1	155	738
RFID	Monitor mode	5.1	5	18
RFID	Sleep mode	5.1	0.04	0.2
MCU	Normal operation mode	3.5~4.28	25	70~83.2
MCU	Sleep mode	3.6~4.07	0.09	0.248~0.323

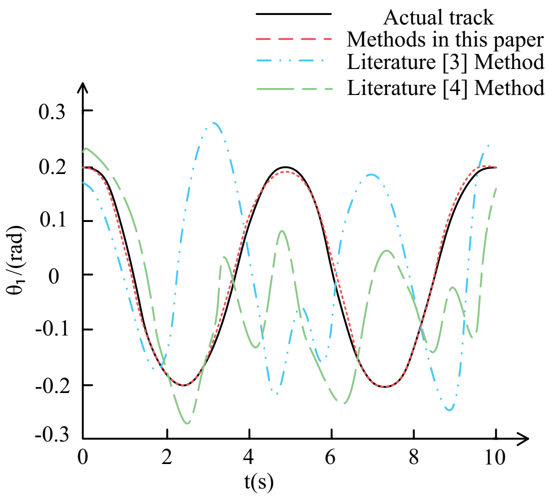

Fig. 10. Simulation results with external interference.

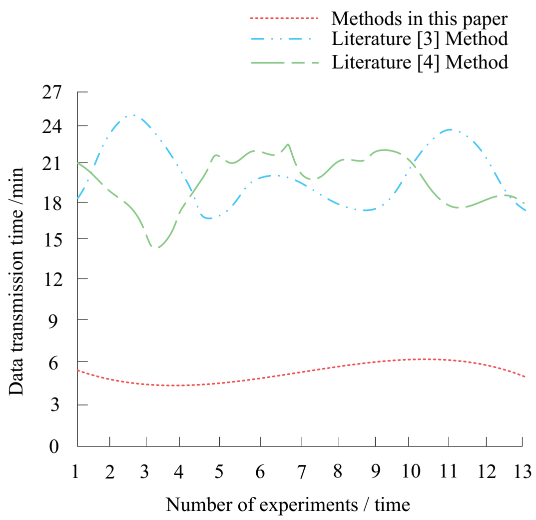

Fig. 11. Comparison of data transmission time of three methods.

reason lies in that the method in this paper combines the data analysis, on the basis of determining the overall demand, constructs its framework and system, then selects the hardware according to the requirements to build the control system, and uses the wireless network communication means in GPRS module. The positioning information of mobile devices and the image information captured by the camera are transmitted to the system server through the network circuit, so as to achieve the effect of positioning and tracking at any time and improve the tracking accuracy. However, the large fluctuation of the comparison method indicates that its tracking effect is poor.

In order to further verify the practicability of the method in this paper, the data transmission time is taken as the experimental index for comparative testing.

According to Fig. 11, the data transmission time of the method in this paper is 6 min at most and 4 min at least; The data transmission time of the method in literature [2] is 25 min at most and 17 min at least; The maximum data transmission time of the method in literature [3] is 22 min and the minimum is 14 min. It can be seen that in the tracking process, the data transmission time of this method is shorter, the efficiency is higher, and the data can be uploaded in time, which is practical.

6. Conclusions

This paper designs a real-time tracking system based on big data. By tracking the mobile device in real time, the data can be effectively transmitted to the system server, which is convenient for real-time monitoring of the movement of benthic organisms, and plays the role of navigation and positioning. The system services include GPS positioning information acquisition, GPRS module alarm and data image transmission. The experimental results show that whether there is external interference or not, the similarity between the method in this paper and the actual trajectory is very high, indicating that the method in this paper can describe the real-time trajectory and play a monitoring role, and the data transmission time of the method in this paper is up to 6 min, indicating that the method in this paper can upload data in time, with small error and good performance.

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