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Logistics Transportation Positioning System Based on STM32

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ABSTRACT: *In modern society, with globalization and the rapid development of e-commerce, the logistics industry is facing unprecedented changes. The problem of accurate positioning and real-time monitoring of goods in the logistics handling process needs to be solved. In order to solve this problem, the logistics handling and positioning system has emerged. The system mainly adopts mature microcontroller technology, as well as advanced positioning technology and data processing technology, which can realize real-time monitoring and accurate positioning of goods and handling equipment. This paper describes the logistics transportation positioning system based on STM32. It mainly expounds the relevant background and main components of the logistics transportation positioning system; The main functions and functional processes of the logistics transportation positioning system based on STM32; The detailed design process of the software and hardware part of the logistics transportation positioning system. The hardware part includes STM32F103C876 single chip microcomputer, GPS positioning module, OLED display module, ESP8266 serial port WiFi module. The software part mainly includes the system function flow, GPS positioning, OLED display, ESP8266 serial port programming and real-time monitoring of the computer; The detailed debugging process of the software is described; This project uses microcontroller to design the logistics handling and positioning system with low power consumption, low cost, short design cycle, simple and reliable system and other characteristics. After hardware debugging the system can fulfill the expected function.*

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I. INTRODUCTION

Desalination is a water-treatment process that separates salt from saline water to produce potable water or water that is low in total dissolved solids; many countries in the world suffer from a shortage of natural fresh water. Increasing amounts of fresh water will be required in the future as a result of the rise in population rates and enhanced living standards, together with the expansion of industrial and agricultural activities, Thermal solar energy is one of the most promising applications of renewable energies to seawater desalination, as it is suitable for arid and sunny regions. A thermal solar distillation system usually consists of two main parts, the collecting device and the distiller. Solar thermal desalination processes are characterized to be direct processes when all parts are integrated into one system, while the case of indirect processes refers to the heat coming from a separate solar collecting device, usually solar collectors, or solar ponds. The review of some of previous work related to {Solar Water Distillation Techniques, Humidification dehumidification, Spherical dome.

Review of solar distillation methods were discussed by Patel et al., [1]. Many various methods were developed by the researchers to distil the brackish water. It were founded that various methods developed for distillation of water. These methods were subjected to request of fresh water, quality of water and the cost. The multi-effect distillation method can be used for mass production of fresh water Opportunities for solar water desalination worldwide was provided by Shatat et al., [2] the thermal desalination method is now used for desalination of seawater in oil rich countries and the reverse osmosis method becomes the second technology on a global scale. Sivakumar and Sundaram [3] were provided Improvement techniques of solar still efficiency. Many research works done on solar still to improve its productivity were reviewed. and The main points are: (heat storing procedure in solar desalination process were effective than that without heat storage; By the introduction of baffle suspended absorber plate the free surface area of water was increased which gives 18.5–20% more productivity. Sharon and Reddy [4] presented a review of solar energy driven desalination technologies. It was found that solar energy driven desalination units can decrease carbon emissions and can supply desalinated water in a sustainable way. Modeling of a solar driven HD (Humidification-Dehumidification) desalination system it had studied by Franchini andPerdichizzi[5].A solar driven HD desalination system has been investigated in the present study. Two different configurations have been compared: an integrated solar cooling and desalination system and separated solar cooling and solar desalination units.Zamen etal.,[6].It had presented Experimental investigation of a two-stage solar humidification–dehumidification desalination process. The multi-stage HD

process for desalination was introduced. Theoretical results show that important parameters of the process such as specific energy consumption, productivity and daily production per solar collector area improved when multi-stage process was used instead of single-stage process.Humidification compression desalination discussed byGhalavandetal.,[7].A new technology is investigated in this study and compared with two conventional HDH methods under similar operating conditions. The proposed method has higher water production, higher water recovery and lower energy consumption in comparison with the two othermethods. Kabeel and El-Said investigated A hybrid solar desalination system of air humidification,dehumidification and water flashing evaporation: Part II.Experimental investigation,[8].

From previous review, the present study aims to experimentally investigate the solar water distillation characteristics of spherical dome as a dehumidifier surface. Parameters that can be used to measure the performance of this type of solar water distillation are also presented, investigated and estimated. The effects of some geometric parameters of the spherical dome on the performance of the solar water distillation will be investigated. The experiments have been carried out to provide comprehensive study of the solar water distillation by using spherical dome as a dehumidifier surface at different key design parameter.

II. OVERALL DESIGN

The logistics transportation positioning system based on STM32 MCU designed in this paper optimizes the workflow of obtaining location information and real-time monitoring through intelligent means. This system uses efficient hardware pin design to quickly acquire and transmit data, which greatly improves the efficiency of data acquisition in the workflow. This efficient acquisition mechanism ensures the real-time and accuracy of data and lays a solid foundation for subsequent processing. In the data processing link, the system conducts efficient data processing through the main control unit. This unit can process data in multiple formats and uniformly convert standard formats for subsequent monitoring. This processing method not only improves the efficiency of data processing, but also ensures the reliability of data. In the real-time monitoring link, the system can display multiple data in real time.

In the system designed in this paper, STM32F103C8T6 is selected as the main control chip. Its PA9 and PA10 pins are connected to the RXD and TXD pins of the GPS positioning module. PB8 and PB9 are connected to the SCL and SDA pins of the OLED display screen. 5V corresponds to 5V of the two modules, and GND corresponds to GND of the two modules. Then connect TXD and RXD of the ESP 8266 module to PB11 and PB10 of the chip, and connect GND to GND. 3.3V corresponds to 3.3V. The receiver of the GPS positioning module receives the signal through the antenna. After internal data analysis and calculation, it sends the data to the chip through the UART serial port. The chip communicates with the OLED display screen through the I2C interface to send display data and control commands to it. Configure the ESP8266 module, configure it in STA mode, and the chip sends data to the ESP8266 through WiFi. Then connect the ESP 8266 module to the upper computer, and send the data to the PC upper computer through TCP protocol for real-time monitoring. The overall schematic diagram of the system is shown in the figure below:

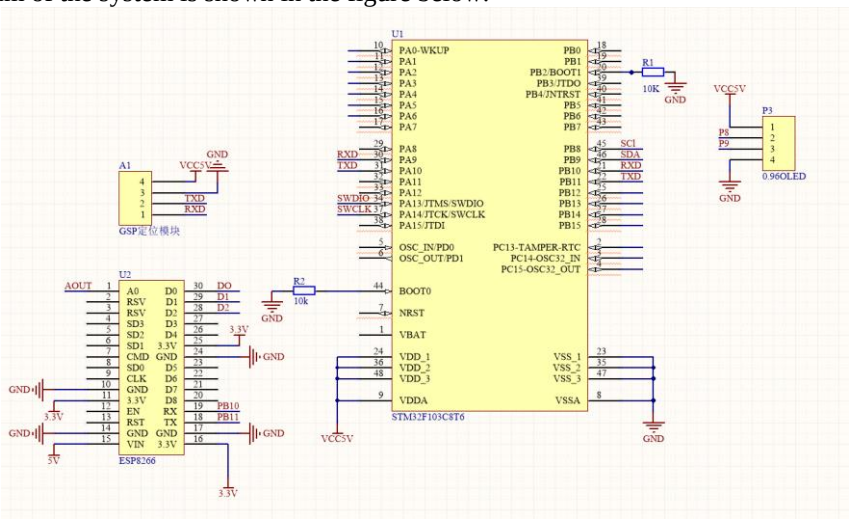

Fig. 1 General schematic of the system

III. HARDWARE DESIGN

3.1 Microcontroller circuit selection

The system is built with STM3F103C8T6 single chip microcomputer. STM32F103C8T6 is a 32-bit microcontroller based on ARM Cortex-M3 core. Its operating frequency can reach up to 72MHz, providing a powerful processing capability. This enables STM32F103C8T6 to handle complex tasks and meet various

application requirements with high real-time requirements. Secondly, STM32F103C8T6 has 64KB flash program memory and 20KB SRAM data memory. At the same time, the built-in real-time clock (RTC) and timer provide support for accurate time management and task scheduling. In addition, STM32F103C8T6 also provides a variety of debugging interfaces, including SWD and JTAG debugging interfaces. These debugging interfaces facilitate user program debugging and online programming, and improve development efficiency and convenience[3]。

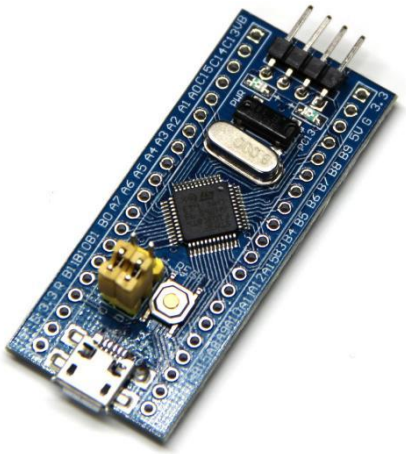

Fig. 2 STMF103C876 Development Board

3.2 Selection of GPS positioning module

GPS module is a high-performance BDS/GNSS positioning and navigation module based on ATGM336H-5N[4]。 The module supports a variety of satellite navigation systems, including all the satellites of China's Beidou-2 and Beidou-3, GPS of the United States, GLONASS of Russia, and QZSS of Japan. It can simultaneously receive the satellite signals of the above satellite navigation systems, and realize joint positioning, navigation, and time service. The module has the advantages of high sensitivity, low power consumption, and low cost, and is suitable for vehicle navigation, handheld positioning Wearable devices.

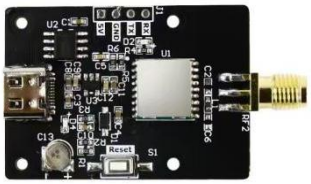

Fig. 3 GPS Positioning Module

3.3 Display module selection

In order to achieve a more beautiful human-computer interaction page, the system selects a 0.96 inch four pin OLED display screen as the display page, which can display Chinese characters, pictures and other contents, and achieve a more complex interface. 0.96-inch OLED display is a small organic light-emitting diode (OLED) display with a size of 0.96-inch. OLED display screen has the characteristics of self illumination, so it does not need backlight, and can present more vivid and real colors, and has higher contrast and deeper black performance[5]。 0.96-inch OLED display screen is usually used for small electronic devices, such as smart watches, smart bracelets, health monitoring equipment, etc. Its small size makes it suitable for use on these devices, while providing enough display area to display necessary information, such as time, date, steps, heart rate, etc. In addition, the 0.96-inch OLED display has the advantages of low power consumption, long life, high response speed, etc., which can meet the high requirements of these devices for display effects. At the same time, with the continuous progress of technology, the resolution, color performance and other aspects of the 0.96 inch OLED display are also improving, bringing better visual experience to users.

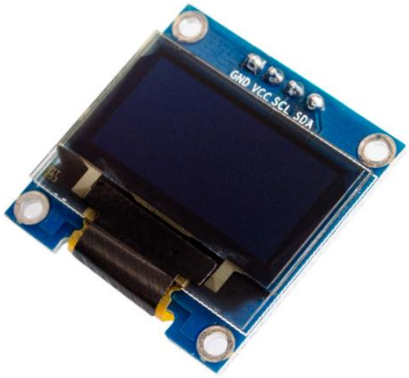

Fig. 4 OLED Display

3.4 Selection of ESP8266 module

In order to realize the function of remote real-time monitoring, the data needs to be transmitted to the PC upper computer, and the ESP8266WiFi module is selected. ESP8266 is a high-performance WiFi serial port module, which has many remarkable characteristics and wide applications.

First of all, ESP8266 is integrated with MCU, which can realize serial communication between single-chip computers. This makes it outstanding in various applications requiring wireless communication, and it is one of the most widely used WiFi modules at present[6]。 Secondly, the performance of ESP8266 is very stable. It can maintain stable performance in a wide range of operating temperatures and adapt to various operating environments. In addition, it is also highly integrated, integrating 32-bit Tensilica processor, standard digital peripheral interface, antenna switch, RF balun, power amplifier, low-noise amplifier, filter, power management module, etc. This allows it to require only a few peripheral circuits, which can significantly reduce the occupied PCB space. Thirdly, ESP8266 is specially designed for mobile devices, wearable electronic products and Internet of Things applications, and is characterized by low power consumption. In addition, although ESP8266 has no hardware I2C pin, it can be implemented in software, so you can use any GPIOx as I2C. Finally, the ESP8266 serial port WiFi module has a wide range of applications. It can realize serial transmission, PWM control and GPIO control. Serial transparent transmission is mainly used for data transmission, such as the application in industrial transparent DTU. PWM regulation is widely used in lighting regulation, three color LED regulation, motor speed regulation and other scenes. GPIO control can be used to control switches, relays and other equipment.

Fig. 5 EPS8266WiFi Serial Port Module

IV. SOFTWARE DESIGN

4.1 Introduction to the main function

This chapter mainly introduces the design of system software, mainly including: GPS positioning module programming, OLED display module programming, ESP8266 module programming and various functional functions. The lower computer software is written in C language under the KeilMDK development software, and the upper computer is developed by the merchant.

The main function mainly analyzes the data obtained by GPS, OLED display and initialization of each module. Initialization includes the initialization of OLED display module, ESP8266 module and serial port. This step needs to consider the special requirements of each circuit, such as pin function configuration, voltage and current settings, etc. Correct initialization not only ensures the correctness of the system's later logical operation, but also provides a basis for effective error diagnosis and elimination.

4.2 GPS positioning subprogram design

NMEA message is sent by GNSS receiver and supports NMEA0183 protocol[7]。 NMEA-0183 is a standard protocol developed by the National Marine Electronics Association of the United States, which is used to define the communication interface between the GPS receiver and other marine electronic equipment. This protocol defines a series of standard data formats and communication protocols, enabling devices from different manufacturers to exchange data with each other, thus achieving interoperability between devices. The GPS positioning program mainly completes serial port initialization, receiving GPS command information, analyzing data, and printing the received data through serial port. Note: In fact, the coordinate system value of GPS/Beidou positioning is not a simple 100 times relationship, but requires a degree minute second conversion. The GPS/Beidou coordinate values we obtained, such as 2429.53531 N and 11810.78036 E, need to be calculated as follows: 24+(29.53531/60) ≈ 24.49225517 118+(10.78036/60) ≈ 118.17967267.

4.3 Data display subroutine design

The data display of OLED is realized by precisely controlling different pins. This control mode is based on binary data transmission, involving the use of specific pins, which are responsible for transmitting binary 0 and 1.

The OLED_WriteCommand() function is typically used to send control commands to OLED screens. These commands are used to configure OLED screen parameters, set display mode, adjust brightness, etc

The main purpose of the OLED_WriteData() function is to send data to the OLED display screen through the I2C communication protocol for display on the screen.

Attention: OLED_I2C_SendByte(); If 0X00 in () is the sending command, 0x40 is the sending data.

The OLED_ShowString() function is typically used to display strings on OLED displays.

The specific process of OLED display is to clear the screen first to prepare for the display of new data. Next is initialization, which provides a reference for accurate data. Then, set the mode to ensure that the data is presented correctly on the screen. Finally, data reception, storage, and display in specific areas of the screen.

4.4 Software design of ESP8266 module

The AT instruction set of the ESP8266 WiFi serial port module is a group of instructions used to communicate and control with the ESP8266 module through the serial port. These commands allow the user to send commands through the serial port to control the Wi Fi function, TCP/IP connection and other related functions of the ESP8266 module.

In order to ensure the reliability of data transmission, applications can conduct reliable data communication in an unreliable network environment. Select TCP protocol in the design of ESP822 software[8] 。 TCP is a connection oriented, reliable, byte stream based transport layer communication protocol. TCP is the main transmission protocol in the Internet protocol family (TCP/IP protocol family), providing reliable data transmission services for many applications.

The specific workflow of the ESP8288 module is first module initialization, and the working mode of the ESP8266 module is configured as STA mode. Restart after the parameters are configured to ensure that the new configuration can take effect. Connect the designated WiFi, and then configure the ESP8266 module as a server to connect the upper computer client. Start the server and transmit data to the upper computer through TCP protocol.

A solar desalination system based on free jet-humidification with an auxiliary cold water system was carried out at Suez city, Egypt 29.9668°N, 32.5498°E. The main conclusions items can be briefly systemized as the following:

- Spherical dome heights 40 cm produce the highest fresh water productivity at the same condition.
- Increase the condensation surface will be increase the fresh water productivity
- Increase the salinemass flow rate will be increase the fresh water productivity
- The system productivity is (2.68 L/m2), the estimated cost is (0.12 $/L) and the efficiency is 61 %.

V. EXPERIMENRAL VALIDATION

The joint debugging of the hardware and software of the system is a key step to ensure the overall performance and reliability of the system. First of all, to ensure the accuracy of the physical connection of hardware, such as the processor, the interface pins of each module, as well as the software logic, which is the basis of the overall interaction of the system. Focus on testing the functionality of each module, which includes not only the physical functionality of the hardware, but also the accuracy of the software code for hardware operation. Immediately following the debugging of emergency functions. This includes simulating various abnormal

situations and observing how the hardware and software respond together.
The system is powered up and tested as shown in the figure below ,and the test is successful.

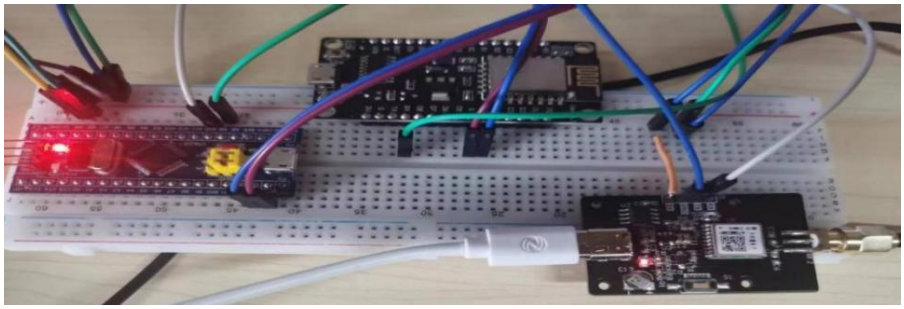

Fig. 6 System power-up test

OLED display data. The test is as shown in the figure below. The test is successful.

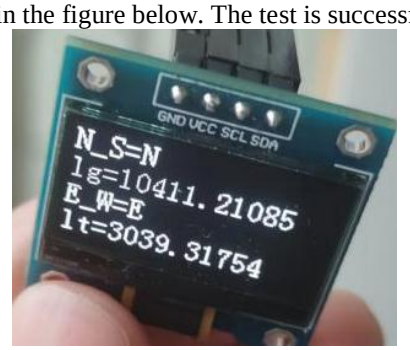

Fig. 7 OLED display test

GPS receives and analyzes the data. The test is shown in the following figure, and the test is successful.

```
$BDGSV,4,1,15,01,,,3181,34,09,07,198,,10,79,007,20,13,53,194,39*68
$BDGSV,4,3,15,19,,,31,20,22,062,22,26,44,289,29*6F
$BDGSV,4,4,15,35,,,24,38,75,156,34,45,.84213,E,0.00,217.74,110424,,,A*76
$GNVTG,217.74,T00,11,04,2024,00,00*41
$GPTXT,01,01,01,ANTENNA OK*35
$GPTXT,01,01,01,ANTENNA OK*35
$GNGGA,071610.000,3031.81898,N,10402.842.000,A,A*49
$GNGLL,3031.81898,N,10402.19,20,22,24,194,195,199,1.2,0.7,1.0*0D
$BDGSA,A,3,03,08,10,13,20,26,29,38,45,,,,1.2,0.7,1.0*29
$GPGSV,4,1,14,03,17,041,33,06,68,309,26,09,00,062,29,19,60,013,28*7A
$GPGSV,4,2,14,12,08,202,32,22,62,161,43,24,12,277,22,194,42,140,
$GPGSV,4,4,14,195,55,061,25,0,03,53,167,36,04,,,29*54
$BDGSV,4,1,15,08,65,181,34,09,07,198,,10,79,007,20,13,53,194,39*68
$BDGSV,4,3,15,19,,,31,20,22,062,22,25,26,189,29*6E
$BDGSV,4,4,15,35,,,24,38,75,156N,10402.84216,E,0.00,217.74,110424,,,A*
$GNVTG,217.70.000,11,04,2024,00,00*49
$GPTXT,01,01,01,ANTENNA OK*35
$GPTXT,01,01,01,0,3031.81902,N,10402.84215,E,1,21,0.7,594.3,M,0.0,M,,
$GNGLL,3031.81902,N,10402.84215,E,0716194,195,199,1.2,0.7,1.0*0D
$G
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Fig. 8 Test of GPS receiving and analyzing data

The upper computer of the system monitors in real time, and the test is successful as shown in the figure below.

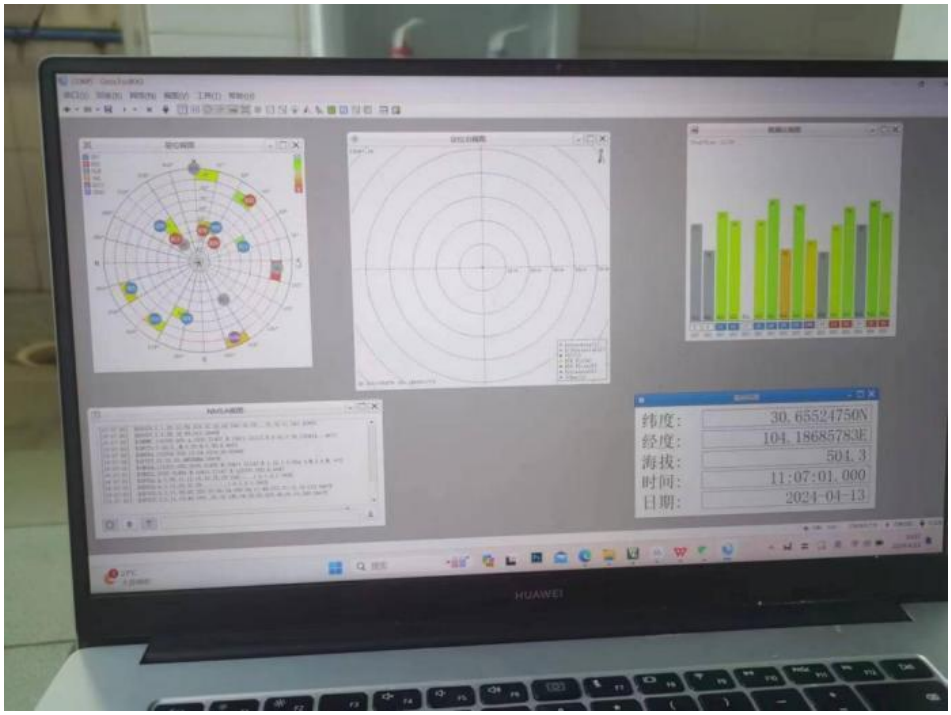

Fig. 9 Upper computer monitoring test

VI. CONCLUSION

In the context of continuous technological progress, intelligent systems have become a hot spot in research and industry. This paper aims to design a logistics transportation positioning system based on STM32. Through a series of hardware design and software writing, this system aims to provide users with accurate and efficient positioning services. The logistics transportation positioning system designed this time aims to improve the efficiency of logistics operations, reduce labor costs, and provide accurate location tracking function. The system is based on GPS technology to realize real-time positioning and monitoring of handling equipment, goods and personnel. The system design takes into account the complexity and diversity of the logistics handling environment, and pays attention to the stability, reliability and flexibility of the system.

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