

Intelligent Positioning Helmet for Granary

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Abstract: Mainly based on positioning system and wireless communication technology, according to the specific situation of the granary to design a reasonable intelligent safety helmet can be used for granary operation. According to the characteristics of grain depot, the intelligent safety helmet can obtain the indoor and outdoor position of personnel, and actively detect all kinds of security incidents, to provide immediate support for the operation personnel in danger. The positioning system is simple to install and deploy, i.e. to use with cloth, without weak current transformation, supporting multi-channel communication, even if there are a large number of on-site operators, their communication will remain stable.

Keywords: Positioning; Wireless communication; Granary operation; Intelligent safety helmet

1. Introduction

Intelligent safety helmet ^[1] is an informatization safety management solution that integrates head protection, eye and face protection and personnel positioning management system. Through the smart personal wearable personal protective equipment and integrated safety production information management and training management platform, the safety management of granary area operators ^[2], vehicle track management and security patrol personnel inspection management of all elements of digital management objective are realized.

The system can realize functions such as boundary management of hazardous areas, hierarchical authorized access management of safety areas, and video tracking and tracing management of personnel. At the same time, based on the analysis of the collected data and information, potential safety operation risks are eliminated, and training and safety designated operation functions can be arranged online.

2. Analysis of Smart Safety Helmet Design for Granary

The intelligent safety helmet of granary includes 4 modules, which are GPS positioning module ^[3], smart detection module, sound and light alarm and call for help module, and remote assistance module. As shown in Figure 1, the four modules together constitute the complete granary intelligent safety helmet, GPS positioning module, smart detection module and sound and light alarm and call for help module form the main

part of the front end of the granary intelligent safety helmet, while the remote assistance module is mainly the main part of the back end.



Figure 1. Design of intelligent safety helmet for granary

2.1 GPS Positioning Module

The GPS positioning module is essentially a GPS signal receiver, which can be connected to a computer or cell phone by either wireless Bluetooth or wired, so that the GPS signal received by the GPS positioning module can be transmitted to the GPS software in the computer or cell phone and processed. GPS positioning module, also called user section, receives and demodulates the propagating pseudo-random code signals from satellites with a frequency of 1,575.42 megahertz L1, which can be compared to a "radio". In addition, the GPS module does not broadcast signals and is a passive positioner.

The development of the serial communication protocol of the GPS positioning module ^[4] is the focus of its use, which is the relevant input and output protocol format of the module. The main content contains data types and information formats. The GPS positioning module calculates the pseudo-phase distance of each satellite and uses the phase rendezvous method to calculate the four parameters of longitude, latitude, and altitude and time correction of the receiver.

2.2 Smart Detection Module

For the smart detection module, it mainly refers to the harmful gas concentration detection alarm part, and the intelligent safety helmet can detect whether the concentration of the main harmful gases phosphine,

carbon monoxide, etc. existing in the granary is too high. If the concentration of the main harmful gases phosphine, carbon monoxide, etc. in the granary is too high, it will cause harm to human health, causing discomfort or even life-threatening. For this situation, if the personnel wearing the helmet is located in the granary where the harmful gas concentration is too high, the intelligent safety helmet can realize the corresponding gas concentration detection based on phosphine and carbon monoxide gas sensor, and connect with the analog / digital converter, so that the gas signal can be convert into digital signal which can be recognized by a microcontroller, so that the intelligent safety helmet can issue a warning in a timely manner to warn the personnel to leave for the safety area in time.

In addition, it can also detect the site temperature and humidity to ensure the normal working environment of the equipment. Temperature and humidity controller with a microcontroller as the control core, using high-performance temperature and humidity sensor, can simultaneously measure and control the temperature and humidity signal, and improve the accuracy. It can also realize LCD digital display by adding LCD display screen. The role of temperature and humidity controller is mainly for anti-interference factors, real-time detection of temperature and humidity, and when the temperature and humidity exceed the normal range, you can take timely measures to remedy. Temperature and humidity control through the temperature and humidity sensor detects the air temperature and humidity information in the granary, and passes to the controller for analysis and processing. When the temperature and humidity reach or exceed the pre-set value, the relay contact closure in the controller can sound and light alarm or display screen through the LCD.

2.3 Sound and Light Alarm and Call for Help Module

When the user presses the call for help button, or the smart detection module detects the existence of danger in the surrounding environment, the data relay device will output the corresponding signal, and at the same time identify the corresponding location information according to the signal at the output end of the data relay device. The rescue center equipment or rescuer end matches the corresponding rescue point according to the location information of the above emergency identification module. After related personnel at the rescue point get the instruction, they can act quickly and implement the rescue.

2.4 Remote Assistance Module

Remote assistance module mainly refers to the wireless visual intercom system [5]. The module, based on the traditional helmet as the main body, adds a wireless visual intercom subsystem. In addition, the backstage monitor is equipped with a supporting wireless visual intercom main system connected with a laptop, which can transmit the live video images around the helmet wearer to the backstage commander, while the two-way intercom. And the backstage main system and the helmet wearer

with a subsystem can achieve one-to-many cooperation. The remote assistance module can make the two sides more direct, faster and more accurate to convey information to each other, so as to facilitate experts and other commanders to guide the front-line personnel to make correct judgment and high precision operation through the returned video [6]. It can issue instructions timely and improve the efficiency of work, which is suitable for most of the construction operations of personnel wearing.

3. Modular Integration of Intelligent Safety Helmets

3.1 GPS Positioning Module

The GPS positioning module is a GPS positioning system based on the STM32 connected to the AliCloud IoT platform. The STM32 microcontroller is the core and is connected to the positive point atomic GPS module and the NB module. After the power is connected, the NB module is connected to the AliCloud IoT platform through the interface. The cell phone can receive the data forwarded by AliCloud IoT platform by downloading the specified APP or applet, so that it can display various data needed, such as temperature and humidity. The computer side through the AliCloud IOT platform can select the region where the device is located, by clicking the device to display temperature and humidity and other information, and can also generate the device's movement track through the correct choice of track time period and the device, etc.



Figure 2. Temperature and humidity sensor of DHT11

The module uses a DHT11 temperature and humidity sensor, as shown in Figure 2, which applies digital module acquisition technology and temperature and humidity sensing technology. The sensor includes a resistive humidity sensing element and an ntc temperature measuring element, which can measure temperature and humidity very quickly and effectively. First call the temperature and humidity sensor library file, and define the sensor pin bits, communicate with the computer through serial port, and finally read the temperature and humidity values and units and update the data in real time.

3.2 Hazardous Gas Sensors

The hazardous gas sensor module uses the MQ7 carbon monoxide gas sensor to collect carbon monoxide concentration information. The MQ7 carbon monoxide sensor is connected to the ADC0832, allowing the carbon monoxide voltage signal collected by the MQ7 to be converted to carbon monoxide concentration. The module is connected to an external buzzer for alarm.

3.3 Visual Intercom System

The visual intercom module has three keys: intercom key, shooting key and video return key. Intercom key corresponds to the voice callable function, and can achieve one-to-one and one-to-many voice calls. The shooting key corresponds to the video shooting function, the device side can shoot the live environments and store them, and the video definition can reach 720P. The video return key can be used to transmit the video shot by the device side to the control side.

3.4 SOS Call for Help Module

The SOS call for help module contains a call for help button and a buzzer, as shown in Figure 3. The call for help button is directly connected to the buzzer, and the data relay device outputs the corresponding signal, while the corresponding location information is identified according to the signal at the output side of the data relay device.



Figure 3. Schematic diagram of SOS call for help module

3.5 WiFi Module

Using ESP8266WiFi module is able to carry software application to ensure that it can connect to wireless network or hotspot. ESP8266 supports three working modes of STA/AP/STA+AP. With SDTO type WiFi module, the transmission speed is fast and can be used to transmit images and videos.

4. System Application Function Design

The system includes 5 modules, each of which has a corresponding function. Only when the 5 modules cooperate with each other can the safety of granary operators be guaranteed and the safety management of operators in granary areas is realized.

4.1 GPS Positioning Module

GPS BeiDou positioning can locate in real time and determine the specific position of personnel. In addition, track tracking can be realized to record the action track of relevant personnel.

4.2 Smart Detection Module

Smart detection module can detect toxic gases, such as carbon monoxide, phosphine, etc., to protect the lives of personnel; Temperature and humidity environment detection, detection of on-site temperature and humidity, and assessment of the environment in the granary can also be achieved to protect the normal working environment of the equipment.

4.3 Sound and Light Alarm and Call for Help Module

Sound and light alarm and call for help module has two functions: SOS call for help. In case of emergency, the personnel can promptly press the key to call for help and alarm; Sound and light alarm. After the detection of the operating site environment, give early warning of danger.

4.4 Remote Assistance Module

The functions of the remote assistance module include: one-click camera, recording the real-time situation on site and leaving traces of key nodes; Video return, or real-time video return on site, helps leaders grasp the scene in a timely manner; Image sharing has a key call for help function, so that accidents can be rescued in a timely manner; Voice intercom realizes on-site operations personnel and backstage monitoring personnel voice dialogue, so as to carry out remote interaction, to facilitate the deployment of command personnel to deal with emergencies in a timely manner; Remote guidance fine operation lets experts through the return of the video, to guide the front-line personnel for high-precision operation; Visual command includes real-time voice and video to help leaders control the overall situation and have a comprehensive grasp of the operational process;

5. Conclusion

This paper designs a kind of intelligent safety helmet for granary with GPS positioning system as the main function. The helmet includes five parts, GPS positioning module, smart detection module, sound and light alarm and call for help module, remote assistance module and wearing abnormality detection module. These modules are introduced from theory and practice, and functional analysis of each module is carried out. This granary intelligent safety helmet effectively alleviates the potential safety problems when the relevant personnel in the granary carry out operations, and provides a more convenient way for the operators to operate in a more standardized manner.

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