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Data analysis equipment for post-disaster relief and reconstruction based on shock-absorbing devices

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Abstract

Natural disasters occurring around the world are commonplace, and we must not only do our best to ensure the smooth conduct of search and rescue efforts but also minimize casualties and property damage. The use of big data artificial intelligence technology to form a fast, efficient, and safe search and rescue mode has become the key to search and rescue work. This paper uses intelligent and precise analysis to combine an efficient rescue and post-disaster reconstruction technology model, and is dedicated to the concept of minimizing losses and optimizing effects with the help of artificial intelligence technology to create a post-disaster rescue and reconstruction data analysis equipment based on a shock-absorbing device. To the greatest extent possible, various data analyses to find out the general location of survivors, while through the combination of shock-absorbing devices and rescue robots to solve the problem of unstable shaking due to terrain, with search and rescue personnel together with the search and rescue work.

Keywords

Natural disasters; shock-absorbing devices; post-disaster relief; face recognition.

1. Introduction

The current production safety situation in China is still extremely serious. According to incomplete statistics, more than 500,000 deaths due to production safety accidents have occurred in the country in more than 10 years since 2008, and among various types of production safety accidents, coal mine safety accidents are the most severe [1]. Economic development cannot be at the expense of safety, therefore, the country is paying more and more attention to production safety and rescue work after production accidents, and an action plan to develop special robots for production operations and accident rescue instead of humans has been started [2].

The project selected computer science and technology, mechanical design, and manufacturing professional classes as the research object, through the current development of artificial intelligence as well as big data, combined with the Java language-based face recognition system, for the victims of face recognition, data analysis and other related technologies, simulation of the environment to collect data processing data analysis, upload the collected data to the MySQL database, the use of high-definition camera scanning will Impact through the server, upload to the background for data storage. Probabilistic statistical learning based on deep learning, machine learning, and neural networks, applied to target detection, image annotation, and image recognition. Data crawling and data analysis using python. Through big data calculation, probability analysis, and a series of comparisons, combined with data from the geographical location of the accident site, infrared scanning using OpenCV, as well as temperature change and terrain detection using binocular vision and LIDAR technology. As a special disaster relief equipment, it can replace the rescuers going deep into the mine after the

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disaster for environmental condition detection the first time, which is of great significance to improve the rescue efficiency and ensure the safety of rescuers.

2. Product hardware

The device is powered by the crawler, and the vibration generated to the main body of the device during operation is effectively attenuated by the suspension system to improve the stable operation of the main components and the accuracy of operation. The tracks are made of nylon material to improve the friction force on the ground, enhance the grip on the climbing slope, reduce the influence of the small terrain on the tracks and improve the stability of the main structure. The tracked chassis is an important part of vibration damping which contributes to the stability of the device. The load-bearing wheel damping structure is one of the important components of the track chassis. Figure 1 below shows the main components of this structure. The chassis is equipped with four pairs of load-bearing wheels on the left and right sides of the chassis, and these eight load-bearing wheels are the main load-bearing mechanism of the tracked robot system and its walking mechanism. These wheels are made of wear-resistant and lightweight nylon material, 10cm in diameter and 2cm thick, with a small precision steel tube of 10mm inner diameter, 13mm outer diameter, and 2cm long embedded in the center of the circle to reduce the friction between the wheels and the connecting axle and to slow down the wear of the wheels to improve their service life. The damping design of the structure uses the lever principle to reduce the vibration of the main body, and the use of damping springs and damping brackets can effectively alleviate the vibration generated during the work of the robot system and achieve the role of cushioning [3]. The design schematic of vibration damping using the lever principle is shown in Figure 2 below. As shown in Figure 2, M is the side view of the main beam of the chassis, which is used to represent the overall weight of the robot system, and points A and B are the parts of the stainless steel threaded rod extending out of the longitudinal beam at the birth of the cross beam, and the average length of the threaded rod extending out is 15 cm, which is used to connect the chassis load-bearing damping bracket with the damping spring and is fixed by the nut. represents the axle rod connected with the tension spring to the damping bracket. As shown in (b) and (c) in Fig. 1, the details of the chassis load-bearing and shock-absorbing structure are shown.

(a)Load-bearing wheels (b)Vibration-damping tension springs (c) Chassis shock absorbing bracket

Fig 1 Parts diagram of the shock absorption system

As shown in the design principle in Figure 2, M is the side view of the main chassis beam, which is used to represent the overall weight of the robot system. points A and B are the parts of the stainless steel threaded rod extending out of the longitudinal beam born from the cross beam, and the threaded rod extends out to an average length of 15 cm, which is used to connect the chassis load-bearing damping bracket to the damping spring and is fixed by a nut. point D is the axle rod representing the connection between the two load-bearing wheels. point T represents the damping tension spring, and point C represents the axle rod connected with the tension

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spring to the damping bracket. As shown in (b) and (c) in Figure 2, the details of the chassis load-bearing damping structure are shown.

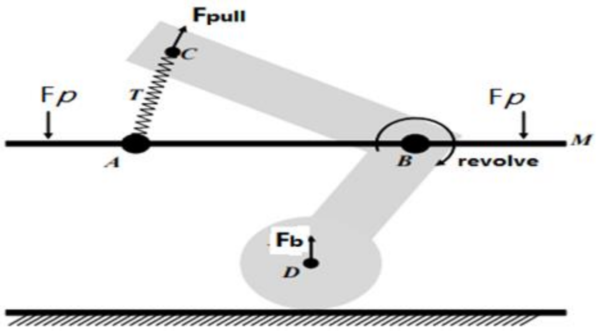


Fig. 2 Principle diagram of vibration damping system

When the overall weight of the system exerts a downward pressure F on the ground through the load bearing wheel, the ground will support the system through the track and the load bearing wheel, so under the action of F support, the whole shock absorbing bracket will rotate around the point B and generate a force F pull on the tension spring T through the point C. The reaction elasticity of the tension spring T is balanced with the F pull. The system is thus brought into balance by the interaction of the components. The vibration of the main device on the chassis is reduced.

The equipment module diagram is shown in Figure 3.

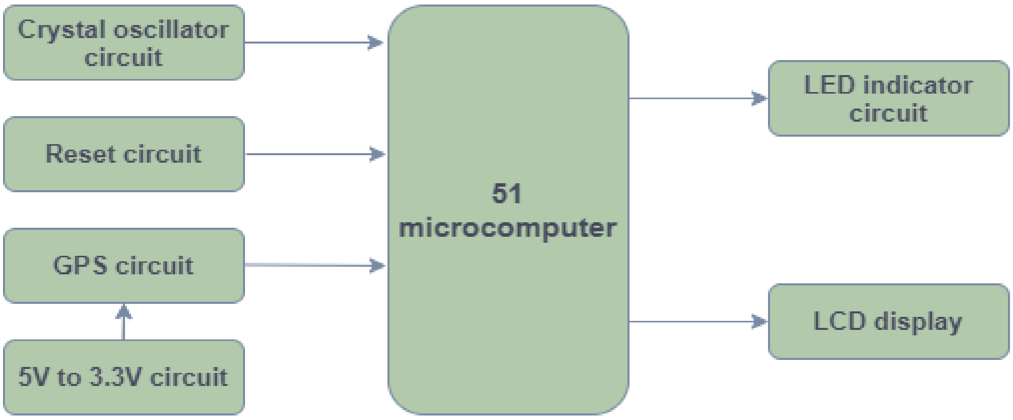
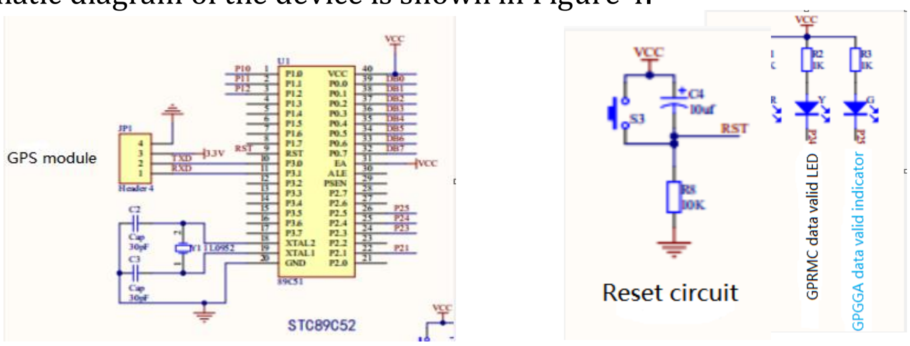


Fig 3 Device module diagram

Choice of microcontroller 51 microcontrollers (STC89C51/52 etc.). GPS positioning module (with antenna). Basic information such as current date, speed, altitude, time, etc. is displayed using LCD LCD [4,5]. Optional 3 LED indicators. Red light: GPS received data indicator, Yellow light: GPRNC data valid indicator, Green light: GPGGA data valid indicator.

The schematic diagram of the device is shown in Figure 4.



(a) GPS module (b) Reset circuit

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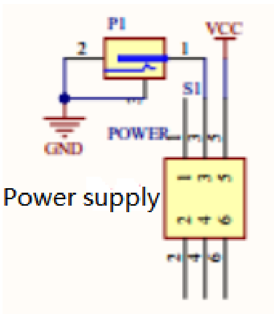
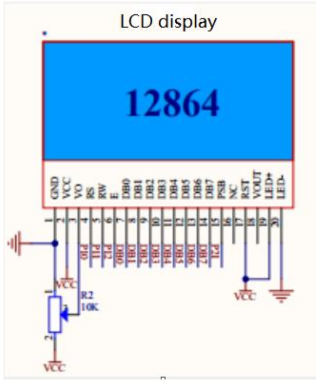
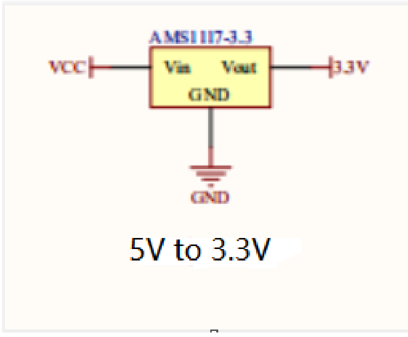


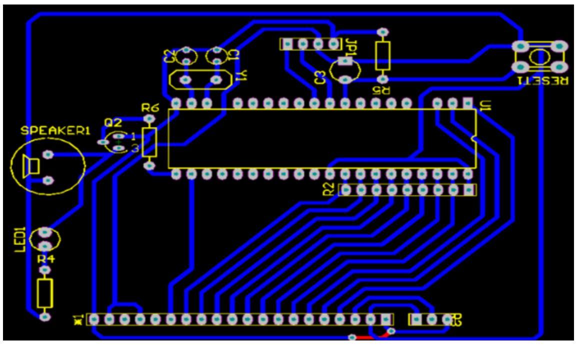
(c) USB power supply



(d) LCD display



(e)5V to 3.3V



(f) Design of PCB diagram

Fig 4 Equipment schematic

3. Face Recognition Development

3.1. Face Recognition Technology

Face recognition technology is a biometric recognition technology that distinguishes individual organisms (generally and specifically people) by their biological characteristics [6].

Face detection refers to determining the presence or absence of a face image in a dynamic scene with a complex background and separating such a face image. There are five general methods: reference template method, face rule method, sample learning method, skin color model method, and feature surface method

Face tracking refers to the dynamic target tracking of detected faces. Specifically, a model-based method or a combined motion-based and model-based method are used. In addition, the use of skin color model tracking is not a simple and effective means.

Face matching is the identification of the detected faces or target search in the facial imaging library. This means that the sampled facial imaging is compared with the inventory facial imaging in turn and the best match is found. Therefore, the description of facial imaging determines the specific method and performance of facial image recognition. Two main description methods, feature vector and face pattern template, are used.

The recognition process first establishes the face image profile of the face. That is, the face image file of the face of the unit personnel is collected by the camera or their photos are taken to form the face image file, and the faceprint code is generated and stored in these face image files. Then obtain the current face image of the person. That is, the face image of the current person captured by the camera or taken from a photo is input and the current face image file is used to generate the faceprint code. Matching the current face code with the file inventory. This means that the face code of the current portrait is compared with the face code in the file inventory. The above "facial coding" method works according to the essential features of the face and the beginning of the face. This facial coding is resistant to changes in light, skin tone, facial hair, hairstyle, glasses, expressions, and postures, and has strong reliability that makes it possible to accurately identify a person from among millions of people. The face recognition process can be done automatically, continuously, and in real-time using common image processing equipment.

3.2. Device Function Module

Face capture and tracking: Face capture is the process of detecting a portrait in one frame of an image or video stream and separating the portrait from the background and saving it automatically. Face tracking refers to the use of portrait capture technology to automatically track a specified portrait as it moves within the range captured by the camera.

Face recognition comparison: Face recognition is divided into two types of comparison modes: verification type and search type. The verification mode means that the captured or specified portrait is compared with a registered pair in the database to determine whether it is the same person. The search type of matching is to search for the existence of the specified person from all the registered images in the database.

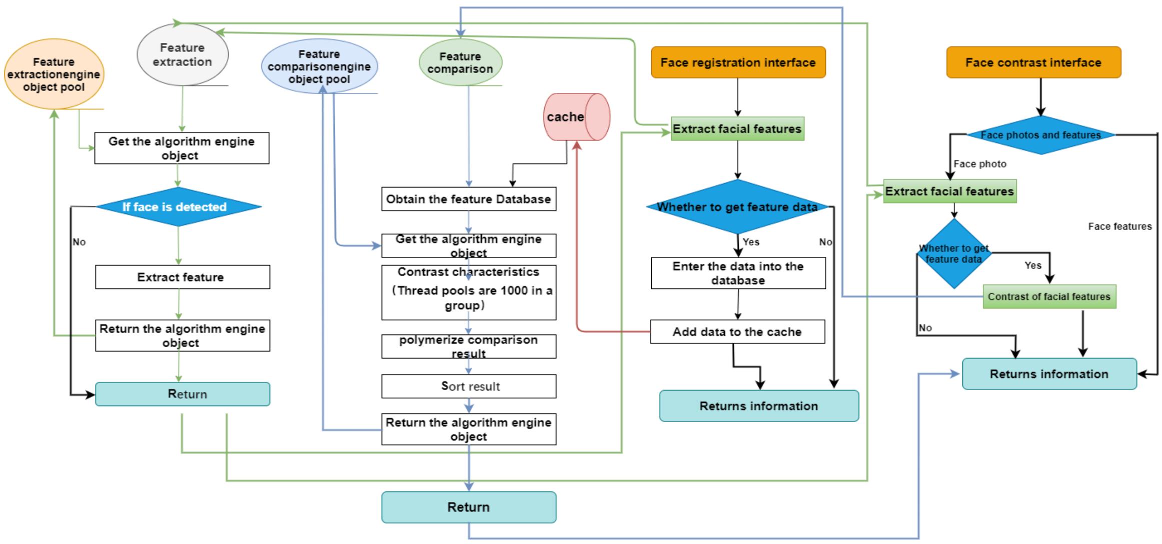


Fig 5 The general flow of face recognition function

Face modeling and retrieval: The registered portrait data can be modeled to extract the features of faces and generate face templates (face feature files) to be saved in the database. When performing a face search (search type), the specified portrait will be modeled and then compared with the template of all the people in the database for identification, and finally, the list of the most similar people will be listed according to the compared similarity value.

Real person identification function: the system can identify whether the person in front of the camera is a real person or a photo. This prevents the user from faking the photo. This technology requires the user to make facial expressions to match the action.

Image quality detection: The quality of the image directly affects the recognition effect. The image quality detection function can evaluate the image quality of the photos to be compared and give the corresponding suggested values to assist the recognition.

The general flow of the face recognition function is shown in Figure 5.

4. Gas content detection

The design is based on a microcontroller as the core, and the gas sensor TGS813 is used to detect the concentration of the gas, which is read into the microcontroller and A/D converted through the signal conditioning circuit. When the gas concentration exceeds a predetermined value, the system issues an audible and visual alarm and activates the exhaust fan. The system comes with an LED display and keyboard input, and the added RS-232 serial communication allows remote control.

The system takes the microcontroller STC12C5A60S2 as the core and works with other peripheral circuits to complete the functions of signal acquisition, concentration display, and keypad input. First, the tiny voltage signal from the gas sensor is amplified by the signal conditioning unit and then converted into a larger voltage signal and sent to the STC12C5A60S2 MCU; then, the MCU performs A/D conversion and concentration comparison; finally, the gas concentration is sent to the LED display unit and determines whether the gas concentration exceeds the alarm limit.

When the gas concentration is in the normal state, the green light is lit; when the gas concentration exceeds the set limit, the sound and light alarm unit immediately issues an audible alarm and completes the detection and alarm of the gas along with the red light flashing, and at the same time starts the ventilation equipment to strengthen the ventilation in time so that the gas concentration is greatly reduced and the danger to the affected people is minimized. The block diagram of the alarm system and the gas detection circuit diagram is shown in Figures 5 and 6.

After the sensor is detected, the program starts to initialize, this part mainly realizes the I/O port input and output state setting, register initialization, interrupt enable, and other functions. The gas sensor will encounter the phenomenon of sharp pulse interference when sampling the gas concentration, so it is necessary to filter the data digitally by first comparing the M sampling data, removing the maximum and minimum values, then calculating the arithmetic mean of the remaining M-2 data, and finally sending the arithmetic mean to the register [7].

The alarm program is designed with a query-type key structure, and the keys are scanned at regular intervals to achieve dynamic monitoring of the keys. The audible and visual alarm is activated when the gas concentration exceeds the set value to prompt the operator to take safety measures or automatically control the relevant safety devices. To prevent false alarms, the program is designed to perform rapid and repeated gas concentration detection and delayed alarms to determine whether a gas leak in the pipeline or a temporary gas trace dissipation due to an open valve is occurring.

The system uses a high-performance, integrated STC12C5A60S2 microcontroller as the core device to design a combustible gas alarm instrument suitable for industrial and certain occasions. The design makes full use of its high-speed data processing capability and rich on-chip peripherals to realize the miniaturization and intelligence of the instrument. In the design of the software, the median-averaged digital filtering algorithm is used to filter the digital signal after A/D conversion to maximize the elimination of field interference, reduce the probability of false alarm of the combustible gas alarm, and improve the accuracy of the instrument.

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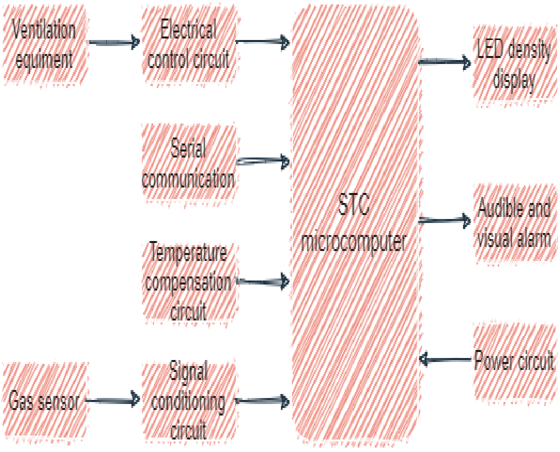

Fig 5 Block diagram of the alarm system

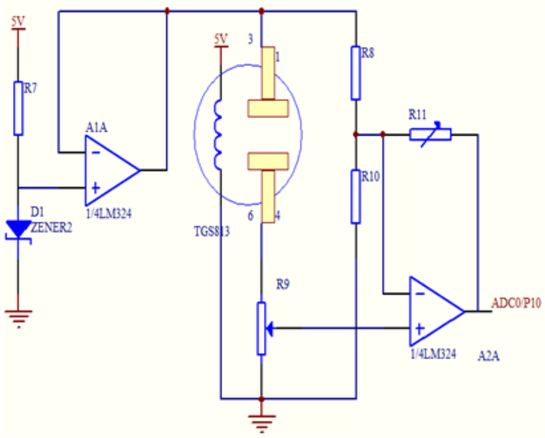

Fig 6 Gas detection circuit

5. Temperature detection analysis

This paper proposes an infrared video temperature measurement analysis method based on MFC and debugging OpenCV library programming to complete the method to achieve dynamic point, line, surface analysis, and automatic capture of high-temperature points and a variety of functions, creative line, and surface analysis added the highest and lowest temperature analysis method and the highest and lowest temperature capture function in real-time. The experimental results show that the dynamic analysis of the method is obvious, the software runs stably and the temperature measurement accuracy is high.

In the PC implementation, we used MFC object-oriented programming as the basis, combined with the OpenCV cross-platform computer vision stop library, to realize the infrared video playback, including point, line, and surface analysis, slider variables for tracking the highest temperature point, and the display of analysis results [8]. The IR video analysis block diagram is shown in Figure 7.

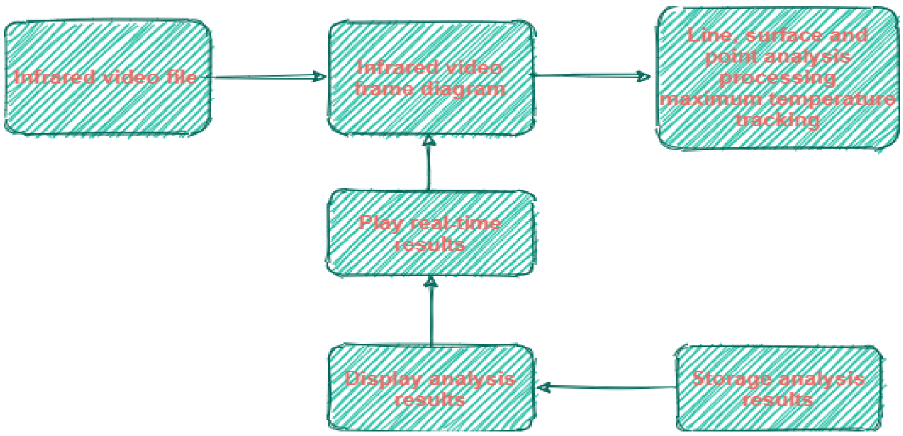

Fig 7 Infrared video analysis block diagram

The implementation of IR video analysis mainly includes two aspects: IR video analysis interactive platform and IR video processing platform. The IR video analysis interactive platform is implemented on a dialog box resource in a single document with a hover window as the parent window. In video processing, a single frame image is first extracted, then the extracted image is processed, and finally, the processed image is displayed.

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In the visualization interface, different events are usually responded to with different mouse behaviors. The analysis processing is done by mouse clicking, dragging, and button clicking to trigger operations on the defined platform class objects. The implementation diagram of infrared video temperature measurement analysis is shown in Figure 8.

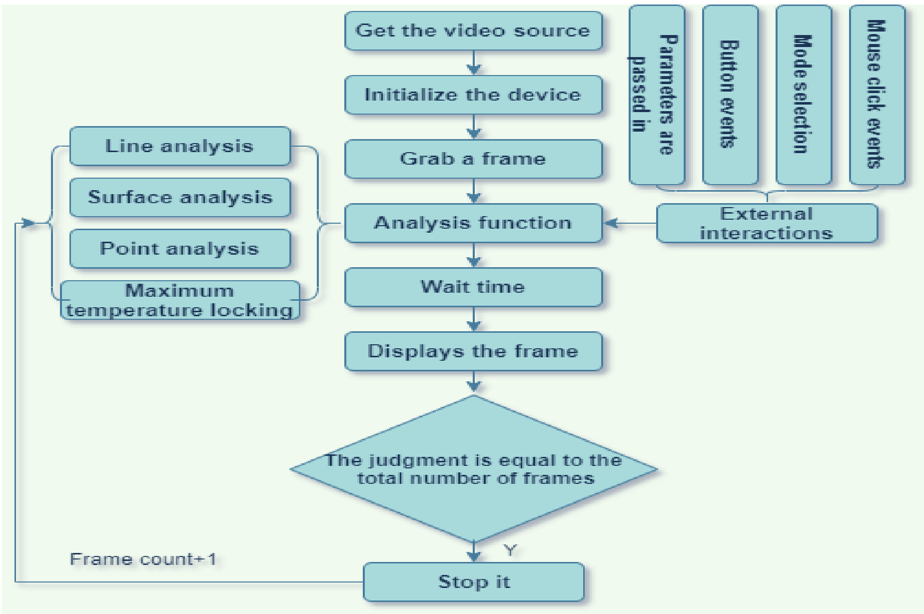

Fig 8 Infrared video temperature measurement analysis

Infrared radiation temperature measurement is done by measuring the infrared radiation on the surface of the object to be measured and then after a series of signal transformations, finally, determining the temperature value of the surface of the object. In the actual infrared radiation temperature measurement, because the measured object's radiation energy intake needs to pass through the atmosphere to reach the infrared detector, it will be affected by various aspects in the process of propagation. Therefore, the radiant energy received by the infrared detector is not only the object's radiant energy but also includes the radiant energy of the surrounding objects and the atmosphere.

OpenCV is a powerful image processing library that provides great convenience for the development of infrared video-based temperature measurement software and algorithm research. The functional implementation includes point, line, and surface temperature analysis as well as the capture of the highest temperature point, which achieves high-temperature measurement accuracy. In addition, we have creatively added the highest and lowest temperature analysis and the real-time capture of the highest and lowest temperature, which provides great help for the dynamic observation and analysis of the target.

6. Terrain exploration and detection

In this paper, the approach of SLAM based on Rao-Blackwellized particle filter PBPF proposed by foreign scholars [9] is used, and this algorithm can better approximate the joint probability density of mobile robot poses and environmental maps.

The SLAM with a fusion of LiDAR and binocular vision is also reviewed and studied to form meaningful environmental landmarks by uniting certain relevant features in the environment where the mobile robot is located, fusing all observations of the mobile robot with odometer information in the calculation of the proposed distribution, and focusing on the study of mobile robot map construction based on the fusion of LiDAR and binocular vision information.

The SLAM problem refers to the determination of the robot's pose and the construction of a map relying only on the observation information Zt and the control information Ut, i.e., moving incrementally in an unknown environment to construct an environmental map, and using the constructed environmental map to estimate its pose. The problem is schematically illustrated in Figure 9.

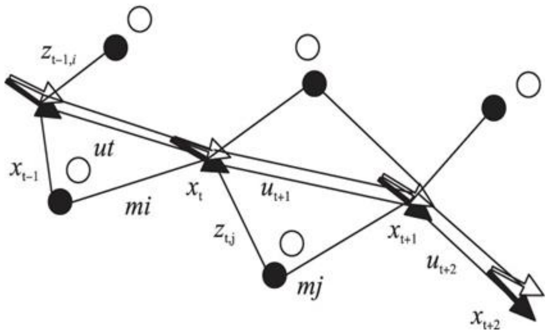

Fig 9 Diagram of the problem

Considering that the mobile robot in the process of movement is likely to slip and other problems lead to inconsistency between the odometer data and the actual movement distance, 2D LiDAR can only obtain information on a certain plane at a certain height; vision is susceptible to environmental background changes and other bars. Therefore, binocular vision and LIDAR combined with odometer data information fusion are used to achieve the navigation of mobile robots.

The combined navigation method of binocular vision and LIDAR information fusion is used to establish a wayfinding database containing the basic coordinate system and obtain a feature map of the global environment and then achieve navigation. It is verified that the redundant information provided by multi-sensor fusion can build a more reliable and accurate 2D raster environment map, which can effectively improve the robustness of SLAM for mobile robots.

7. Conclusion

This paper combines the current development of artificial intelligence as well as big data, using high-definition cameras for scanning, a face recognition system based on Java language to identify trapped people and collect environmental data for analysis and upload the collected data to MySQL database for storage. Probabilistic statistical learning based on deep learning, machine learning, and neural networks, applied to target detection, image annotation, and image recognition. Data crawling and data analysis using Python. Through a series of comparisons such as big data calculation, probabilistic analysis, combined with data from the geographic location of the accident site, infrared scanning using OpenCV, as well as temperature change and terrain detection using binocular vision and LIDAR technology. Through a variety of data, analyses to find out the general location of survivors, the addition of shock-absorbing devices makes the data analysis equipment like a tiger, with search and rescue personnel together with the search and rescue work. Intelligent analysis equipment uses big data artificial intelligence technology to maximize the traditional search and rescue mode of system optimization, improve the traditional search and rescue infrastructure, improve rescue efficiency, dedicated to minimizing losses and optimizing the effect with artificial intelligence technology, saving rescue costs and manpower consumption, providing an important reference for rescue work, and minimizing the risk of emergency rescue work.

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