Design of ice snow accident detection system based on Embedded System

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Abstract. Frequent accidents in ski resorts affect the development of skiing industry. In order to solve the problems faced by skiing industry, an ice snow accident detection system based on embedded system is designed. The system combines embedded system with image processing technology, and has high development value. This paper first introduces the hardware composition, function and hardware selection of the system, and then introduces the design of software. The software program is mainly realized by target detection, target tracking and collision detection algorithms. The design of the system provides ideas for the research of ice and snow accident detection, and has very important practical value.

1. Introduction
With the arrival of the 2022 Winter Olympic Games, the skiing industry is becoming more and more popular. As a new developing industry, the ice and snow industry has a wide range of development and plays an important role in accelerating the development of sports in China. At the same time, more and more people are involved. But skiing is a high-risk sport, especially for beginners without experience and skills. In recent years, skiing accidents occur frequently, which seriously harm the health of skiers and cause huge economic losses to ski resorts. According to statistics, there are many reasons for skiing accidents, among which skiers have the most injuries due to collisions. At present, there are many collision detection methods and equipment on the market, most of them are vehicle collision detection, and there is almost no ice snow collision accident detection.

In view of the current problems faced by the ski industry, the ski resort needs an intelligent monitoring system to accurately monitor the situation of the ski resort, so that the staff can grasp the situation of the ski resort in real time, so as to respond to emergencies in time.

2. Overall system design
Ice and snow accident detection system mainly includes the following modules: power module, video acquisition module, data transmission module, central control module, accident detection module, cloud service platform and alarm module. The overall structure of the system is shown in Figure 1.
The specific implementation steps of the system are as follows:

After system initialization, the video acquisition module transmits the collected image information to the central controller through the data transmission module;

- The central controller forwards the data to the accident detection module and controls the system detection module to work;
- In the system detection module, firstly, the target detection method based on Gaussian mixture model is used to detect skiers; secondly, the improved Kalman filter tracking algorithm is used to track the target; finally, the collision detection algorithm based on bounding box is used for collision detection;
- When all videos from two perspectives are judged as suspected collision accident, the accident detection module sends the detection results to the central controller, which forwards the data to the cloud service platform;
- The cloud service platform calculates the collision results to determine whether there are ice and snow accidents;
- If there is an accident, the cloud service platform will feed back the results to the system and display the accident location and other information;
- System alarm;

3. System hardware design

3.1. power supply module
The power module supplies power for the system, which is the basis of the normal operation of the whole system. Because the power module works in the low temperature environment of ice and snow, the selection of power supply is very important. The power supply uses rechargeable lithium battery to charge the single chip microcomputer chip, which can maintain 80% of the power in low temperature environment.

3.2. video capture module
A number of omni-directional monitoring cameras are set up on the skiing track to detect the condition of the ski track in real time through the monitoring video, and obtain the image information in the area to be detected, which provides the basis for the follow-up work. The video acquisition module uses
multiple HD webcams to monitor the condition of the ski resort in real time, and sends the image information of the ski resort to the central controller through the data transmission module.

3.3. data transmission module
The system uses two data transmission modules, one of which is used to transmit the image information collected by the video capture module to the central control module, and the other is used for data transmission between the central controller and the cloud service platform. The data transmission module includes two parts: data sending module and data receiving module. The data transmission module adopts WiFi data communication mode, which can realize the data sharing and timely communication between devices with short distance and low rate. The wireless transmission terminal connects the alarm information with the cloud platform of intelligent and safe power consumption hidden danger monitoring in real time through the Internet of things, which has the characteristics of high precision, high reliability, fast response and various communication modes.

3.4. central control module
The central control module is the core of the system and the brain of the whole system. It connects the various modules of the system together. Its main functions are: to receive the video image information transmitted by the video acquisition module; to control the normal operation of the alarm module and accident detection module; to forward the two-way data. The embedded A8 ARM microprocessor is used in the central control module. The arm structure is superior in power consumption, price and performance, and can achieve high cost performance.

3.5 cloud service platform
The central control module and cloud service platform are connected through 5G network for real-time two-way data transmission, so that the management personnel of the ski resort can grasp the location information of skiers in the ski resort in real time, and provide simple interpersonal interaction page. When an accident occurs, it can alarm and send the location information of the accident, which is convenient for rescue.
3.6. alarm module
When the accident occurs, the alarm module starts to realize the sound and light alarm. The connection diagram of the system is shown in Figure 2.

4. Software design
The accident detection module in the system is mainly realized by software. The software includes image preprocessing, target detection, target tracking and collision detection. Software implementation process: firstly, the target detection model based on Gaussian mixture model is established, the foreground and target area are extracted, and the target area is refined by the fusion of multiple features (color, texture, edge and other features), so as to extract the accurate target, and obtain the position and size of the target in the image, and then Kalman filter combined with average drift tracking is used. The algorithm can track the target, obtain the trajectory and state of the moving target, and finally realize the ice snow accident detection through the directed bounding box collision detection algorithm. The software workflow is shown in Figure 3.

4.1. target detection method
In order to achieve better detection results, it is necessary to preprocess the image data collected by the video capture terminal. Histogram equalization image enhancement method can be selected to increase the image contrast of skiers and snow fields, and improve the image quality information. Gaussian mixture model [2] is used to model the preprocessed image, and then morphological operation method [3] is used to process the motion saliency map obtained by statistical histogram to extract the rough information of the foreground target area. Through HS I color features, LBP texture features and edge features, the shadow part of the foreground target area is optimized to obtain the accurate foreground target.

4.2. target tracking method
In the target tracking part, an improved tracking algorithm combining Kalman filter and mean shift is adopted [4]. Firstly, the parameters of Kalman filter are initialized and the target position is predicted. Then, the iterative process of mean shift is started as the starting point until convergence, and the real target position is obtained, so as to update the Kalman filter. This is repeated until the position of the target in the next frame is found, and the parameters such as target velocity, acceleration and motion trajectory are obtained.

4.3. Collision detection
Collision detection uses a collision detection algorithm based on a directed bounding box [5]. Two surveillance cameras are set in the area to be detected to perform accident detection separately. If the same target in the two perspectives has a directed bounding box collision, can be preliminarily determined as a suspected collision accident; Then through the detection of the degree of collision to finally determine whether it is an accident that requires rescue. According to the relationship between momentum [6] and the degree of collision, the degree of collision is divided into three levels in advance: light collision, moderate collision and severe collision. When a minor collision is detected, the system does not deal with it. When a moderate or severe collision is detected, the system alarms. Rescuers can take different rescue measures according to the degree of collision. And when multiple accidents occur at the same time, the order of rescue is distinguished according to the degree of collision.

The specific implementation process: When the system detects a suspected collision accident, upload the speed, acceleration and other data obtained in the target tracking to the cloud service platform. The cloud service platform calculates the target momentum and matches it according to the pre-divided collision level to determine the degree of collision of the target. If a minor collision occurs, the system does not handle it. If a moderate or severe collision occurs, it means an ice and snow accident has occurred. The cloud service platform feeds back the results to the system, the system
activates the alarm module, the cloud service platform displays the location information of the accident, and rescues according to the prompts.

Figure 3 Software workflow
According to the target tracking, the velocity and acceleration parameters of the target are obtained, and the data are uploaded to the cloud service platform.

The cloud service platform calculates the target momentum and matches the momentum with the collision level.

When a slight collision is detected, the system does not deal with it; When moderate collision and serious collision are detected, the cloud service platform will feed back the processing results to the system, and display the location information of the accident, and the system will start to alarm;

Figure.4 Incident detection process

5.Conclusion
This paper designs an ice and snow accident detection system, introduces the composition of the system and the functions of each part in detail, expounds the design ideas of hardware and software, combines the embedded system with the computer vision field, and promotes the intelligent monitoring video. It avoids the disadvantages of slow manual detection and inaccurate detection, and also provides a new method for the research of ice and snow accident detection, which has very broad practical value.

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