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Snowboard Wear Safety Monitoring and Data Analysis System based on Network Technology

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Abstract

This study develops a network-based system for snowboarding safety, leveraging sensor technologies, network communication, and data analysis for real-time monitoring and risk identification. It dynamically tracks snowboarders' position, speed, and acceleration, analyzing data to detect risks like falls or off-course movements, and instantly alerts users or rescue teams. Key innovations include comprehensive monitoring via sensors, real-time data processing for quick risk detection, and a user-friendly interface for efficient warning communication. Experimental evidence supports the system's effectiveness in enhancing safety and response times, highlighting its potential to improve extreme sports safety.

Keywords

Network Technology; Snowboard Wear; Security Monitoring; Data Analysis; Intelligent Warning System.

1. Introduction

In response to the growing popularity of snowboarding amid global warming and the surge in winter tourism, the need for advanced safety measures has become increasingly critical. The rise in participation rates has unfortunately led to a higher frequency of safety incidents, underscoring the limitations of traditional protective gear like helmets and knee pads in offering sufficient protection during high-speed impacts. This situation calls for an urgent upgrade in real-time safety monitoring and emergency response capabilities. Leveraging the advancements in network technology, this study proposes the development of a network-based snowboarding suit safety monitoring and data analysis system. This innovative approach aims to significantly enhance skier safety by integrating cutting-edge sensor technology, network communication, and data analysis algorithms to facilitate real-time monitoring, risk analysis, and the provision of timely warnings and automated emergency responses. The research encompasses a thorough investigation of current skiing safety technologies, the design and development of the system architecture, the formulation of safety strategies and algorithms, extensive experimental validation, and case studies to assess the system's practicality and efficacy in mitigating skiing accidents. This holistic system not only addresses the gaps in existing skiing safety equipment but also sets a new standard for integrating technology into sports safety protocols, potentially revolutionizing the way skiing safety is approached.

2. Theoretical Basis and Technical Background

2.1 Network Technology Foundation

With the rapid development of information technology, network technology has become an indispensable part of modern society, especially in the field of security monitoring. Network technology mainly relies on the Internet, including but not limited to technologies such as the Internet

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of Things (IoT), Cloud Service, and Big data. These technologies provide powerful data transmission, storage, and processing capabilities for security monitoring systems[1][2].

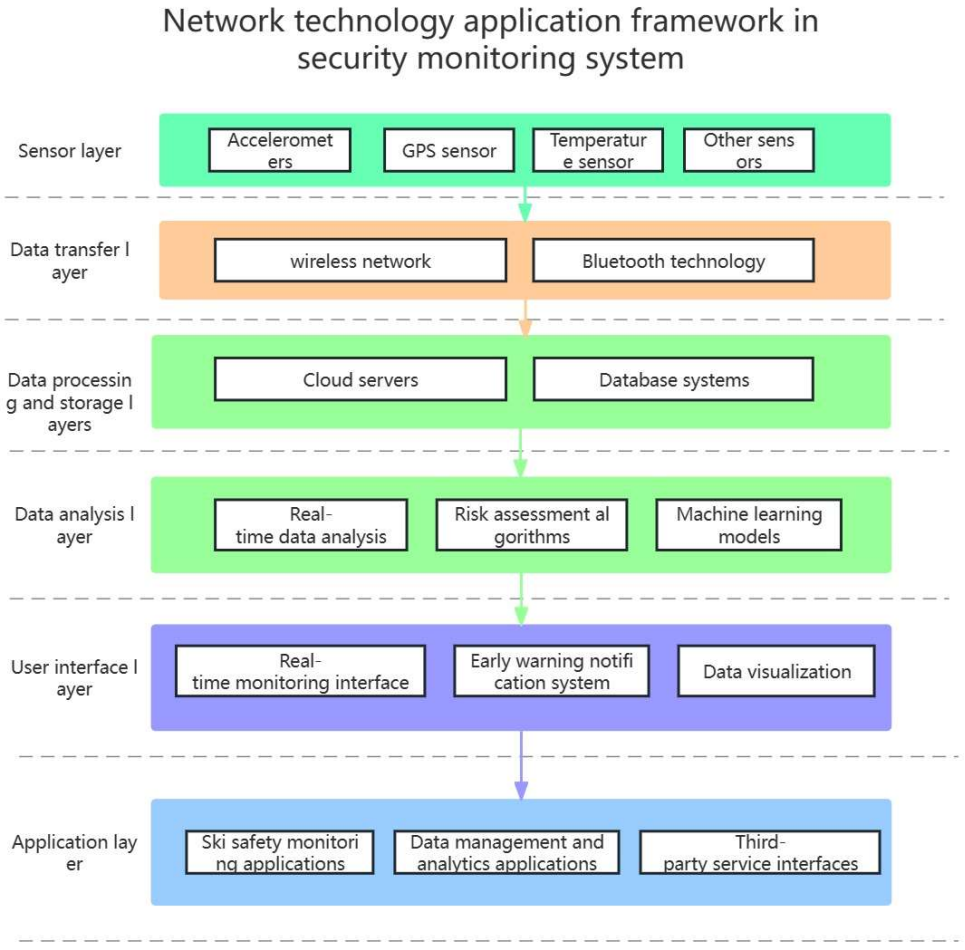

Figure 1. Network technology framework in security monitoring.

In the field of safety monitoring, the application of network technology is mainly manifested in real-time data collection, remote transmission, cloud processing, and feedback execution. Specifically for the ski clothing safety monitoring system, network technology can realize real-time data circulation from the sensors worn by skiers to the monitoring center, thereby realizing real-time monitoring and early warning of skiers' safety status[3].

2.2 Design and Functional Requirements for Snowboarding Suits

As an important part of winter sports equipment, snowboarding suits not only need to meet basic functions such as warmth, waterproofing, and breathability, but also should have certain safety protection functions. With the advancement of technology, the design concept of snowboarding suits is constantly being updated, and more and more safety technologies are being applied to the design of skiing suits, such as built-in protective pads and intelligent sensing devices[4].

In terms of safety requirements, snowboarding suits need to provide additional protection for common injured areas in skiing (such as knees, spine, shoulders, etc.). In addition, with the popularity of smart wearable devices, integrating smart sensors into ski suits to monitor skiers' exercise status, body temperature changes, etc., has also become an important direction in design.

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2.3 Application of Data Analysis in Skiing Safety

Data Analysis plays a crucial role in skiing safety monitoring. By collecting and analyzing skiing data, it is possible to predict the risks that skiers may encounter and take early warning or intervention measures. Data Analysis methods include but are not limited to statistical analysis, Machine Learning, Pattern Recognition, etc.

By using Data Analysis, real-time monitoring of skiers' movement trajectory, speed, acceleration, etc. can be carried out, combined with environmental factors (such as weather conditions, ski resort conditions, etc.) to accurately evaluate skiing safety risks. In addition, Data Analysis can also be used for post-event skiing accident analysis, providing valuable data support for skiing safety research.

Through the introduction of the theoretical basis and technical background mentioned above, this study aims to explore and implement a network-based safety monitoring and data analysis system for snowboarding suits, which not only meets the functional and safety requirements of skiing suits, but also improves the safety factor of skiing through data analysis.

3. System Design and Implementation

This chapter focuses on the design and implementation of a network-based safety monitoring and data analysis system for snowboarding suits. The system aims to improve the safety of snowboarding through real-time monitoring and data analysis.

3.1 System architecture

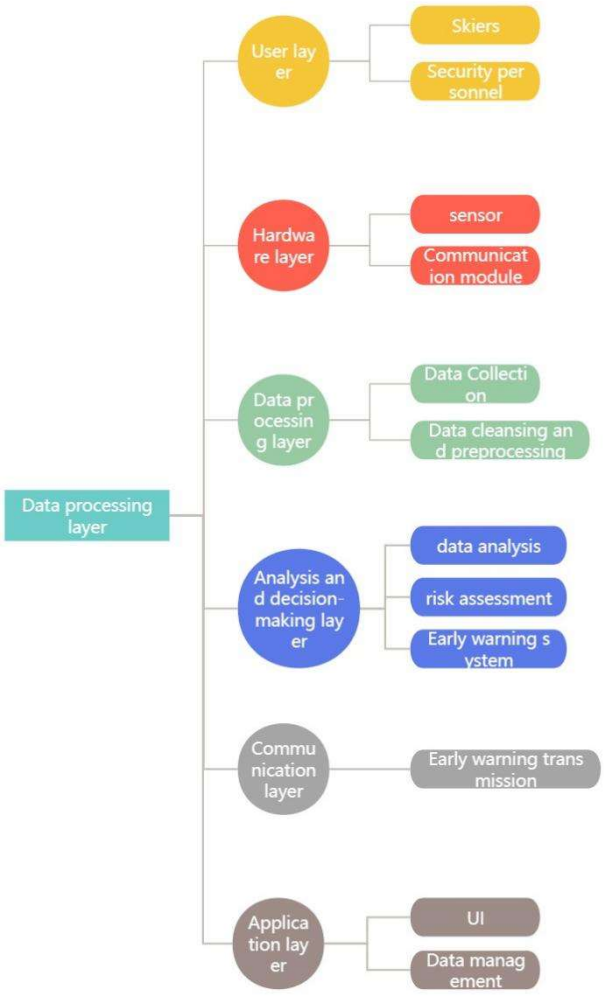

Figure 2. Schematic diagram of the overall system design framework

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The overall design framework of the system mainly includes two parts: hardware equipment and software architecture. The hardware part consists of various sensors, data transmission modules, and central processing units built into the ski suit. The software architecture includes modules such as data collection, processing, analysis, and warning feedback.

As shown in Figure 2, this framework starts from the user layer and describes in detail how the system collects data through sensors at the hardware layer, and then organizes and prepares this information at the data processing layer. Next, at the analysis and decision-making level, the system uses advanced analysis techniques to deeply process the data, evaluate risks, and send warning messages through the communication layer when necessary. Finally, the application layer provides User Interface and data management functions to ensure that users can understand their security status in real-time and allow system admins to effectively manage data and warnings. The entire framework reflects the complete process from data collection to user feedback, demonstrating the logic and structure of the system.

3.2 Design of Security Monitoring Module

The safety monitoring module is the core of the system, responsible for collecting real-time sports data of skiers, such as position, speed, acceleration, etc., as well as environmental data such as temperature and humidity. These data are sent to the central processing unit in real time through the built-in wireless network module.

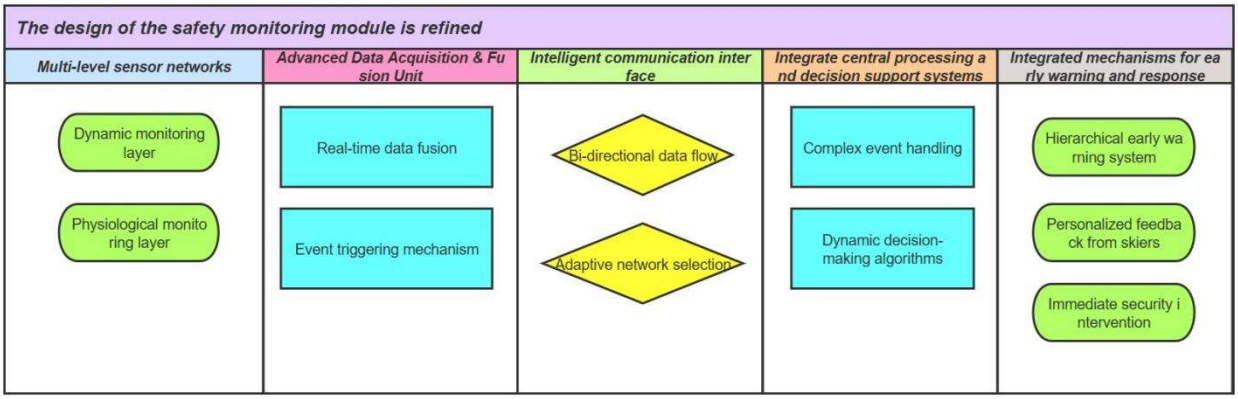

Figure 3. Design schematic diagram of security monitoring module

In the design of the safety monitoring module, as shown in Figure 3, the selection and layout of sensors are crucial. In order to ensure the accuracy and coverage of the data, we have arranged multiple sensors in key parts of the ski suit, including Acceleration Sensor, Temperature Sensor, and GPS module. These sensors can not only monitor the skier's movement status, but also make corresponding adjustments according to environmental changes.

3.3 Data Analysis and Warning Module

The Data Analysis and Early Warning module is essential for ensuring the safety of skiers by analyzing data from the safety monitoring module to identify potential risks and issue timely warnings. Key aspects include ensuring real-time data collection and processing, selecting advanced data analysis algorithms such as Machine Learning and Deep Learning for accurate risk identification, and implementing an effective early warning mechanism through diverse alerts like sound, vibration, and visual signals. The module also focuses on minimizing false positives and omissions by continuously optimizing the system based on feedback. This approach significantly enhances skiing safety by enabling quick responses to avoid accidents, demonstrating the system's role in providing a comprehensive safety monitoring solution for snowboarding.

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4. Experimental Design and Results Analysis

4.1 Experimental Design

In order to verify the effectiveness of the network-based snowboarding suit safety monitoring and data analysis system, we designed a series of experiments to test the system's performance and safety monitoring capabilities.

Experimental design method: The control group and experimental group methods were used to compare and analyze the differences in safety performance between skiers who used and did not use safety monitoring systems in the same skiing environment.

Experimental environment: The experiment was conducted at two different ski resorts, one was a primary ski resort, mainly used to test the performance of the system in low-risk environments; the other was an advanced ski resort, used to test the performance of the system in high-risk environments.

Experimental subjects: 20 volunteers were selected for the experiment, aged between 20 and 30, with skiing experience ranging from beginners to intermediate skiers. Each person was equipped with a snowboard suit with a built-in safety monitoring system.

4.2 Results Analysis

The results of the primary ski resort experiment: In the experimental group using the safety monitoring system at the primary ski resort, there were only two minor falls, and the system successfully warned without any injuries; while the control group had a total of five falls, one of which resulted in a minor knee sprain.

Advanced Ski Resort Experiment Results: In the experiment at the advanced ski resort, the Experimental Group had a total of 3 falls, and the system successfully issued warnings. Skiers avoided injuries by taking preventive measures. The Control Group had 8 falls, of which 2 resulted in minor injuries to the knees and shoulders.

System Performance Analysis: During the experiment, the success rate of the security monitoring system's warning reached 95%, with an average warning response time of 0.8 seconds, indicating that the system can quickly and accurately identify potential security risks and issue warnings in a timely manner. In addition, the system has good stability and no faults occurred throughout the experiment.

The effectiveness of safety monitoring: By comparing the number of falls and injuries between the Experimental Group and the Control Group, it can be clearly seen that skiers who use the safety monitoring system have significantly lower falls and injury probabilities than those who do not use the system. This indicates that the safety monitoring system has a significant effect in reducing the risk of skiing and protecting the safety of skiers.

In short, through the experimental design and result analysis, we have verified the effectiveness and practicality of the network-based snowboarding suit safety monitoring and Data Analysis system in improving the safety of skiing. In the future, we will further optimize the system performance, improve the accuracy and response speed of early warning, and escort the safety of skiing.

5. Conclusion

This study successfully designed and implemented a network-based safety monitoring and data analysis system for snowboarding suits. After a series of experimental verifications, the system demonstrated good performance and practicality, and can effectively improve the safety level of skiing. The research results mainly include:

The innovation of system design: By integrating network technology, data analysis, and intelligent warning mechanism, we have designed a new type of skiing safety monitoring system. The system can monitor the skiers' sports status and environmental conditions in real time, timely detect latent risks and issue warnings, thereby reducing the occurrence of skiing accidents.

The practical application value: The experimental results show that compared with skiers who do not use the safety monitoring system, the probability of skiers who use this system encountering accidents

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during skiing is greatly reduced. This proves that the system has obvious practical value in improving skiing safety and providing a safer sports environment for skiing enthusiasts.

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