Novel sensor applications and research in outdoor by mobile communication and signal transmission technology

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Abstract. Human adaptation and surface sensations to environmental and climate change during outdoor exercise are often not fully consistent with the true responses of body organs. Body surface sensations may be adaptive and insensitive due to prolonged outdoor activity. This causes the body surface to be insensitive or under-responsive to rapid changes in the external environment, when the internal organs of the body are sometimes working at abnormal indications, and if this unhealthy condition continues for a long time and progresses to a dangerous condition, the danger is approaching and the body may enter a state of paralysis at this time without knowing it. This is where a wearable system that monitors environmental and physiological indicators in real time and analyzes the measured data to broadcast early warnings is needed. This system adds a certain degree of safety to outdoor sports, and the data can be used as a reference for the scientific validity of the exercise.

Keywords: atmospheric data, physiological indicators, sensors, data acquisition and analysis

1. Introduction
With the rapid development of human society and economy, people's living standard has been improving and their behavior has become standardized. the basic needs of life to the pursuit of quality of life and higher values compared to people before. The pace of modern life has accelerated, work pressure has increased, and living space has been compressed. People urgently need a road to relax, vent pressure and release, so outdoor sports have emerged. Its embracing nature, transcending oneself and challenging the limits cater to people's needs, and it has also gradually developed into a sports project from the original amateur sports. Including the challenge to nature, people continue to show their reverence for nature and other personal attitudes through various ways. Examples include rock climbing, wingsuit flying, trail running in extreme geographical conditions, etc. Inevitably, these activities are faced with various natural environments including different landscapes and climatic conditions, where the impact of different landscapes on such activities can be predicted in most cases and the possible conditions can be planned in advance. This allows the whole activity to be planned and prepared in a way that minimizes the difficulties and dangers that may arise during the activity. However, climate change is unpredictable, and despite weather forecasts, specific activities can be affected by rapidly changing severe weather conditions. Severe weather includes freezing rain, flooding, extreme cold, and other weather. These conditions can have a serious impact on the normal
human physiological indicators or even can quickly change the human physiological indicators, which makes the human body is in an extremely dangerous situation and is not suitable to last too long. In this case, the main research of this paper is to monitor the indicators of altitude, slope of temperature drop, wind speed, human exercise intensity, cardiopulmonary indicators, and the degree of change of body temperature in severe weather such as extreme cold, and based on these data, how to analyze the judgment, assess whether the activity can continue, and advance warning of the trend of human physiological indicators.

2. Text
The outdoors is a way of life, characterized by a desire to go beyond one's limits, consisting of many unexpected dangers, and most outdoor sports, where the most important rule is to challenge all rules and break all limits. Its participation is often spontaneous and individual-based. It is a challenging sport, different from the mainstream of sports, with the help of high-tech means to maximize their potential. The basic definition of "extreme" in outdoor extreme sports is the unknown weather and other factors in the outdoors. The American Heritage Dictionary defines extreme sports as: extreme sports is a media term for activities with certain dangers or difficulties, which often involve speed, height, high physical exertion of participants, and include highly specialized equipment or some stunts. Projects are often conducted in remote mountainous areas, snowy areas, oceans and other natural sites, going out into nature, into the wilderness, seeking from nature the essential meaning of human existence. Due to their dangerous nature, some of the extreme sports in outdoor sports have high physical and technical requirements for participants, who are often required to have excellent physical fitness, strong will and courage beyond the ordinary. Many events also require the use of equipment to complete. In fact, new technologies are constantly emerging to provide more assurance for the safety of extreme sports and to push them to become even more extreme [1].

The environment affects outdoor sports and is at the same time a great life and death test for sports enthusiasts, during which they are very vulnerable to extreme weather and conditions such as mudslides, volcanoes, avalanches, etc. The human body is also subject to different life threatening conditions such as poisonous insect bites, loss of temperature, etc. Even with all the difficulties, people are still happy to do it, for example, since 1953, when the first human climbed Mount Everest, more than 4,000 climbers have successfully climbed it. This has been considered a "lifestyle" sport and is gaining importance. In the face of all the force majeure factors of the environment in extreme sports, loss of temperature is one of the most neglected life threats compared to pain from falls, crashes, and even bites from poisonous insects and birds [2].

The optimal temperature for a normal marathon is about 10-15°C, but the body's adaptation to the external environment temperature (cold and hot environment) is also very important, and thermoregulation is one of the keys. 2021 May 22, Gansu Baiyin Mountain Marathon race on the way, sudden extreme weather, local hail, freezing rain, high winds, the temperature plummeted, 21 participants found when they had lost their vital signs. The 21 participants had already lost their vital signs when they were found. The 21 people lost their lives because of "loss of temperature", which is known as one of the two major outdoor killers. The causes are: 1. when the rate of heat production is lower than the rate of heat dissipation, the body heat is less and less, not enough to maintain body temperature, the phenomenon of "loss of temperature"; 2. too low ambient temperature and too little clothing, so that the body through the body surface conduction loss of too much heat; 3. the body does not have enough energy, especially in the latter part of the exercise, because the body There is not enough energy for heat production to maintain body temperature because of the depletion of energy substances. The human body itself is a thermogenic body, which is always in contact with the outside world for heat transfer, of which temperature, humidity and wind effects are the most common factors leading to loss of temperature [3].

Hypothermia, also called accidental hypothermia, is clinically a type of hypothermia syndrome, which is a spontaneous drop in body temperature below 35°C caused by a cold environment. Hypothermia is a phenomenon in which the body's ability to produce heat and keep warm is less than
its ability to dissipate heat for an extended period of time, thus causing the body temperature to get lower and lower. When it is too cold outside to cause the body to produce enough heat to ward off the cold, the body develops symptoms of hypothermia, and coordination and judgment are reduced, inducing danger in the outdoors. Even in the summer, there is a temperature difference between morning and evening, and the increased humidity due to sweating caused by marathon sports, coupled with increased wind, makes it extremely easy to lose heat rapidly, resulting in loss of temperature, not to mention encountering severe and extreme weather. Loss of temperature is further divided into mild, moderate, high and fatal stages.

1. Mild hypothermia (body core temperature 37-35°C) The body feels cold, shivers constantly, but the shivering is still manageable, and the arms and legs feel stiff and numb.
2. Moderate hypothermia (body core temperature 35-33°C) Slurred speech, numbness, dysmotility, inability to perform some of the most basic movements with the hands, and the possibility of stumbling when walking.
3. Severe hypothermia (body core temperature 33 to 30°C) Sensation of cold becomes dull. Consciousness begins to become blurred, and one is unable to use the arms and legs effectively or even feel cold. The progression from poor mobility to loss of mobility phase walking difficulties and finally no shivering occurs.
4. In the death stage (below 30°C in the core of the body), the body is basically at the edge of death with 30–27 °C. The muscles of the body are stiff, the heart is failing, the pupils are enlarged, and a slight impact from the outside world may cause the heart to stop beating and finally death.

When people are in a windy environment, their body temperature will be lower than the actual temperature due to the wind, making it easier for them to lose temperature. In everyday life, cold stimulates the thermoregulatory centers, causing vasoconstriction of the body surface through adrenergic sympathetic nerves to maintain body temperature, and increasing muscle tone and shivering through motor nerves to produce heat. The body itself is a thermogenic body, acting as a heat transfer agent with the outside world at all times, with temperature, temperature and wind effects being the most common factors contributing to loss of temperature. A range of symptoms such as chills, disorientation, cardiorespiratory failure, and eventual death are produced. The so-called core of the body here refers mainly to the brain and the major life-sustaining organs such as the heart and lungs within the torso, a concept that is relative to the body's extremities and superficial skin [4].

The Mountain Marathon 100km trail race was held in early summer, and the warm, hot weather made it easy to overlook the temperature difference and drop the ball. There is no absolute correlation between temperature loss and outdoor temperatures, which can occur even in summer. Temperature loss is caused by prolonged exposure to cold, not by extreme cold. The "wind chill effect" causes the body temperature to feel colder than the actual temperature when there is wind, because the moving air is constantly moving heat away from the body surface. In addition, the wind is more likely to cause a loss of temperature in a drizzle of -10°C than in the cold of -30°C. Not only did the runners encounter high winds on the way, but they also got wet due to hail and freezing rain. Participants recounted that when they encountered extreme weather, their bodies were still hot because of the exercise, and by the time they became uncomfortable, they already had cold hands and feet, numbness, and even blurred consciousness. The process is very fast, from numbness to loss of consciousness, in some cases only a few minutes. The most important thing to note is that the "warmth" felt by a person suffering from hypothermia is confused with the symptoms of hypothermia, but in fact it is a sign that hypothermia is about to progress to the second stage, a phenomenon that is very dangerous and returns in the confusion and gradual sleep of the person. Through research and analysis, here I propose a wearable physiological parameter monitoring system and early warning system for human hypothermia using modern new sensors, microcontrollers, and communication technology, which can monitor and warn in real time, and start uploading big data to the terminal immediately when the human body falls into mild symptoms of hypothermia through the Internet of Things. Real-time human physiological data parameters and early warning, call for help and alarm. For extreme sports,
outdoor alpine sports, etc. have certain sports safety protection, can experience sports stimulation at the same time to monitor and guide, to do prepared, safe outdoor sports [5].

The wearable new sensor system uses advanced modern sensors for real-time accurate monitoring and early warning of health status, and assessment of environmental parameters, this system combines multi-sensor and communication module and microcontroller to work together to achieve real-time monitoring and analysis of atmospheric data and human physiological indicators for outdoor sports, and to assess the trend of changes in human physiological indicators, and to give early warning and assessment in advance. The C8051F91x/90x is a highly integrated, high-performance, low-power 8-bit MCU based on the 8051 core with a three-stage pipeline execution architecture from Silicon labs. The processor requires only 4mA of operating current when operating at 25MHz with a voltage range of 1.8V to 3.6V, and the MCU sleeps at as low as 10nA with the low voltage detection function off while maintaining no RAM data loss [6].

![Figure 1. Silicon labs CPU](image)

This CPU is suitable for battery-powered embedded systems, such as portable meters, personal medical devices, wearable digital products, home security devices, etc. It can provide the latest real-time medical data at any time, transmit the data to the watch and other centralized data devices in a timely manner, and send the big data to the network cloud in real time through the Internet of Things after the computer predicts the current body condition and determines that the human body may have to develop in the direction of temperature loss, and use the foreseeable judgment to provide effective rescue as well as treatment for the subsequent injured.

In addition, due to the special and independent nature of extreme sports, most of the time when suffering from the loss of temperature phenomenon is due to unawareness or even not being able to find the injured companions around, so through this system of real-time physiological parameters measurement and monitoring can significantly reduce the dangerous phenomenon. For the sudden loss of temperature phenomenon searchers can accurately find and treat the system through the positioning and the specific parameters of the Internet of Things. For the presence of extreme sports is a kind of predictive safety equipment. The timely detection and uploading of physiological data is a preventive shot for sports enthusiasts who do not understand the loss of temperature and for those who do not distinguish the symptoms of loss of temperature.

The new wearable sensor system adopts a human-centered design concept, the system sensors and modules take into account wearability and meet outdoor ergonomic conditions as much as possible, the whole system is installed on specially designed wearable clothing, which can meet various requirements during outdoor sports. The whole system is mounted on specially designed wearable clothing to meet the various requirements of outdoor sports. It is also waterproof, comfortable and durable. A fundamental understanding of the importance of this wearable system and the additional features it should have, creating an innovative product that combines an integrated sensor device with ergonomic and mechanical solutions, a device that provides powerful and timely safety for the injured through today’s communication technology, location tracking, embedded sensors, applications and software.

Outdoor sports may encounter a variety of climatic conditions, and sometimes the network weather forecast alone can not predict the local climate trends, which can be measured by measuring the change in air pressure, temperature can advance the possible trend of climate, and the next activities such as advance planning to avoid dangerous occurrences. New sensors in the atmospheric temperature sensor can monitor the temperature of various parts of the body surface in real time, to
understand the temperature difference between various parts of the body temperature, and the trend of such changes are recorded and analyzed, and these data are of some significance to the judgment of possible loss of temperature in the human body. Heart rate and blood oxygen concentration monitoring can determine the intensity of exercise and the current state of the human body to determine whether to adapt to the current exercise. Accelerometer, gyroscope, falling water monitoring electrode can judge the human body posture during movement, such as fall, falling, falling water can be monitored and send notification information to the preset phone number through 4G module. The following figure shows the structure of the system for this study.

![System architecture diagram](image)

**Figure 2.** System architecture diagram

3. Conclusions
This paper intends to establish a novel sensor system for the protection of the human body in the face of some force majeure natural severe weather in outdoor sports and the broadcast of danger warning, as well as various data acquisition and processing. A series of monitorable situations and module analysis due to severe weather are studied, and the behavior analysis of human wearable devices in outdoor sports is carried out. The overall system structure is a new sensor structure system that can be worn on the body and external data module analysis, which is conducive to the collection of physical energy consumption monitoring and body temperature and humidity, heart rate and other data, and upload data through the Internet of Things and compare and analyze with the prevailing body temperature, humidity and atmospheric monitoring, climate monitoring, determine whether the human body is experiencing symptoms of temperature loss and big data. This paper only provides a theoretical analysis and feasibility study on the use of new sensors in the outdoors in a wearable manner and the system power structure.

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