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RAY SHIELD:COMPREHENSIVE SUNSTROKE DETECTION IN HEAT EXPOSURE

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Abstract: With the rising impact of extreme heat due to climate change, individuals exposed to high temperatures for prolonged periods such as outdoor workers, athletes, travelers, and the elderly are at significant risk of sunstroke and other heat-related illnesses. Sunstroke can cause severe dehydration, organ failure, and even death if not detected early. To address this, we propose the system called "RAY SHIELD-COMPREHENSIVE SUNSTROKE DETECTION IN HEAT EXPOSURE". It is an advanced wearable device designed to monitor environmental and physiological parameters in real-time to prevent sunstroke. The system integrates multiple sensors to track UV exposure levels (240-370 nm), body temperature, and humidity. These data points are processed using an onboard microcontroller to assess the risk of heat-related illnesses. Upon detecting unsafe thresholds, the device activates an alert mechanism, which includes a buzzer alarm system, SMS alerts, and call notifications to designated emergency contacts. The SMS alerts contain critical information about the user's condition, ensuring timely intervention. The primary goal of this project is to develop a functional and reliable prototype for individuals exposed to extreme heat, such as outdoor workers, athletes, and military personnel. This innovation enhances safety by preventing dehydration and sunstroke through proactive monitoring and alerting mechanisms.

Keywords: Sunstroke Detection; UV Sensor; Temperature sensor

I INTRODUCTION

With the increasing frequency of heatwaves and rising global temperatures, individuals exposed to extreme heat for prolonged periods such as outdoor workers, athletes, and elderly individuals face a high risk of sunstroke. Sunstroke, also known as heat stroke, occurs when the body's temperature regulation fails due to excessive heat exposure, leading to dehydration, organ failure, and, in severe cases, death. Existing preventive measures like hydration and shade are not always effective, and there is a lack of real-time monitoring systems to detect early signs of heat-related illnesses.

To address this, we propose RAY SHIELD – A Comprehensive Sunstroke Detection System, a wearable device designed to monitor environmental and physiological parameters in real-time. The system integrates GUVA-S12SD (UV sensor) and DHT11 (temperature & humidity sensor) to track UV radiation levels, body temperature, and humidity. These data points are processed using an Arduino Nano microcontroller, which continuously assesses the risk of sunstroke. Upon detecting unsafe conditions, the system activates a buzzer alarm, SMS alerts, and call notifications to warn the user and designated emergency contacts, ensuring timely intervention.

This innovative solution aims to provide a functional and reliable prototype to safeguard individuals exposed to extreme heat. By utilizing IoT-based real-time monitoring, the system enhances personal safety, minimizes the risk of heat-related health complications, and offers an early warning mechanism. Its portability and efficiency make it a valuable tool for outdoor workers, military personnel, and athletes, helping them stay protected in high-temperature environments.

II OVERVIEW

The RAY SHIELD – Comprehensive Sunstroke Detection System is a wearable device that continuously monitors UV exposure, body temperature, and humidity levels to prevent sunstroke and other heat-related illnesses. Designed for outdoor workers, athletes, and the elderly, the system integrates GUVA-S12SD UV sensor and DHT11 temperature & humidity sensor, with data processed in real-time by an Arduino Nano microcontroller. When critical thresholds are exceeded, the device triggers an alert mechanism, including a buzzer alarm, SMS notifications, and call alerts to emergency contacts, ensuring timely intervention.

This IoT-based wearable solution enhances personal safety through real-time monitoring and early warning alerts. Its

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compact and portable design allows users to receive proactive health alerts without restricting movement. By providing continuous risk assessment, the RAY SHIELD system helps individuals mitigate the dangers of extreme heat exposure, reducing the likelihood of dehydration, heat exhaustion, and life-threatening sunstroke conditions.

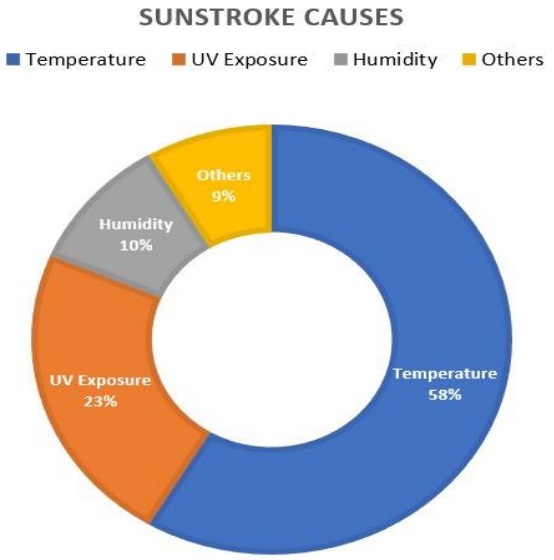

Fig 1: Real-Time data of reasons of sunstroke causes

III COMPONENTS

1) GUVA-S12SD SENSOR: The S12SD sensor, more specifically the GUVA-S12SD, is an ultraviolet (UV) sensor designed for detecting UVA radiation (wavelength range 240–370 nm). It's commonly used for applications requiring measurement of UV exposure or intensity, such as environmental monitoring, UV index detection, and industrial processes involving UV light.

2) DHT11 SENSOR: The DHT11 sensor is widely utilized for measuring temperature and humidity in various applications due to its affordability and ease of integration. In home automation systems, it plays a crucial role in monitoring indoor climate conditions, allowing users to maintain optimal comfort levels by controlling heating.

In research and industrial environments, the DHT11 sensor is employed in data logging systems to continuously record temperature and humidity data. This information is valuable for studies on climate impact, equipment performance, and product storage conditions.

The DHT11 can be used in health and wellness applications to monitor indoor air quality, as excessive humidity can lead to mold growth and affect respiratory health.

SOFTWARE SPECIFICATION:

1) Arduino IDE
2) C++

IV EXISTING SYSTEM

The idea of the existing system is that the developer created a wearable device that detects heat and alarm the user, this basic idea is implemented by artificial intelligence (AI) and internet of things, the wearable device maybe watches or patches and These solutions detect sunstroke symptoms, monitor vital signs, and provide alerts for heat-related illnesses. and moreover, there is no perfect existing solution for sunstroke detection system and the previously existing system only

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detects the heart rate and body temperature.

V PROPOSED SYSTEM

A. ABBREVIATIONS AND ACRONYMS

1) DHT11 SENSOR - Digital Humidity and Temperature sensor model 11.
2) UV rays - Ultra Violet rays.
3) Gallium Ultraviolet A - S12SD (model designation).

B. OBJECTIVE

- Real-Time Monitoring – Continuously track body temperature, humidity levels, and UV exposure to detect early signs of sunstroke.
- Early Detection & Prevention – Identify critical health risks such as dehydration and heat exhaustion before they escalate into severe conditions.
- Alert Mechanism – Provide instant notifications through buzzer alarms, SMS alerts, and call notifications to ensure timely intervention.
- Portable & User-Friendly Design – Develop a lightweight, wearable device for easy use by outdoor workers, athletes, and elderly individuals.
- Integration with Smart Systems – Enable connectivity with mobile apps or smartwatches for real-time health monitoring and emergency alerts.

C. METHODOLOGY

The RAY SHIELD – Comprehensive Sunstroke Detection System is designed to provide real-time monitoring of UV exposure, body temperature, and humidity levels to detect and prevent sunstroke. The system integrates GUVA-S12SD (UV sensor) and DHT11 (temperature & humidity sensor), which continuously gather environmental and physiological data. These sensors are connected to an Arduino Nano microcontroller, which processes the collected data and compares it with predefined safety thresholds.

When the system detects that temperature, humidity, or UV exposure exceeds safe limits, it activates an alert mechanism. The user is notified through a buzzer alarm for immediate awareness, while SMS notifications and call alerts are sent via the SIM800L GSM module to emergency contacts. This ensures timely intervention, preventing serious health complications caused by heat exposure.

The device is designed to be compact, lightweight, and wearable, making it ideal for outdoor workers, athletes, and elderly individuals. Additionally, the system can be integrated with mobile applications or smartwatches, allowing users to monitor real-time data and receive alerts on their devices. This enhances usability and ensures accessibility across different user groups.

To validate the system's efficiency, rigorous testing and performance evaluation will be conducted under various environmental conditions.

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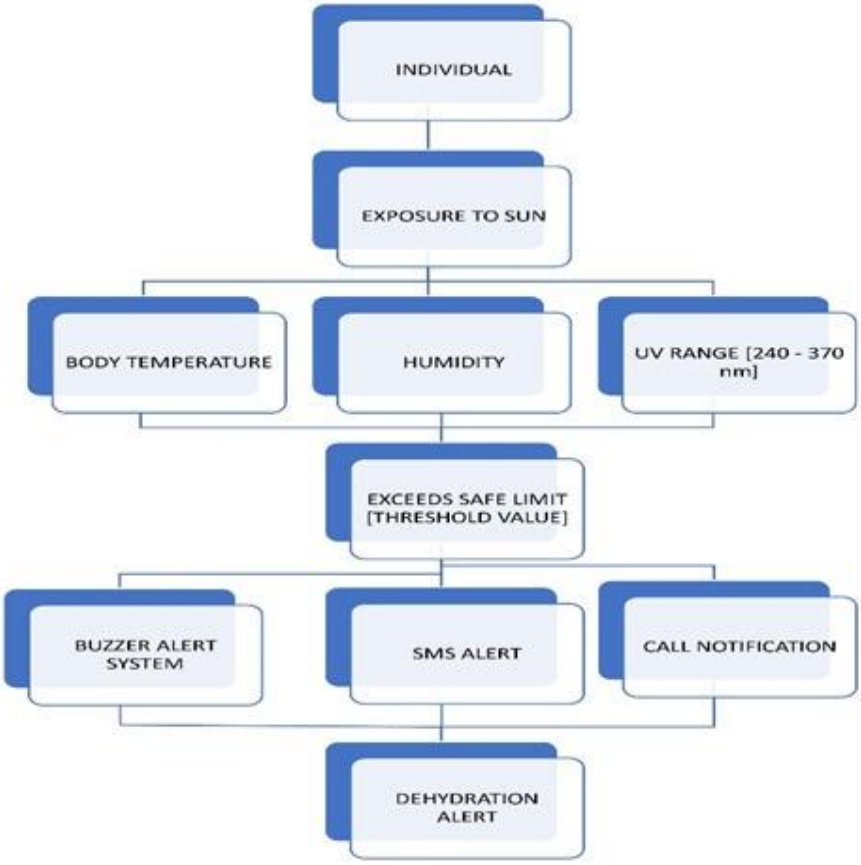

Fig 2: System modules

VI IMPLEMENTATION OF PROJECT

The RAY SHIELD – Comprehensive Sunstroke Detection System is implemented as a wearable device that continuously monitors UV exposure, body temperature, and humidity levels to prevent sunstroke. The system integrates GUVA-S12SD UV sensor to detect UV radiation (240–370 nm) and DHT11 sensor to measure temperature and humidity. These sensors are connected to an Arduino Nano microcontroller, which processes the data in real time. A 18650 Lithium-ion battery powers the system, ensuring portability and extended usage in outdoor environments.

The software development phase involves programming the Arduino Nano using C++ in the Arduino IDE. The microcontroller continuously reads sensor values and compares them against predefined safety thresholds. If the temperature, humidity, or UV exposure exceeds the safe limit, the system triggers an alert mechanism. A buzzer alarm notifies the user immediately, while a SIM800L GSM module sends SMS alerts and call notifications to emergency contacts, providing real-time health data.

To ensure reliable communication, the system operates independently of internet connectivity, making it effective in remote areas where high temperatures pose significant health risks. The device can also be integrated with mobile applications or smartwatches, allowing users to track their health conditions and receive alerts through their devices. This enhances usability and ensures broader accessibility. The final stage involves testing and performance evaluation under different environmental conditions to validate system accuracy. The device is tested on outdoor workers, athletes, and elderly individuals to assess real-time.

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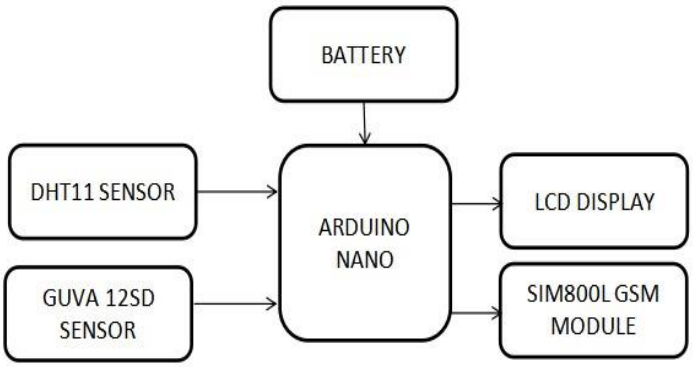

Fig 3: Architecture diagram

REAL-TIME STATISTICAL DATA:

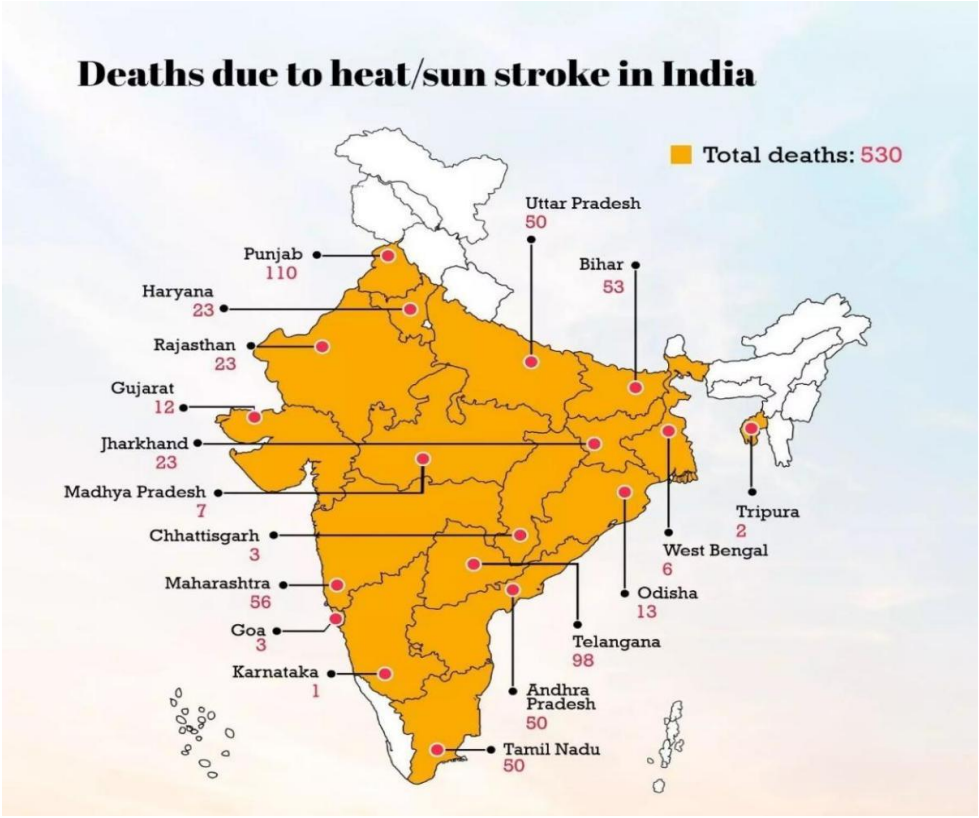

Fig 4: Deaths rate due to heat/sun stroke in India

There were at least 80 deaths due to sun strokes, including both confirmed and suspected cases, reported across the country in May, according to the Health Ministry's data on heat-related illnesses and deaths. In fact, there have been 56 confirmed deaths due to heat strokes between March and May, of which 46 occurred in May alone.

As of 2023, wearable health devices have seen rapid growth, with the global market for such devices expected to reach over $70 billion by 2025. Surveys show that about 60% of consumers are now using wearable devices for health monitoring, with a significant rise in demand driven by increased awareness of health risks due to extreme weather conditions. Devices focusing on heat-related illnesses are gaining traction, particularly in regions experiencing hotter summers. A study in the U.S. revealed that heat-related deaths could rise by 200% by 2050, prompting a growing interest in wearable solutions that help monitor and prevent conditions like sunstroke.

In parallel, the integration of IoT in healthcare is expanding, with over 70% of healthcare executives indicating plans to invest in It-enabled health monitoring systems by the end of 2023. Real-time alerts and data-driven health solutions, like

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sunstroke detection systems, are becoming essential in this context. With rising global temperatures and frequent heatwaves, demand for these solutions is expected to grow, particularly in outdoor-intensive industries like agriculture, construction, and sports. This shift is paving the way for innovations heat-related health risks.

VII ADVANTAGE

- Early Sunstroke Detection – Continuously monitors body temperature, humidity, and UV exposure to detect heat-related risks before symptoms appear.
- Real-Time Alerts – Provides instant buzzer alarms, SMS notifications, and call alerts to ensure timely intervention and emergency response.
- Wearable & Portable Design – A lightweight and compact device that is easy to wear, making it ideal for outdoor workers, athletes, and elderly individuals.
- Independent Operation – Functions without the need for an active internet connection, ensuring reliable alerts even in remote areas.
- IoT-Enabled Monitoring – Integrates smart sensors with an Arduino Nano microcontroller to provide accurate real-time data processing.
- User Safety & Health Protection – Helps prevent heat exhaustion, dehydration, and organ failure, reducing fatalities caused by extreme heat.
- Customizable & Scalable – Can be integrated with mobile apps or smartwatches for enhanced user experience and remote monitoring.

VIII FUTURE WORK

1. **Machine Learning and AI Integration:**

- Predictive algorithms to assess sunstroke risk based on temperature, UV exposure, and user-specific factors.
- Personalized alerts tailored to individual health profiles and environmental conditions.

2. **User-friendly Interfaces and Mobile Apps:**

- Intuitive apps for monitoring sunstroke risks with insights and early warnings.
- Gamification to encourage proactive sun protection behavior.

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