



Intelligent Solar Powered Climate Adjustable E-Uniform with Health Monitoring for Soldiers

K.Prasuna¹, V.Sowjanya², B.Swathi³, R.Tejaswini⁴, G. Chandraja⁵

¹Assistant Professor, Department of Electronics and Communication Engineering, Vijaya Institute of Technology for Women, Enikepadu, Vijayawada, India.

²Department of Electronics and Communication Engineering, Vijaya Institute of Technology for Women, Enikepadu, Vijayawada, India.

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KEYWORDS	ABSTRACT
Arduino, Dallas Temperature sensor, CPU fan, Peltier Module	The Intelligent Solar-Based Climate Adjustable E-Uniform for Soldiers project aims to enhance the comfort and operational efficiency of soldiers by integrating advanced climate control technologies into their uniforms. Utilizing an Arduino microcontroller as the central control unit, this innovative system incorporates a Dallas temperature sensor to continuously monitor the soldier's body temperature. The sensor's waterproof design ensures reliable performance in various environmental conditions. The system employs relays to manage the operation of a cooling fan and a Peltier module, providing effective temperature regulation; the Peltier module, known for its thermoelectric cooling capabilities, can be activated or deactivated based on real-time temperature data, allowing the uniform to adjust the internal climate dynamically and maintain optimal comfort levels. The uniform is further enhanced by solar power, which harnesses solar energy to support the cooling mechanisms, making the system energy-efficient and sustainable. This intelligent approach not only improves the soldier's comfort but also contributes to better performance in diverse and challenging environments. The integration of these technologies represents a significant advancement in wearable climate control systems for military applications. In addition to climate regulation, the project incorporates an ADXL345 sensor as a critical health parameter monitor; this sensor continuously tracks the soldier's movements to detect falls, which can indicate injuries during combat or training. Whenever a fall is detected by the ADXL345 sensor, the event is automatically flagged as a potential injury. The system then uses the MQTT protocol to upload this data in real time to Adafruit IO, providing remote monitoring and immediate alert capabilities to medical support teams. This integration not only enhances the overall situational awareness on the battlefield but also ensures that prompt medical intervention can be initiated, thereby

1. INTRODUCTION

In extreme climatic conditions, soldiers often struggle with maintaining their body temperature, which can significantly impact their efficiency and well-being. The Intelligent Solar-Based Climate Adjustable E- Uniform for Soldiers is designed to address this challenge by integrating wearable temperature regulation technology. This innovative uniform utilizes an Arduino microcontroller as the central control unit, which continuously monitors the soldier's body temperature using a Dallas waterproof temperature sensor. The sensor's real-time temperature tracking ensures that the system can automatically respond to environmental changes and regulate the internal climate of the uniform accordingly.

The system employs a combination of Peltier modules and CPU cooling fans, which work together to regulate temperature. The Peltier module, known for its thermoelectric cooling properties, can either cool or heat the uniform based on the detected temperature. The cooling fans provide additional ventilation, ensuring that heat is efficiently dissipated. Relays are used to control these components, allowing the system to activate or deactivate the temperature regulation mechanisms as needed. By automating this process, the uniform ensures that soldiers can remain comfortable and focused on their tasks without being affected by extreme weather conditions.

A key feature of this system is its reliance on solar energy, making it a sustainable and energy-efficient solution for military personnel deployed in remote locations. The uniform is equipped with solar panels that generate power to operate the cooling and heating components, reducing the need for external power sources. This makes it ideal for long-duration operations in harsh terrains such as deserts, mountains, and snowy regions. By integrating smart climate control, solar energy utilization, and automated temperature regulation, this project represents a major advancement in wearable technology for defence applications, improving both the comfort and performance of soldiers in the field.

II. LITERATURE SURVEY

Soldier Health and Position Tracking System, Akshita V. Armarkar , Deepika J. Punekar , Mrunali V. Kapse, Sweta Kumari, Jayshree A. Shelk, International Journal of Engineering Science and Computing, March 2017

Soldier's tracking is done using GPS and GS to provide wireless communication system. For monitoring the health parameters of soldier we are using bio medical sensors such as temperature sensor and heart beat sensor. An oxygen level sensor is used to monitor atmospheric oxygen so if there are any climatic changes the soldiers will be equipped Accordingly

IoT Based Soldier Navigation and Health Monitoring System, Krutika Patil, Omkar Kumbhar, Sakshi Basangar, Priyanka Bagul, International Journal of Electrical, Electronics and Computer Systems (IJECS) ISSN (Online): 2347-2820, Volume -5, Issue-1, 2017

This system uses GPS module and wireless body area sensor network to record all parameters in real time and send it to the base station. The different types of sensors used in this system are the humidity sensor, temperature sensor and pulse sensor which help in deciding the health status of that particular army official. This is a wearable technology which is the most important factor of this project.

III. SYSTEM MODEL

A. Existing system

Existing methods for climate control in military uniforms typically rely on passive materials and insulation techniques to manage temperature, often lacking dynamic adjustment capabilities. Traditional uniforms use thermal liners and moisture-wicking fabrics to regulate body heat, but they do not actively control the internal temperature based on real-time data. Some systems incorporate basic ventilation or cooling packs, but these are limited in effectiveness and require manual intervention. Current solutions do not leverage advanced sensors or automated controls, resulting in a static approach to temperature management that may not adequately address the varying conditions soldiers face.

B. Proposed system

The proposed method introduces an advanced, intelligent approach to climate control in military uniforms by integrating an Arduino microcontroller, a

Dallas temperature sensor, and a cooling system into the uniform design. The Arduino acts as the central controller, continuously processing data from the waterproof Dallas temperature sensor to monitor the soldier's body temperature in real-time. Based on this data, the system automatically activates or deactivates a cooling fan and a Peltier module through relays. The Peltier module, known for its efficient thermoelectric cooling, adjusts the temperature inside the uniform, ensuring optimal comfort for the wearer.

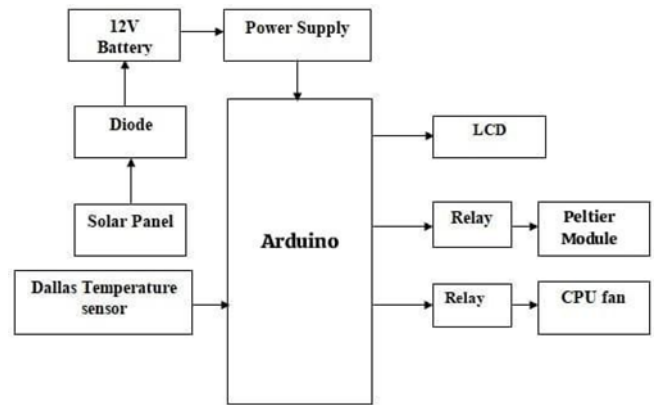
Solar power is utilized to enhance the system's sustainability and efficiency, with solar panels integrated into the uniform to provide energy for the cooling components. This approach not only ensures that the uniform can operate independently of external power sources but also minimizes the need for frequent battery replacements. By combining real-time temperature monitoring with dynamic cooling adjustments and solar energy, the proposed method offers a more responsive, energy-efficient solution for maintaining optimal comfort and performance in diverse environmental conditions. Additionally we are measuring fall detection of a soldier by using ADXL345 sensor. Whenever he gets major injury, he fall down. The position is uploaded to Adafruit IO server using MQTT protocol

The Features are added ESP32 and ADXL345.

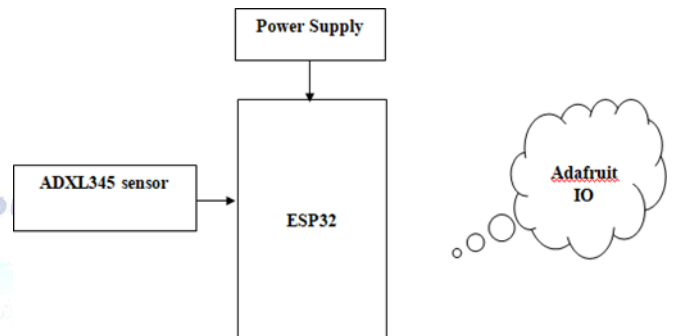
ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios.

The ADXL345 is a 3-axis accelerometer sensor that measures acceleration, orientation, and vibration. The ADXL345 is a 3- axis accelerometer used to measure both static (due to gravity) and dynamic (due to motion or shock) acceleration, finding applications in areas like mobile devices, robotics, and vibration sensing.

Block Diagram:



III. FLOW CHART



IV. BENEFITS OF SOLAR-BASED TEMPERATURE CONTROLLED E- UNIFORMS

There are several benefits to using solar-based temperature- controlled e-uniforms for soldiers, including:

Comfort: One of the key advantages of temperature controlled e-uniforms is that they can keep soldiers at a comfortable temperature regardless of the outside temperature. Soldiers who are exposed to extreme temperatures are more prone to grow tired, compromising their performance and safety.

Reduced Heat Stress: Heat stress is a major worry for soldiers who work in hot environments, heat stress is a major worry. Solar-powered temperature controlled e-uniforms can aid in body temperature regulation, lowering the danger of heat stress.

Increased Performance: Soldiers are more likely to perform well when they feel at ease. Temperature controlled e- uniforms can assist soldiers in being alert and focused even under harsh conditions.

Energy efficiency: Solar-powered uniforms are extremely energy-efficient because they do not require any external power source. The uniform's solar panels can generate enough energy to power the temperature control system. worry. Solar-powered temperature

controlled e-uniforms can aid in body temperature regulation, lowering the danger of heat stress.

V. APPLICATIONS

Military Operations in Extreme Climates: Soldiers in extreme weather face temperature fluctuations, discomfort, and fatigue. This smart uniform regulates body temperature, enhancing endurance, reducing fatigue, and improving operational efficiency in hot and cold environments.

Smart Wearables for Healthcare: Patients with thermoregulatory disorders or conditions like multiple sclerosis can benefit from a temperature-regulating uniform, as can elderly individuals sensitive to temperature changes.

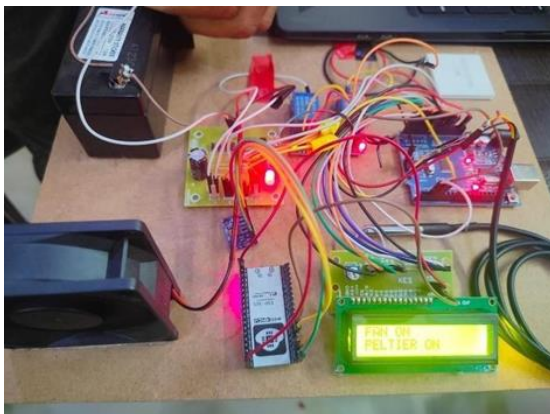
Border Security Forces: Soldiers at high-altitude borders (e.g., Siachen Glacier) and desert regions benefit from the uniform's:

- Thermoelectric Peltier module for warmth, reducing hypothermia and frostbite risk
- Cooling feature for desert climates

VI. RESULT

The image shows an electronics project with various components, including a fan, a Peltier module, an LCD display, an Arduino board, and a relay module. The LCD screen displays "FAN ON" and "PELTIER ON," indicating that the fan and the Peltier module are active.

This setup aligns with an "Intelligent Solar System Based on Climate Adjustable Uniform for Soldiers" project. The project aims to regulate the temperature of a soldier's uniform by using a Peltier module for cooling or heating and a fan for airflow. The Arduino microcontroller manages the system, while sensors and relays control the activation of the fan and Peltier module based on environmental conditions.



IV. CONCLUSION

The Intelligent Solar-Based Climate Adjustable E-Uniform is a revolutionary innovation designed to provide comfort and protection to soldiers operating in extreme weather conditions. By utilizing components like the Dallas temperature sensor, CPU fan, and Peltier module, this system effectively regulates body temperature. Powered by solar energy, it is both energy-efficient and sustainable, reducing reliance on external power sources.

This technology not only enhances the performance and safety of military personnel but also has potential applications in fields like disaster relief, firefighting, industrial safety, and healthcare. With smart automation and real-time temperature control, the uniform sets a new standard for adaptive clothing.

Future advancements, such as AI-based climate control, improved battery efficiency, and biometric sensors for health monitoring, can further enhance its functionality. This innovation holds the potential to revolutionize wearable technology for both professional and civilian use.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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