

# Air Conditioning Jacket for Worker or Travelers

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**Abstract**—The Air Conditioning Jacket is a wearable cooling system designed to provide localized thermal comfort using a thermoelectric cooling mechanism. The system is centered around a TEC1-12706 Peltier module integrated into the back panel of the jacket, which produces a cooling effect when electric current passes through it, creating a cold junction on one side and a hot junction on the other. To improve heat exchange efficiency, aluminum heat sinks are mounted on both sides of the Peltier plate. Dual fan units are employed, with one fan circulating cooled air inside the jacket and the other dissipating heat from the hot side to prevent thermal buildup and maintain stable operation. The setup is powered by a regulated 12V, 5A external adapter to ensure consistent performance during testing. A temperature sensor continuously monitors internal jacket conditions and sends real-time data to a microcontroller such as an Arduino Nano, which controls fan operation and generates alerts based on predefined temperature thresholds. All electronic components are insulated and embedded within a breathable, ergonomic fabric structure to ensure user safety and comfort. The prototype is intended for controlled testing with student volunteers under simulated heat exposure conditions to evaluate cooling efficiency, response time, and overall system performance.

**Index Terms**—Air Conditioning Jacket, Thermoelectric, Peltier Module, Arduino Nano.

## I. INTRODUCTION

In the face of rising global temperatures and rapidly changing climatic conditions, there is an urgent demand for adaptive, wearable technologies that ensure personal comfort, especially for individuals exposed to harsh outdoor environments. Outdoor workers, such as construction laborers, farmers, traffic police, and even frequent travelers, often face

discomfort, fatigue, and health risks due to prolonged exposure to extreme heat. Conventional air conditioning systems are stationary, energy-intensive, and not accessible in mobile or outdoor conditions. To address this critical need, the concept of a portable air-conditioning jacket emerges as a groundbreaking innovation offering a wearable, lightweight, and energy efficient solution that maintains thermal comfort on the go.

The Air Conditioning Jacket is a wearable system integrated with compact thermal regulation components like the Peltier plate, heat sinks, dual fans, and sensors. The Peltier module creates a thermoelectric effect, which absorbs heat from one side and dissipates it to the other. Strategically placed heat sinks and fans accelerate the dissipation process and maintain a cooling airflow within the jacket. The system is powered through an external adapter to ensure safe and consistent performance during testing. A temperature sensor is employed to monitor internal temperatures and adjust the cooling response dynamically. The integration of such a control loop is vital for energy optimization and personal safety. The wearable module is currently designed for testing by students to evaluate its efficiency, comfort, and performance across various environmental scenarios. Its modularity allows for iterative development, making it ideal for academic research and commercial prototyping. Beyond comfort, this system holds the potential to reduce heat-induced stress, increase productivity among workers, and offer relief during long travel or trekking in heated regions.

This paper focuses on principles from thermodynamics, electronics, and ergonomics to

deliver a practical solution for real-world problems. Furthermore, its simplicity and use of readily available components like the Peltier plate, sensor, fans, and Arduino microcontroller allow for ease of prototyping and scalability. Through iterative design and testing, the paper aims to create a user-friendly cost-effective solution for wearable climate control.

## II. LITERATURE REVIEW

Seeberg, et al. discuss the role of smart textiles in improving safety and thermal protection for workers operating in cold climates. Their work highlights how advanced textile technologies can integrate sensors, heating elements, and responsive materials into garments to actively regulate body temperature and monitor environmental conditions. The study emphasizes that traditional cold-protective clothing often provides only passive insulation, whereas smart textiles enable adaptive thermal management and real-time safety feedback, reducing risks such as hypothermia, reduced mobility, and productivity loss. The authors also note the importance of ergonomic design, energy efficiency, and durability when embedding electronic components into wearable fabrics. Overall, the paper positions smart textile systems as a promising direction for next-generation protective clothing by combining comfort, safety monitoring, and intelligent temperature control features.

Duebendorf and St. Gall (2020) describe the development of “real smart” protective clothing equipped with an inbuilt air-conditioning system aimed at improving worker comfort and safety in high-temperature environments. The work focuses on integrating compact cooling units directly into garments to provide active temperature regulation rather than relying only on passive ventilation or insulation. The study highlights how embedded A/C technology, combined with lightweight materials and ergonomic garment design, can significantly reduce heat stress and fatigue for industrial workers and emergency responders. It also discusses design challenges such as power consumption, portability, airflow distribution, and durability of embedded components. Overall, the report presents built-in A/C clothing as an innovative step toward intelligent

wearable protection systems that enhance both thermal comfort and operational performance.

Hemavani, et al. present a temperature programmable suit that uses a thermoelectric cooler/heater based on Peltier modules to provide both heating and cooling functions within a wearable system. Their work explains how thermoelectric devices can reverse operation depending on current direction, allowing a single module to act as a cooler in hot conditions and a heater in cold environments. The system integrates temperature sensors and a programmable control unit to maintain user-defined temperature levels automatically. The authors emphasize advantages such as compact size, solid-state operation, low maintenance, and precise temperature control compared to conventional HVAC-based wearables. The study concludes that thermoelectric-based suits are a promising solution for adaptive personal thermal management, especially for industrial, medical, and extreme-environment applications.

Sabarish and Reddy et al. propose a solar-powered thermal jacket designed to support soldiers operating in extreme temperature conditions by providing portable and renewable thermal regulation. Their study describes a wearable system that integrates solar panels, energy storage units, and embedded heating elements to maintain body warmth without relying on conventional battery-only supplies. The jacket converts solar energy into electrical power, which is then used to drive controlled heating components distributed across the garment, ensuring uniform temperature support and improved endurance in harsh climates. The authors highlight benefits such as energy efficiency, mobility, and reduced logistical burden in remote operations. Related conference work reported in IOP Conference Series: Materials Science and Engineering (2024) further support the feasibility of advanced thermal garments by emphasizing improved material selection, smart control mechanisms, and hybrid energy approaches for next-generation protective clothing. Together, these works underline the growing importance of renewable-powered and smart thermal wearables for defense and extreme-environment applications.

Paul et al. present a battery-powered heating and cooling suit designed to provide active thermal regulation for users in variable environmental conditions. The system integrates thermoelectric modules, temperature sensors, and a microcontroller to maintain a user-defined comfort range by dynamically switching between heating and cooling modes. Powered by a compact battery pack, the wearable ensures portability and independence from external power sources, making it suitable for outdoor workers, military personnel, and emergency responders. The authors discuss design considerations such as energy efficiency, weight distribution, thermal comfort, and safety, emphasizing the need for effective heat dissipation and ergonomic integration of electronic components. The study demonstrates that battery-powered thermal suits offer a flexible and adaptive solution for personal climate control, enhancing both comfort and operational performance in extreme conditions.

Annapurnadevi et al. propose an adaptable jacket that automatically adjusts to varying climate conditions using an ARM microcontroller as the central control unit. The system integrates temperature sensors to monitor ambient and body temperatures in real-time and controls embedded heating and cooling elements accordingly, maintaining user comfort across different environmental conditions. The microcontroller processes sensor data and regulates the operation of thermoelectric modules, fans, or heating elements based on predefined thresholds, enabling dynamic and responsive thermal management. The study highlights advantages such as low power consumption, precise temperature control, and enhanced wearability due to the lightweight and ergonomic design. This work demonstrates the potential of intelligent, microcontroller-driven garments for personalized climate adaptation in both every day and extreme environmental scenarios.

Jeena Raju Poikayil's et al. focuses on the development of a wearable thermal management system that uses thermoelectric (Peltier) modules to provide both heating and cooling within a single garment. The study explains how reversing the direction of current through the Peltier device enables dual-mode operation, allowing the jacket to adapt to

different environmental conditions. The design integrates heat sinks, fans, and a control unit to improve heat transfer and regulate temperature effectively, while embedded sensors support feedback-based control for user comfort. Emphasis is placed on portability, compact design, and solid-state operation without refrigerants, making the system suitable for outdoor workers and extreme climate use. The work concludes that Peltier-based jackets are a promising approach for smart wearable thermal regulation, though efficiency, power consumption, and heat dissipation remain important design considerations.

Dr. Sumeet Hangargi's et al. presents a wearable cooling garment developed to improve personal thermal comfort in high-temperature environments. The study focuses on designing a jacket that uses forced air circulation and compact cooling mechanisms integrated into a wearable structure to regulate the user's body temperature. It discusses the selection of lightweight materials, airflow channels, miniature fans, and embedded control elements to ensure effective cooling while maintaining comfort and mobility. The fabrication process emphasizes ergonomic layout, safety insulation of electronic parts, and uniform air distribution across the body. The research highlights that such air comfort jackets can significantly reduce heat stress and fatigue for industrial workers and outdoor users, while also noting the need for optimization in power usage, airflow efficiency, and wearable design for long-duration operation.

K. M. Jamiul Haque's et al. presents a wearable cooling solution that integrates thermoelectric (Peltier) modules into a jacket to provide localized and controllable temperature reduction. The study describes a compact, portable design in which Peltier plates are combined with heat sinks, cooling fans, and a control circuit to efficiently remove body heat and circulate cooled air inside the garment. Sensor-based monitoring and microcontroller control are used to regulate temperature and optimize performance while maintaining user comfort. The author emphasizes portability, modular construction, and suitability for outdoor and high-temperature working conditions. The research concludes that thermoelectric-based smart jackets are a practical

approach for personal cooling, though improvements in power efficiency, battery life, and heat dissipation are important for large-scale real-world deployment.

Kahori Hashimoto's et al. investigates how forced-air wearable garments can help regulate human thermal response under extreme heat conditions. The research evaluates a jacket equipped with integrated fans that actively circulate air between the garment and the body, enhancing sweat evaporation and convective heat transfer. Experimental results show that even when ambient temperature is higher than body temperature, continuous airflow inside the clothing microclimate can suppress the rise in core body temperature and reduce physiological strain. The study highlights improvements in thermal comfort, reduced heat stress indicators, and better tolerance during heat exposure trials. It concludes that fan-assisted wearable cooling garments are an effective and practical approach for personal heat protection, especially for workers and individuals operating in very hot environments.

### III. METHODOLOGY

The Air Conditioning Jacket system is built around the thermoelectric cooling effect generated by a single Peltier plate (TEC1-12706), which is integrated into the back panel of the wearable prototype. When current flows through the Peltier plate, one side absorbs heat (creating a cold junction) and the other side releases it (hot junction). To enhance thermal transfer, aluminum heat sinks are affixed on both sides of the Peltier module. Two fans are placed one near the cold side to circulate cool air within the jacket, and another at the hot side to expel warm air, preventing overheating of the module. The system is powered via an external adapter (12V, 5A) to ensure stable voltage and current supply during controlled testing conditions.

The Temperature sensor continuously monitors the jacket's internal temperature, sending real-time data to a microcontroller (e.g., Arduino Nano). Based on predefined temperature thresholds, the microcontroller adjusts the fan operation or triggers alerts. The jacket is designed for testing with student volunteers in simulated heat exposure scenarios to collect performance data.

All electronic components are safely insulated and mounted on a breathable, ergonomic fabric structure to ensure user comfort during trials

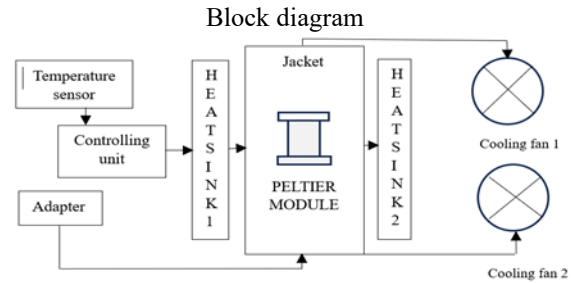


Fig 1. Shows the Block Diagram of the System

### Description

In this paper we have used the Peltier Module. In input we have used a temperature sensor connected to the controlling unit and adapter. In output we have used two cooling fans.

### Flowchart

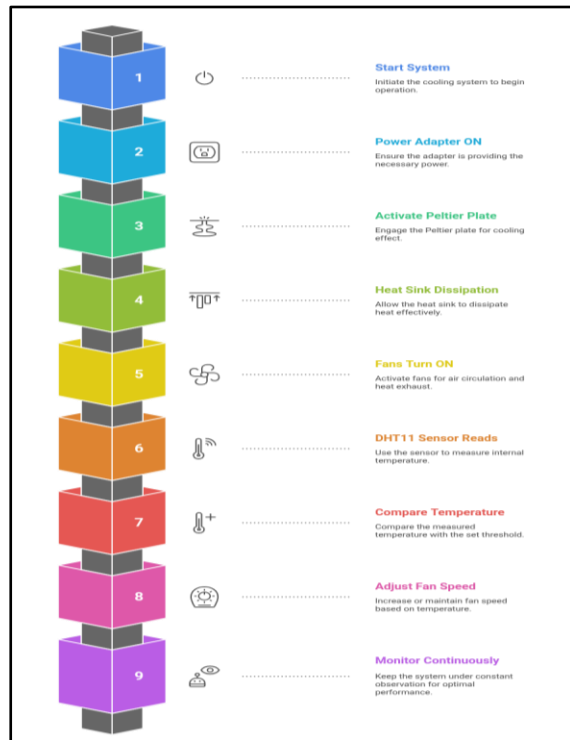


Fig. 2 Shows the Flowchart of the System

### Working

1. Power ON the system – Jacket is connected to the 12V, 5A adapter.
2. The temperature sensor reads the internal jacket temperature continuously.
3. The microcontroller receives temperature data from the sensor.
4. Compare temperature with predefined thresholds stored in the microcontroller.

If temperature > upper threshold → activate cooling.  
If temperature < lower threshold → maintain or alert (optional heating if implemented).

5. Activate Peltier module:  
The cold side absorbs heat and cools the jacket.  
The hot side releases heat.
6. Fans operation:
  - A fan on the cold side circulates cool air inside the jacket.
  - A fan on the hot side expels heat from the hot junction.
7. Monitor temperature continuously while fans and Peltier module operate.
8. Adjust fan speed or module operation dynamically based on real-time data to maintain comfort.
9. Trigger alerts if temperature goes beyond safe limits (optional safety feature).
10. System OFF – After testing or when the desired cooling is achieved.

### IV. SYSTEM REQUIREMENT

#### Hardware Requirement:

- Peltier Plates (2 units)
- Cooling Fan 2 (3.7V)
- Adapter (12V, 5A DC)
- 2 Heat Sink
- Wires, Soldering Kit, Enclosure Box
- Temperature Sensor

### V. EXPERIMENTAL SETUP & RESULT

#### Experimental Setup



Fig 3. Shows the Experimental Setup of the Proposed System

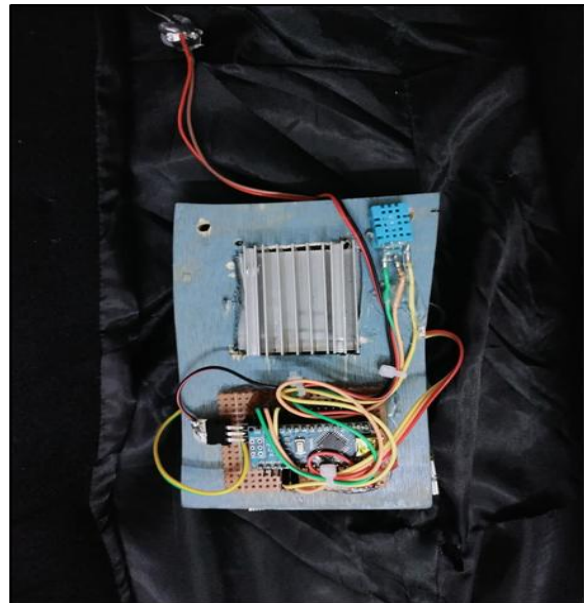


Fig 4. Shows the Experimental Setup of the Proposed System

Result: The developed Air Conditioning Jacket prototype successfully demonstrated the feasibility of wearable thermoelectric cooling using a TEC1-12706 Peltier module integrated into the back panel. During controlled testing with a 12V, 5A power supply, the system was able to produce a noticeable temperature drop inside the jacket microclimate within a short

response time after activation. The aluminum heat sinks and dual-fan arrangement effectively supported heat transfer, with the cold-side fan distributing cooled air inside the jacket and the hot-side fan preventing thermal buildup at the module.

Temperature sensor readings transmitted to the Arduino Nano showed stable real-time monitoring, and the microcontroller correctly responded to predefined thresholds by adjusting fan operation and issuing alerts when required. Test trials with student volunteers under simulated heat exposure conditions indicated improved thermal comfort compared to normal clothing, along with consistent system behavior and safe operation. The insulated mounting and breathable fabric structure ensured user comfort and electrical safety throughout testing. Overall, the results confirm that the proposed design provides practical, controlled, and wearable cooling performance, while also highlighting opportunities for further improvement in portability and energy efficiency.

#### VI. CONCLUSION

In conclusion, the Air Conditioning Jacket for Workers or Travelers presents an innovative, efficient, and wearable solution to combat heat stress in harsh environments. By integrating a Peltier module with dual heat sinks, cooling fans, and a temperature-sensing feedback system, the jacket provides targeted, real-time thermal comfort for individuals exposed to high temperatures. Its energy-efficient, portable design ensures both functionality and user safety, making it a practical option for outdoor workers, travelers, and field personnel. This paper not only demonstrates the potential of thermoelectric cooling in wearable tech but also opens avenues for further development in smart, climate-responsive clothing solutions.

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