# Air Conditioned Cooling Work Jacket

**Name: Mehedi Hasan Shakil**
**Roll: 2010876138**
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**A Project Proposal for Designing and Manufacturing**

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## 1 Abstract

Air conditioning is the process of removing heat from an enclosed space to achieve a more comfortable interior environment and in some cases also strictly controlling the humidity of internal air. The air conditioning system can be installed in a small room or in a huge warehouse. But we are going to integrate this system into our wearable solutions. This project is about embedding the air conditioning system in our clothes. Our goal is to design and manufacture air conditioned cooling work jacket for workers who work outside in extreme heating conditions. The work jacket will be built with cotton along with two fans, a temperature and humidity sensor, a micro-controller chip and a battery to power up these devices. As the temperature and humidity sensor will collect information from the body and the fan will respond accordingly, we need some programs to control these devices. The programs will be implemented in C by ourselves. All the hardware required will be purchased from the vendors as per design.

## 2 Project Background

### 2.1 Introduction

Heat strain is a common phenomenon in the occupational field, especially in those sectors with outdoor work activities like agricultural, road and construction sectors. This directly impacts the productivity of the workers. In addition, global warming has boosted this situation to a dangerous level. As a result, the productivity of the workers reduces by a significant level. Along with productivity, there are health issues. Many studies provided evidence of the association between heat exposure and the risk of occupational injuries[1]. Prolonged exposure to heat may, in fact, produce an important impact on the health of workers (dehydration, heat cramps, heat exhaustion and heat stroke) as well as on their productivity[2]. To overcome this situation we need air conditioning system. But the conventional air conditioning system can be installed only in an enclosed area. Whereas most of the workers work in open areas. For this reason, we are going to develop wearable technology. A simple air conditioned cooling work jacket will be built to resolve the described problem.

### 2.2 Literature Review

This type of product has been developed to improve work conditions and reduce risks within the workplace. In the field of the Ergonomics of Thermal Environments, technological innovations are geared towards the development of wearable solutions with the scope of preventing heat strain, creating innovative and smart systems for continuously monitoring workers' physiological

parameters during heat exposure or personal cooling garments (PCGs)[3]. Nowadays, different types of PCGs exist, designed using different principles such as air-cooled garments (ACG), subdivided into natural air-cooled garments (ACG-Ns) which use evaporative cooling and cold air-cooled garments (ACG-Cs) that use conductive, convective and evaporative cooling; liquid cooling garments (LCGs) based on conductive cooling of a circulating liquid and phase change materials (PCMs) mainly based on conductive cooling by using the latent heat storage of phase change materials.

PCGs based on evaporative cooling are less effective in very humid environments while those using conductive cooling can be effective regardless the environmental conditions) and the duration of the cooling power; any interferences with the working activity or with possible personal protective equipment and the acceptance by the worker. Innovations are continuously being developed in cooling garments such as the use of fans embedded in the clothing creating an air ventilation garment (AVG), as well as hybrid cooling garments (HCGs), which combine two of the above-mentioned cooling systems, for example PCMs and fans.

# 3 Methodology

Evaporation is the process that changes liquid water to gaseous water (water vapor). For this process, temperature is the main force. Water gets vapor and decreases temperature. Here the liquid water is the sweat that comes out of the worker's body. This project will focus on the evaporative properties of a ventilation jacket, which are crucial to ensure heat dissipation from the human body through evaporation during heat exposure. Due to the temperature of the body, sweat gets into vapor. But this is a slow process. Because inside our clothes the humidity is high. If we can increase the evaporation rate, the body temperature will be decreased. For this reason, the ventilation jacket will have two high-speed fans located at the lateral lower back sides. See Figure 1. The jacket will be composed of cotton. The short-sleeve jacket will have two layers so that it can contain other devices inside it.

Figure 1: Short Sleeve Cotton Air Conditioned Jacket

Ventilation will be assured by two fans, with a diameter of 8 cm, powered by a rechargeable Lithium-Polymer battery pack with an autonomy of 8 h, a voltage of 7.4 V and an energy capacity of 4400 mAh, embedded in a pocket placed inside the jacket. We know that rechargeable Lithium-Polymer battery is more powerful than alkaline battery[4]. So we are going to use Lithium Polymer battery. This battery will power up two fans and the temperature and humidity sensor as well as the microcontroller chip for about 8 hours. Air velocity can be adjusted at six different levels, reaching the maximum value of the flow rate of about 12 l/s for each fan. The jacket will have six additional circular air – openings, placed vertically in the middle-upper part of the back, each of them with a diameter of 1 cm. The distance between two consecutive openings in between 4.5 cm and 5 cm with a total of about 23.5 cm between the first and the last openings (from center to center).

The most important component of the proposed design is the temperature and heat sensor. It will be placed in the middle back of the jacket. This device will be placed inside part of the jacket so that it can be in touch with the body. It will collect the temperature of the body and also the humidity inside the jacket. This device will continuously send data to the microcontroller chip. The microcontroller will be programmed to analyze the data received from the sensor. The chip will have six states of temperature and humidity. This means that the fans will get six different velocities in response to different temperatures. According to the analyzed data, the microcontroller will control the speed of the fans. This process will provide an automatic control system according to the requirements. No need to manually speed up or down the fans. The program to control the fan will be very easy, so that it can be modified as per requirements. These arrangements are shown by the block diagram in the second picture of Figure 2.

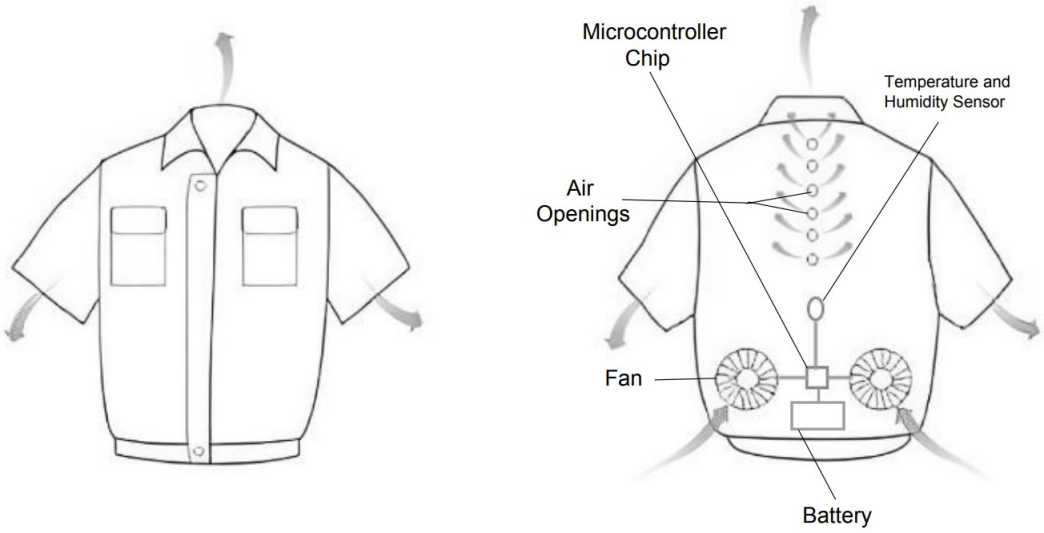


Figure 2: Block Diagram of the Proposed Jacket

# 4 Time Schedule

Table 1: Estimated time schedule for this project

| Time in Week | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Work activity** | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th | 12th |
| Background Study | | | | | | | | | | | | |
| Components Collecting | | | | | | | | | | | | |
| Designing | | | | | | | | | | | | |
| Assembling Components | | | | | | | | | | | | |
| Writing Program | | | | | | | | | | | | |
| Testing | | | | | | | | | | | | |
| Beta Version | | | | | | | | | | | | |
| Debugging | | | | | | | | | | | | |
| Final | | | | | | | | | | | | |

# 5 Cost Estimation

Table 2: Estimated cost for this project

| **Component** | **Specification** | **QTY** | **Cost**$_{(BDT)}$ |
|---|---|---|---|
| Cotton Cloth | - | - | 500 |
| Fan | Standard Fan 80mm | 2 | 2 X 1,000 |
| Battery | 7.4V 4400mAh | 1 | 1,000 |
| Temperature and Humidity Sensor | DHT11 | 1 | 1000 |
| Microcontroller Chip | ESP32 | 1 | 2,500 |
| Wire | - | - | 100 |
| Total | - | - | 7,100 |

# 6 Conclusion

This project will help to reduce the temperature of the body by evaporation of sweat. Nothing complicated to this project. As a minimal number of devices are used to design the jacket, it won't weigh too much. Also, the ventilation jacket has an inbuilt temperature and humidity sensor, no need to control the speed of the fans manually. Which will be too much user-friendly for the workers. The jacket can be worn alone or along with a work ensemble and a combination of both. Being a simple project, this won't take too much time and cost. The project will take near about 3 months for completion and the total estimated cost for the project will be 7,100 TK.

# References


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