

Interactive Smart Textile Garment with Automatic Temperature Control and Monitoring

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ABSTRACT

Smart textiles are available since 1980; advancements in wearable technology have made the smart textiles smarter. In this proposed product, interactive smart textile garment has been proposed which will have conductive structures, separated by an insulating layer sandwiched between the garment fabrics. This smart garment integrated with wearable electronics for health care & safety purpose, also helpful for industrial working peoples, sportspersons, automotive & entertainment applications, and also in Military, were persons worked under high temperature in hills and cold regions. The heating fabric element is flexible and washable in nature to make the product daily useable with easy maintenance. Automatic body and environment temperature monitoring are done using a smart control unit which can do garment heating operations as per the situation and customer demand. The product can be used in geotextiles, biomedical clothing and protective clothing's.

Index Terms: Smart textile, Heating pad, LM35 Sensor, Bluetooth module, Mobile device.

1. INTRODUCTION

Important resources of the military are soldiers. Soldiers are the backbone of our country conjointly incorporates an important role to safeguard one's country. The term soldiers mean which includes service men and women from the military, Air Force, Navy, and Marines. If a military person is in a fieldwork his physiological signals ought to be monitored altogether cases. Because the military individuals are the foremost vital and needed people of our country. They need their own fieldwork at anytime and anyplace. Military individuals should have to shield throughout temperature reduction cold winter conditions, in spite of what garments an individual puts on, they are exposed to the cold atmosphere and want thermal protection. They'll forever be taking and holding the duty in extreme climate throughout the year. Whereas providing security for the country, they're going to face troubles in extreme hot/cold climate. The solution to the current drawback is to decorate in layers, which regularly ends up in the persons being dressed heavily and their movements restricted. Once an individual has to keep or travel a cold place he/she should carry out heat garments which might be simply administered by traditional travelers and shifting peoples. But, for an individual who has to work or ought to keep in cold place for his or her operating purpose or for any vital analysis scenario, it takes a great deal of days to continue within the same place for their work. So, in this scenario, this sort of garment material is helpful and makes them comfortable with this material for a short time. Throughout this condition, the protective and wearable Physiological observation of wear is one among the simplest solutions.

An electronic textile may be a material which will conduct electricity. If it's combined with electronic elements it will sense changes in its setting and respond by giving off light-weight, sound or radio waves. Electronic textiles (e-textiles) are materials that have natural philosophy and interconnections woven into them. Components and interconnections are a section of the material and therefore are abundant less visible and, a lot of significantly, not vulnerable to turning into tangled along or snagged by the environment. An electronic textile refers to a textile substrate that comes with capabilities for sensing (biometric or external), communication (usually wireless), power transmission, and interconnection technology to permit sensors or things such as science devices to be networked

along inside a cloth. Electronic textiles enable very little bits of computation to occur on the body. They usually contain semiconducting yarns that are either spun or twisted and incorporate some quantity of semiconducting material (such as strands of silver or untainted steel) to alter electrical physical phenomenon.

2. LITERATURE REVIEW

[1] Bao-guo Yao of china jiliang university has proposed “Protective thermo-physiological clothing integrated with intelligent control and wireless measurement” in the year 2010. In the research work he has used artificial intelligence thermal control and body physiological monitoring. They had three main experimental protocol as computer controlled climatic chamber, infrared camera for thermal images and temperature and humidity wireless measurements. It has increase the system lost and not washable product also had large conditions to solve.

[2] Gregory paul of state university of New York has proposed “Battery powered heating and cooling suit” in the year 2014. In this research work the proposed system has battery powered heating/cooling suit has controlled by thermoelectric devices. The circuit is designed using ATmega16 microcontroller with 12v alkaline battery and temperature sensing by LM34. But it cannot be applicable for easy way of wearable also connect carry easily.

[3] Faming wang of Lund University has proposed “A review of technology of personal heating garments” in the year 2010. In this research paper, modern fiber and electronic technology makes it possible to make smart garments, which can help wearers to manage in specific situations by improving the functionality of traditional garments. The personal heating garment (PHG) widens the operating temperature range of garment and improves the protection against cold. It describes four types of personal heating garments and their advantages and disadvantages are presented. Some challenges and suggestions are finally addressed are finally with regard to the further development of personal heating garments.

[4] Hansup lee of Lund university has proposed “Evaluation of an electrically heated vest (EHV) using a thermal manikin in cold environments” in the year 2009. In this research paper, the heating efficiency of an electrically heated vest (EHV), its relationship to the microclimatic temperature distribution in a three-layer clothing ensemble, and the effect of an EHV on clothing total thermal resistance were investigated by both theoretical analysis and thermal manikin measurements. It was found that the EHV can alter the microclimatic temperature distribution of the three layer clothing ensemble. The EHV can provide an air temperature of 34 degree Celsius around the manikin’s torso skin. The highest temperature on the outside surface of EHV was around 38 degree Celsius which indicates that it is safe for the consumer. The higher the heating temperature the lower the heating efficiency obtained. This was due to much more heat being lost to the environment and hence the heat gain from the EHV was small.

[5] M.Sivalingamaiah, E.Satheesh Kumar, and M.Vijaya Lakshmi has proposed “Solar based E-Uniform for Soldiers- Used for Temperature Control and Tracking” in the year 2016. In this research paper, it gives better protection to the soldiers who are working in extreme weather conditions. Solar panels are used up the internal circuitry of the E-uniform. A 12 V DC lead acid rechargeable battery is used for storing the energy. They are using

conventional battery changing unit also for giving supply to the circuitry. It's main application is used in military applications and this uniform can be used for all the climatic conditions.

3. PROPOSED SYSTEM

The proposed system may be a sensible garment that is predicated on automatic temperature management and watching exploitation Arduino mega, by that the people/user can simply manage the temperature of the garment employing a Bluetooth module. The garment is extremely versatile to wear, convenient, healthy and lightweight in weight. The user wears a climate flexible wear as a dress, and additionally there's a facility to look at and management the temperature standing through the Bluetooth device, that is placed during this jacket. The ultimate style is associate in nursing Arduino primarily based system, that the system makes heat by exploitation the reversible battery power provide. That the heating method is completed by a heating pad material. The warmth conducting material is controlled by a current negative feedback circuit that is associate in nursing SMD (Surface Mount device) heating device to provide the facility supply to the circuit the reversible battery is employed. Generally, the warmth conducting materials square measure placed within the garment to supply heat that is controlled by circuit style. The circuit is definitely connected and removed for wash-and-wear purpose and it's not harmful to the form. The system additionally exploitation LM-35 temperature sensing element, Bluetooth module, and reversible battery.

A. Personal heating garments (PHG)

Modern technology makes clothes smart, which can facilitate a user to manage specific things by raising the functionality of the clothes. The personal heating garment (PHG) widens the operative temperature vary of the garment and improves its protection against the cold. Majorly cold injuries are classified into temperature reduction and non-freezing cold injuries. These cold-related injuries affected the individuals by inflicting frostbite, lower vital sign, heat stroke, heat rash, dehydration, physiological condition, etc., and are the main issues. To reduce these issues individuals will wear the personal heating garment (PHG) to increase their exposure time in cold regions and reduce cold stress. Personal heating clothes have numerous styles of materials that are expected to achieve success within the market. The performance of those products helps us and guides us to decide on appropriate personal heating clothes. The personal heating garment has different types for his or her useful purpose and style materials is selected and used for personal heating systems. During this project, one in every one of the main kinds of personal heating garment (PHG) is used and named as an electrical heating garment (EHG). This electrical heating merchandise use embedded heating components to come up with the heat. In most EHG's, one electrical heating wire is employed and it's connected to an influence offer. There are some attainable heating components which might be used for sensible garment purpose that are graphite components, electrically semiconducting rubbers, neutralized textile materials, positive temperature constant polymers, and carbon polymer heating materials.

B. Design

The structure of this piece of clothing gives better assurance to the fighters and naval force individuals who are working in outrageous climate conditions. Armed force individuals dependably are taking and holding the things and security materials amid their obligation in extraordinary climate conditions consistently. While giving security to the nation they may confront inconveniences in outrageous chilly climate conditions. The outrageous climatic conditions are irritating and bizarre since the commencement of people, for example, heat stroke, heat rash, frostbite, lack of hydration, hypothermia, and so on., are the serious issues and one can't escape from these issues. Some innovative arrangements made to keep individuals thermally agreeable which will be understood out by this keen article of clothing. In the proposed framework, it is constrained by an Arduino mega which is associated with a Temperature sensor, Bluetooth module, and a Heating pad. This warming garment is a noteworthy component of this venture. The warming garment is built utilizing a work of polyester fiber and miniaturized scale metal conductive fiber collapsed into a defensive polyimide film. This Heating cushion is an electrically warming item which was utilized to produce heat by an inserted warming component. The warming cushion is evaluated up to 5V and draws about 600Ma. The entire structure has an effect over the shrewd material field and furthermore makes a tremendous reaction over the implanted innovation to the following dimension of the material field.

4. HARDWARE DESIGN

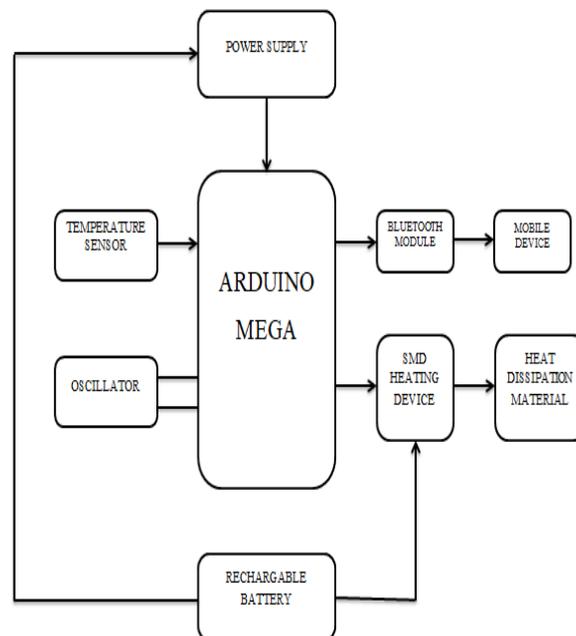


Figure 1: Block Diagram

A. Operation

The Arduino Mega may be a microcontroller board supported the ATmega2560. it's 54 digital input/output pins (of that 14 are used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 megahertz oscillator, a USB affiliation, an influence jack, associate ICSP header, and an electric switch the facility supply is chosen mechanically. External (non-USB) power can come back either from associate AC-to-DC

adapter (wall-wart) or battery. The board can operate associate external offer of 6 to 20 volts. The counseled range is 7 to 12 volts.

In this project, this board has connected with the temperature sensor and Bluetooth module to observe the temperature details. The temperature sensor analog pin is connected to the analog pin of Arduino board and therefore the ground and voltage pins are connected several area provided in Arduino board. The Bluetooth module has six pins within the module however only four pins were connected to the Arduino board for sending the temperature details to mobile device. This Arduino board is very compact and easy to write the program for temperature sensor and Bluetooth module procedure.

The LM35 is a temperature sensor which senses the out temperature and displays in Celsius temperature. This LM35 has three pins namely ground, analog pin and voltage. These pins are connected with Arduino mega board and when supply is given it senses the temperature and displays in the application developed by the user. It is mainly controlled by the Arduino programming language and its help full to user by giving accurate details of temperature. The LM35 has an output voltage that's proportional to the Celsius temperature.

Bluetooth module in the hardware part is the HC-05 Bluetooth module. This module helps in this project while the hardware part needs to transfer the data's to the application developed by the user, the user must connect the mobile application with the Bluetooth device and the transfer the data's easily. This Bluetooth module consists of six pins in it. Only four pins connected to the Arduino mega module. The receiver and transmitter pins are connected to transmitter and receiver of Arduino respectively. Then ground pin and power supply pins are connected with Arduino ground pin and 5v pin respectively. This Bluetooth module plays important role in this project by connecting with application developed by the user. Monitoring temperature details using this procedure gives better way of accurate temperature details and able to connect with the heating pad and then it gets heated.

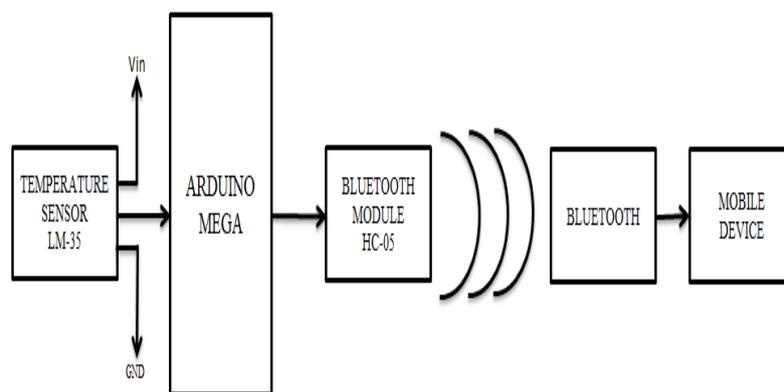


Figure 2: Monitoring Temperature Details Using Mobile Device

B. Heating pad

The heating pad is small and easily usable material constructed using a mesh of polyester filament and micro metal conductive fiber folded into a protective polyimide film. The features of the heating pad are given by that the operating voltage given is 5V DC and operating current is $\sim 750\text{mA}$ ($\sim 6.5\Omega$).

There are a lot of great projects can be done through heating pads (5x10cm and 5x15cm) in, ranging from warming gloves, slippers, a blanket, or anything you want to keep nice and warm. It can go as simple as getting the appropriate power supply and a heating pad. One warmer is rated for 5V, and attracts regarding 600mA.

5. MOBILE APPLICATION

In this project, to monitor and control the temperature details a mobile application is developed. This application is connected with the Bluetooth option in mobile also the hardware part is connected with the HC-05 Bluetooth module. This module helps to transfer the data's to the mobile device with the help of connecting with Bluetooth option in mobile. When it's connected it automatically senses the out temperature with the help of temperature sensor and display in the mobile device. Then the user can select the minimum and maximum temperature in the application and it makes to work the heating pad. After that heating pad gets heated for what temperature the user has selected and it makes the user warm in cold region. This application has to display out temperature with the help of temperature sensor. Also it connected with Bluetooth module in hardware. The minimum and maximum temperature will be selected by user only. Also it displays a mobile battery percentage for the user.



Figure 3: Mobile Application

6. RESULTS AND DISCUSSION

In this project, the heating pad has the major source element in which the smart garment gets heated and makes thermal clothing. This heating pad is sandwiched between the garment and it heated up with the help of circuit. Since the heating pad has its own value of heating analysis that can be monitored and noted with the help of the circuit. The mobile application has the major role in this project. This application has to be connected with the mobile Bluetooth option and after connecting with Bluetooth option the application get started and then the user

need to select the maximum and minimum temperature by seeing the temperature displayed in the application. Since the hardware is connected with the temperature sensor so that the out temperature will be automatically detected and displayed in the temperature option in the application.

After selecting the maximum and minimum temperature the circuit gets started and the heating pad gets heated with the help of MOSFET connection. The voltage will be get triggered using the MOSFET in the circuit and it also gets heated for different maximum and minimum temperature values. The user can change it frequently when the heat is needed and also user can disconnect the Bluetooth option by selecting the disconnect from the device so that the application will be stopped from operating the circuit.

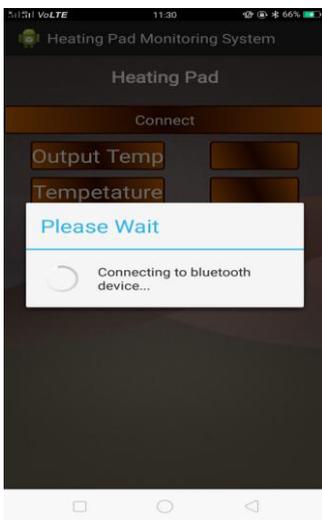


Fig 4: Connecting Bluetooth Fig 5: Connected with Device Bluetooth and mobile Battery percentage displayed



Fig 5: Out temperature is Detected



Fig 6: Minimum and Maximum temperature has selected.

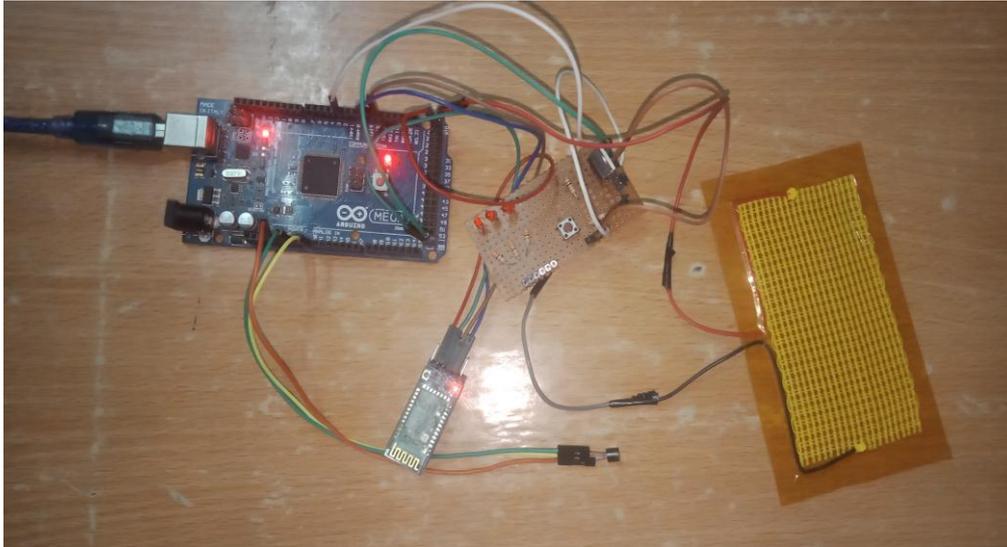


Fig 7: Hardware circuit connection

7. CONCLUSION

The project “Interactive smart textile garment with automatic temperature control and monitoring” is implemented and analyzed. This garment has the feature as controlling the temperature in cold conditions using the heating pad and temperature sensor and also monitored the temperature in mobile device with the help of circuit design. This system is compact in size and easily controlled. It is also portable and easy to use. The electrical parts are detachable and suit can be used to comfort the soldiers in cold regions. Due to this high temperature, it causes the human body some problems, for example, frostbite, hypothermia, insect bites, shivering, and other health issues. These problems affect the soldiers unable to work in any important situation, so this can be controlled through this garment. This product automatically controls the body temperature and triggers the heating for comfort and acts as a lifesaving device.

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