

DESIGN AND FABRICATION OF SOLAR BASED E-UNIFORM AND HEALTH MONITORING

PROJECT REPORT

Submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Electronics and Communication Engineering

By

A SRIHARI REDDY (40130011)

B MANIKANTESHWAR REDDY (40130020)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

CATEGORY-1 UNIVERSITY BY UGC

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JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **A.SRIHARI REDDY (40130011)** and **B.MANIKANTESHWAR REDDY (40130020)** who carried out the project entitled "**DESIGN AND FABRICATION OF SOLAR BASED E-UNIFORM AND HEALTH MONITORING**" under our supervision from November 2023 to April 2024.

Krishna
17/4/24

Internal Guide

Dr. R. KRISHNAPRASANNA, M.Tech., Ph.D.
Assistant Professor

T. Ravi
Head of the Department

Dr. T. RAVI, M.E., Ph.D.
Professor

Submitted for Viva voce Examination held on 18/4/24

Krishna
Internal Examiner

Raj
18/4/24
External Examiner

DECLARATION

I A. SRIHARI REDDY (40130011) hereby declare that the Project Report entitled "DESIGN AND FABRICATION OF SOLAR BASED E-UNIFORM AND HEALTH MONITORING" done by me under the guidance of Dr. R. KRISHNAPRASANNA, M.Tech., Ph.D. Assistant Professor, Dept. of Electronics and Communication Engineering at SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

DATE: 18-4-2024

PLACE: Chennai

SIGNATURE OF THE CANDIDATE

A. Srihari Reddy

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ABSTRACT

Solar-based E-Uniform furnished with better protection to the soldiers who are working in extreme weather. Solar Panels are used to power up the interior circuitry of the E-uniform. A 12 V DC lead-acid rechargeable battery is employed for storing the energy. We are using a conventional battery charging unit also for giving supply to the circuitry. ATmega328 microcontroller is the heart of the circuit as it controls all the functions. The temperature sensor will measure the body temperature of the human wearing that uniform. The heart beat sensor is used to measure the pulse rate of the person whether it constant or not and if it is high or lesser than normal level it will send the constant readings to the cloud and also via SMS by using GPS technology. The metal sensor will detect the metal-like bomb, any other planted weapon in ground and intimate the soldier. The GSM is interfaced with the microcontroller and GPS is additionally interfaced such the tracking of the whole soldier is observed. And the location is messaged to the particular concerned person /dept. This Uniform will make the soldier work in any kind of environment without any stress or distraction.

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	v
	LIST OF FIGURES	viii
	LIST OF ABBREVIATIONS	ix
1	INTRODUCTION	1
	1.1 General	1
	1.2 Embedded systems	2
	1.3 Design of Embedded systems	4
	1.4 Classification	5
2	LITERATURE SURVEY	6
3	AIM AND SCOPE OF PRESENT INVESTIGATION	10
	3.1 Aim	10
	3.2 Scope of the Project	10
	3.2.1 Technological Integration	10
	3.2.2 Design Consideration	11
	3.2.3 Health Monitoring Capabilities	11
	3.2.4 Applications and Use cases	12
	3.3 Objective	12
	3.4 Feasibility study and Risk Analysis	12
	3.5 Requirements Specification	14
	3.6 IEEE Standards	15
	3.7 Constraints	16
4	EXPERIMENTAL METHODS	18
	4.1 Existing System	18
	4.2 Proposed System	18
	4.3 Architecture Diagram	19
	4.4 Hardware Requirement	20
	4.4.1 Arduino UNO	20
	4.4.2 Power supply	25

	4.4.3 Temperature Sensor	26
	4.4.4 Heart Sensor	28
	4.4.5 Metal Sensor	30
	4.4.6 GPS and GSM	32
	4.5 Software Requirement	37
	4.5.1 Arduino IDE	37
5	RESULT AND DISCUSSIONS	42
	5.1 Result	42
	5.2 Source Code	44
	5.3 Discussion	48
6	CONCLUSION AND FUTURE SCOPE	50
	6.1 Conclusion	50
	6.2 Future Scope	50
	REFERENCES	51
	RESEARCH PAPER	54

LIST OF FIGURES

FIGURE NO	FIGURES NAME	PAGE NO.
1.1	Embedded Product Development Life Cycle	4
4.1	Architecture Diagram	18
4.2	Arduino Board	20
4.3	Arduino UNO pin configuration	22
4.4	General Block of Power Supply Unit	24
4.5	Temperature Sensor	25
4.6	Heart Rate Sensor	27
4.7	Metal Sensor	30
4.8	GSM Module	31
4.9	GPS Module	33
4.10	GPS Antenna	34
4.11	GPS Distance Calculator	35
4.12	Open Arduino IDE	38
4.13	Select COM Port	38
4.14	Select Arduino board	38
4.15	Sketch the Arduino IDE	38
4.16	Compile and Upload to Board	39
5.1	Working Model	41
5.2	Message Alert	42

LIST OF ABBREVIATIONS

IoT	Internet Of Things
ADC	Analog to Digital Conversion
DHT	Digital Humidity and Temperature
PIC	Peripheral Interface Controller
LCD	Liquid Crystal Display
GPS	Global Positioning System
GSM	Global System for Mobile Communication
IEEE	Institute of Electrical and Electronics Engineer
IDE	Integrated Development Environment
MCU	Micro Controller Unit
FTDI	Future Technology Devices International
ICSP	In Circuit Serial Programming
SRAM	Static Random Access Memory
EEPROM	Electrically Erasable Programmable Read Only Memory
PWM	Pulse Width Modulation
WLAN	Wireless Area Network
SCL	Serial Clock Line
SDA	Serial Data
UART	Universal Asynchronous Receiver and Transmitter
RTD	Resistance Temperature Detector

CHAPTER-1

INTRODUCTION

1.1 GENERAL

Warriors are the Army's most imperative asset. Warriors assume an important part to make sure one's nation. The term warriors incorporate administration men and ladies from the military, Air Force, Navy, and Marine. While giving security to the country, they could challenge inconveniences in hot/frosty climate conditions. Both exceptionally hot and icy temperatures might be unsafe for well-being. This venture may be a solution for this circumstance. During this venture, an E-Uniform is planned which provides better security to the officers who are working in great climate conditions. A temperature sensor is employed to see the temperature whenever. The DHT11 is a circuit temperature sensor, whose yield voltage is directly relative to the Celsius (Centigrade) temperature. Solar-based E-Uniform furnished with better protection to the soldiers who are working in extreme weather. Solar Panels are wont to power up the interior circuitry of the E-uniform. A 12 V DC lead-acid rechargeable battery is employed for storing the energy. For supplying power to the circuitry, a typical battery charging machine is used.

ATmega16a microcontroller is the heart of the circuit as it controls all the functions. The project is operated in two modes like summer mode and winter mode. By selecting the mode of operation, we are operating the system such that it can drive the body temperature according to heater/cooler. The heater/cooler in turn will help us to provide a cooling or warming effect inside the uniform which helps the soldier to bear any kind of external environment. The metal sensor will detect the metal-like bomb, any other planted weapon in the ground and intimate the soldier with a buzzer indication. This Uniform will make the soldier work in any kind of environment without any stress or distraction. Warriors are the Army's most imperative asset. Warriors assume an important part to make sure one's nation.

A temperature sensor is employed to see the temperature whenever. The DHT11 is a circuit temperature sensor, whose yield voltage is directly relative to the Celsius (Centigrade) temperature. In this project, an E Uniform is designed that gives more confidence to the fighters operating in wonderful weather. This uniform will make the trooper stand out in any setting.

Here, solar panels are being used to control the temperature 12 within the hardware

of the E-uniform. A 12 V DC lead corrosive rechargeable battery is employed for putting away the vitality. A routine battery charging unit is utilized additionally to offer supply to the hardware. A temperature sensor and heart beat sensor utilized for checking the wellbeing of the trooper in any circumstance. ATmega16a miniaturized scale controller is the heart of the circuit because it controls all of the capacities. The undertaking system is worked in two modes: summer mode and winter mode. The warmer/cooler will help to offer chilling or warming impact inside the uniform which helps the officer to face any kind of outer environment and he can work proficiently without warmth stress or frosty anxiety.

A 12 V DC lead corrosive rechargeable battery is employed for putting away the vitality. A standard battery charging unit is utilized likewise to offer supply to the hardware. Soldiers are one of the important factors in a country because they are the forces who protect our country day and night living behind sleep and rest. Solar based E-Uniform provides better protection to the soldiers who add extreme weather. This Uniform made the soldier work in any kind of environment. So, he could work efficiently without heat stress or cold stress. When the weather is too hot, the cooling system kicks in, and when it's excessively cold, the warming system kicks in. Significantly fewer soldiers will die as a result of its adverse consequences (low commando at the border).

1.2 EMBEDDED SYSTEMS

A system is something that maintains its existence and functions as a whole through the interaction of its parts. E.g. Body, Mankind, Access Control, etc A system is a part of the world that a person or group of persons during some time interval and for some purpose choose to regard as a whole, consisting of interrelated components, each component characterized by properties that are selected as being relevant to the purpose.

- Embedded System is a combination of hardware and software used to achieve a single specific task.
- Embedded systems are computer systems that monitor, respond to, or control an external environment.
- Environment connected to systems through sensors, actuators and other I/O interfaces.

- Embedded system must meet timing & other constraints imposed on it by environment.

An embedded system is a microcontroller-based, software driven, reliable, real-time control system, autonomous, or human or network interactive, operating on diverse physical variables and in diverse environments and sold into a competitive and cost conscious market.

An embedded system is not a computer system that is used primarily for processing, not a software system on PC or UNIX, not a traditional business or scientific application. High-end embedded & lower end embedded systems. High-end embedded system - Generally 32, 64 Bit Controllers used with OS. Examples Personal Digital Assistant and Mobile phones etc. Lower end embedded systems - Generally 8, 16 Bit Controllers used with a minimal operating systems and hardware layout designed for the specific purpose.

Applications

Embedded systems find applications across a wide range of domains, including:

Consumer Electronics: From smartphones and smartwatches to smart home devices and entertainment systems, embedded systems enhance the functionality and connectivity of consumer electronics.

Automotive Industry: Embedded systems control numerous functions in modern vehicles, including engine management, infotainment systems, safety features, and autonomous driving technologies.

Industrial Automation: Embedded systems enable process control, monitoring, and automation in manufacturing, robotics, and industrial machinery, improving efficiency and productivity.

Healthcare: Medical devices, wearable health monitors, and diagnostic equipment utilize embedded systems for patient monitoring, data collection, and treatment delivery.

IoT (Internet of Things): Embedded systems form the backbone of IoT devices, facilitating communication, data processing, and interaction with the physical world in smart cities, agriculture, healthcare, and more.

Aerospace and Defense: Embedded systems are critical for avionics, spacecraft control, navigation systems, weapon systems, and surveillance applications in the aerospace and defense sectors.

1.3 DESIGN OF EMBEDDED SYSTEM

Like every other system development design cycle embedded system too have a design cycle. The flow of the system will be like as given below.

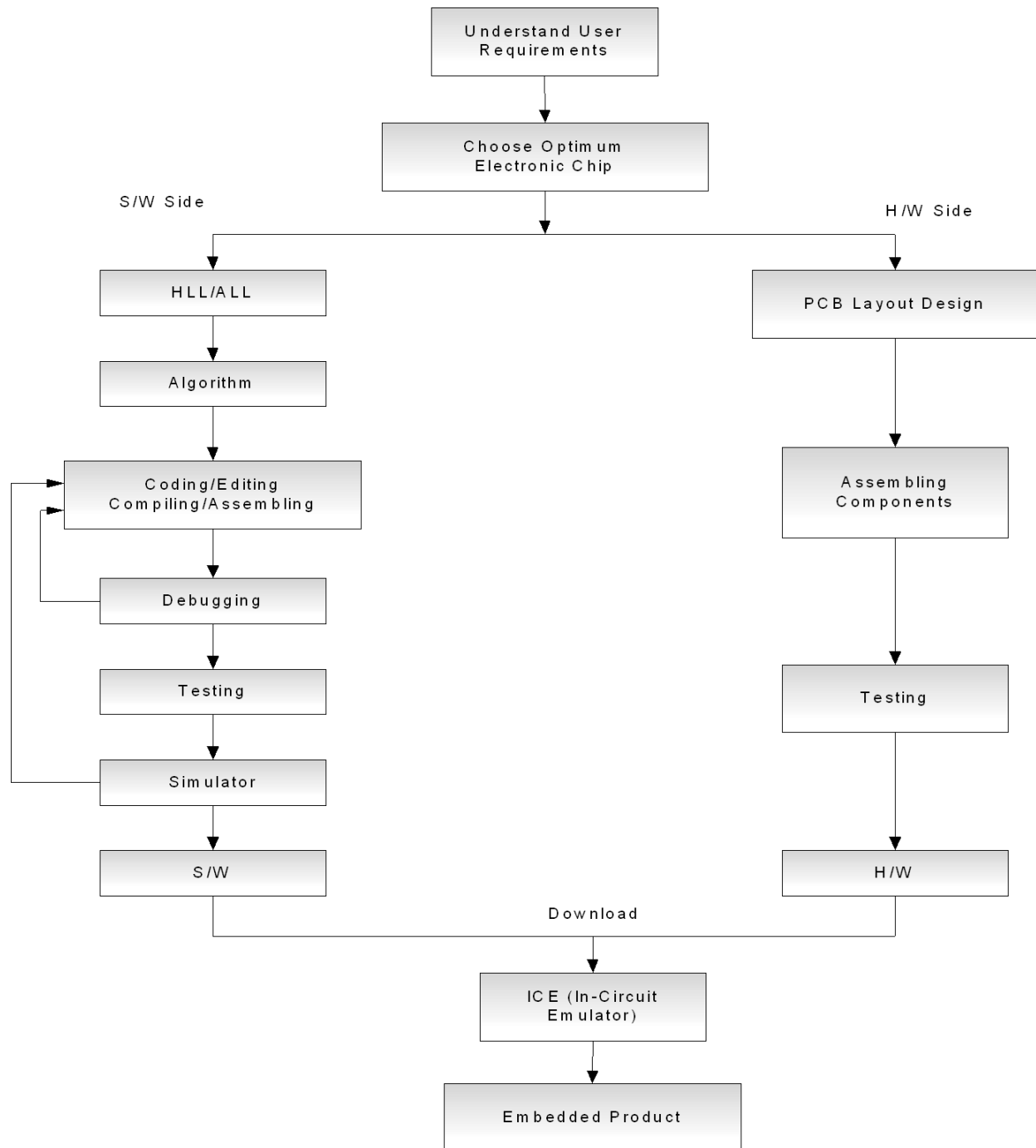


Fig 1.1 Embedded Product Development Life Cycle

From the initial state of the project to the final fabrication the design considerations will be taken like the software consideration and the hardware components, sensor, input and output. The electronics usually uses either a microprocessor or a microcontroller. Some large or old systems use general-purpose mainframe computers or minicomputers.

1.4 CLASSIFICATION

- Real Time Systems.
- RTS is one which has to respond to events within a specified deadline.
- A right answer after the dead line is a wrong answer
- RTS classification
 - Hard Real Time Systems
 - Soft Real Time System

Hard Real Time Systems

- "Hard" real-time systems have very narrow response time.
- Example: Nuclear power system, Cardiac pacemaker.

Soft Real Time System

- "Soft" real-time systems have reduced constraints on "lateness" but still must operate very quickly and repeatably.
- Example: Railway reservation system – takes a few extra seconds the data remains valid.

CHAPTER-2

LITERATURE SURVEY

Below are the literature surveys we have done. Every study based on the different methods in which they are executed the systems of solar based e-uniform which carried out for us to make new proposed system.

S Annapurna Devi and P Ramesh Kumar (2016) proposed an e-uniform which gives better assurance to the troopers in outrageous climatic condition. Temperature sensor is utilized to check the temperature which gives simple voltage which is changed over to computerize by utilizing ADC in the PIC microcontroller (PIC16F877A). The advanced qualities are checked with the warmth and cold limit level of temperature. In the event that the temperature is more than the edge cooler and fan will be initiated. Clock begins and the status of the framework is appeared on the LCD show.

Dr. S. N. Kannan and R. krishnavenisri (2018) proposed gadget uses the idea of solar and IoT primarily based tracking, controlling and monitoring device for soldiers who working severe climatic circumstance. The PIC18F452 microcontroller receives the statistics from the GPS, GPS and heartbeat detector. The heart price of the soldier is sensed via the heart beat sensor. If the heart fee is ordinary the alert message are despatched to the military manage unit through GSM module.

Nithyapriya. A.P.et.al (2020) proposed the undertaking "Solar based e-Battledress for soldiers" help the officers who work at extraordinary high temperature or outrageous low temperature is effectively tried and actualized. By utilizing this undertaking continuously applications we can help warriors to work even in outrageous climatic applications. It is an exceptionally solid and self-fixing sun powered innovation. This solar based E-Jacket for soldiers will assist us to give warm and cool effects, so that fighter can survive any form of exterior surroundings.

Sonali Kavitate and Onkar Jallapelli (2017) proposed the model of solar based e-uniform for soldiers safety in various unconditional temperatures like extreme high and extreme low. The advanced qualities are checked with the warmth and cold limit level of temperature. By utilizing this undertaking continuously applications we can help warriors to work even in outrageous climatic applications. In the event that the temperature is more than the edge cooler and fan will be initiated. Clock begins and the status of the framework is appeared on the LCD display.

Vignesh. A.et.al. (2022) proposed the system will help us in various aspects. Majorly it will save a lot of soldier's lives and its side-effects (low commando at the border) will get reduced drastically. This project has a huge part in our everyday life. Also, it can be utilized as a part of different floods of industrial applications. This Uniform made the soldier work in any kind of environment. So, he could work efficiently without heat stress or cold stress. The metal sensor will detect the metal-like bomb, any other planted weapon in-ground and intimate the soldier with a buzzer indication.

Adarsh K S.et.al (2016) proposed the system that they designed a jacket, named as "E-Uniform", which gives better protection to the people living in extreme weather conditions. This jacket maintains the desired temperature inside the jacket. This jacket is powered up by solar panel. By using this uniform we can monitor the body temperature of the soldier. This paper also concentrate on tracking the location of soldier from GPS, which is useful for control room station to know the exact location of soldier and accordingly they will guide them also soldier-to-soldier wireless communications to relay information on situational awareness and GPS navigation, Bio-medical sensors, Wireless communication.

Sri devi S.H.et.al (2020) proposed Solar based E-Uniforms provide better protection for soldiers working in extreme weather conditions. Solar panels are used to power up the internal circuits of the uniform. Energy is stored by using a 12V DC lead-acid battery. Regular batteries can also be used as charger. The LPC2148 microcontroller controls all the functions. A voltage sampler is interfaced, with the system using an ADC to obtain the voltage generated from the battery, as displayed on the 16X2 LCD. In this article, we have designed an electronic military uniform that provides better protection for soldiers working in extreme weather conditions.

Rahul Khairamode.et.al (2021) Design and fabrication of solar based E-jacket for soldiers. In every year we are facing several patterns of climates, the summer season, rainy season and winter seasons are the main. Temperatures that are very high and very low are both hazardous to health. "Too much exposure to heat is called heat stress as well as excessive too much cold is called "cold stress". At a very high temperature the most serious problem is heatstroke. In extreme cold, the most serious trouble is the risk of dehydration or dangerously cold bodies. Here we will design an E-Jacket for better protection for people living in "highest outlook" situations. GPS module also used in this jacket, for spot the location. Soldiers play an important role in the defense of a country. Soldiers will be constantly on duty in extreme weather conditions.

Abhinav Maheshwari (2018) Proposed Electronic-Jacket , In a global scenario, the prime question in every girl's mind is about her safety and the harassment issues. The only thought haunting every girl is when they will be able to move freely on the streets even in odd hours without worrying about their security. This project suggests a new technology to protect women. This project focuses on security for women so that they will never feel helpless. The system consists of various modules such as GSM, GPS, memory card, shock circuit, buzzer, camera, Raspberry pi-3 module. Today there are many cases which are happening about women. It was high time where women needed a change. This project is based on women security where women feel protected. This paper describes a safety electronic system for women, built in public transport vehicles such as cars, buses and auto-rickshaws as nowadays women are being molested, kidnapped and harassed by the drivers.

Dr. S. Ramesh (2020) Climate adjustable E-military suit. Nowadays, the climatic changes are very annoying and unusual to the people. In order to overcome this problem, air-conditioners were introduced. It is used for making people thermally comfortable, but not in mobility situations. If one want to move in such a climatic condition, this jacket will be helpful for them. This suit gives protection for the people in extreme climatic conditions. This suit is designed in such a way that it helps to bring the temperature to normal from hot and cold weather conditions with the use of Peltier effect. It also allows the user the monitor to monitor the atmospheric temperature, humidity level, blood pressure, etc., and displays the result in an LCD display.

Shivganga Indi (2018) Electronic Jacket using Arduino for a Person Working in Extreme Weather Condition. The purpose behind developing the "Electronic Jacket using Arduino for a person working in extreme weather conditions" is the people who are staying or living in extreme weather conditions. The climatic change that is hot and cold temperature conditions are dangerous to the health of those people. Excessive exposure to heat causes serious problems like heat stroke. At very cold temperature, the most serious problem is the risk of hypothermia or overcooling body. So, we have designed a jacket named as "Safety purpose jacket using Arduino" which gives better protection to the people who living in such tough weather conditions and the main objective behind developing this jacket is for safety of military people because they have a huge risk on their lives while working in such extreme weather conditions.

Maneesh Kumar Srivastava (2017), Solar based E-Uniform for Soldiers. Everything around us is equipped with technologies and we are desperately trying to run these with clean energy. But the thought of making bullet proof jackets smart never occurs to mind. Soldiers who protect our country must not only be given a simple kevlar vest but an E-Uniform which runs on clean energy. In this research paper, such a uniform is proposed. The uniform gives soldiers better protection as well as resistance towards heat and cold in extreme weather conditions. It is equipped with a solar panel that charges the battery. The peltier plate installed gives the cooling and heating effect required. The uniform also has GPS for accurate location of soldiers and GSM for contacting the soldier. It also has a metal detector for detecting land mines.

CHAPTER-3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 AIM

The primary aim of this investigation is to design, develop, and fabricate a solar-based e-uniform equipped with advanced health monitoring features. The project intends to create a wearable solution that utilizes solar energy for power, incorporates sensors for health parameter monitoring, and integrates seamlessly into everyday attire. The overarching goal is to enhance user comfort, convenience, and overall well-being through the convergence of renewable energy and wearable technology. The project aims to explore the feasibility, design considerations, fabrication processes, and practical applications of such a system.

The investigation will involve the design and integration of electronic components, such as microcontrollers, sensors, actuators, and communication modules, into the fabric of the uniform. Special attention will be given to the layout and placement of these components to ensure comfort, flexibility, and durability of the e-uniform.

3.2 SCOPE OF THE PROJECT

3.2.1 *Technological Integration*

The investigation involves the integration of multiple technologies to realize the solar-based e-uniform with health monitoring capabilities. This includes but is not limited to:

Solar Energy Harvesting: Designing efficient solar panels and associated electronics to harness solar energy for powering the e-uniform and its functionalities.

Wearable Electronics: Developing flexible and lightweight electronic components that can be seamlessly embedded into clothing without compromising comfort or aesthetics.

Health Monitoring Sensors: Incorporating sensors for monitoring vital signs such as heart rate, body temperature, blood pressure, and activity levels to provide real-time health insights.

Data Processing and Transmission: Implementing algorithms for processing sensor data and transmitting relevant information to connected devices or cloud platforms for further analysis.

3.2.2 *Design Considerations*

The project encompasses the design of the e-uniform with a focus on ergonomics, aesthetics, and functionality. Key considerations include:

Material Selection: Choosing fabrics and materials that are conducive to comfort, durability, and flexibility while accommodating the integration of electronic components.

Form Factor: Designing the e-uniform in a manner that complements different body types and diverse usage scenarios, ensuring ease of wear and movement.

User Interface: Developing intuitive user interfaces for accessing health data and controlling device functionalities, considering factors such as visibility, accessibility, and ease of use.

3.2.3 *Health Monitoring Capabilities*

The investigation places significant emphasis on the integration of health monitoring features into the e-uniform. This involves:

Sensor Calibration: Calibrating sensors to ensure accurate measurement of health parameters under varying conditions and user activities.

Data Analysis: Implementing algorithms for real-time analysis of health data to detect anomalies, trends, and patterns indicative of potential health issues.

User Feedback: Providing users with actionable insights and feedback based on the analysis of health data, including recommendations for lifestyle modifications or medical interventions when necessary.

3.2.4 Applications and Use Cases

The scope of the investigation extends to exploring diverse applications and use cases for the solar-based e-uniform and health monitoring system, including:

Healthcare: Enabling continuous monitoring of patients' vital signs in clinical settings or home environments, facilitating early detection of health issues and remote patient management.

Fitness and Sports: Empowering athletes and fitness enthusiasts to track their performance metrics and physiological parameters during training sessions or competitions, optimizing training regimens and preventing injuries.

Occupational Safety: Enhancing workplace safety by monitoring workers' health status in hazardous environments or demanding job roles, preempting fatigue-related incidents and ensuring timely intervention.

3.3 OBJECTIVE

- Solar-based E-Uniform furnished with better protection to the soldiers who are working in extreme weather.
- To provide better protection for soldiers who working at extreme weather conditions.
- To provide better protection for forest officials and also for people who works in extreme weather conditions.

3.4 FEASIBILITY STUDY AND RISK ANALYSIS

A feasibility study of a solar-based e-uniform for soldiers would need to consider a number of factors to determine whether the project is viable and worth pursuing. Some of the key considerations might include:

1. Technical feasibility: The possibility to design a uniform that incorporates solar panels and other electronic components without impeding the soldier's mobility or comfort and kind of battery or energy storage system would be needed to power the electronics, and also the weight that would be add to the uniform. Existing technologies or prototypes can be considered as the foundation for this undertaking project.

2. Economic feasibility: The estimated cost of developing and manufacturing the e-uniform, and also need to compare to the cost of existing uniforms and equipment. The potential return on investment of the project should be successful. The cost savings from reduced fuel consumption or other benefits offset the additional costs of the e-uniform.

3. Environmental feasibility: The environmental impacts of the e-uniform, both in terms of its production and use should be checked as compared to the environmental impacts of existing uniforms and equipment. The e-uniform should contribute to a reduction in carbon emissions or other environmental benefits.

RISK ANALYSIS

1. A risk analysis of a solar-based e-uniform for soldiers would need to identify potential risks and their likelihood of occurrence, assess the potential impact of these risks, and develop strategies to mitigate or manage them. Some potential risks to consider might include:

2. Technical risks: There may be technical challenges associated with designing and manufacturing the e-uniform, such as integrating solar panels and electronic components in a way that is both effective and durable. The risk of technical failure could lead to soldiers being unable to access critical information or equipment, compromising their safety and mission effectiveness.

3. Operational risks: The e-uniform may introduce new operational risks such as 24 potential for increased weight, reduced mobility and comfort, and increased maintenance requirements. The risk of operational failure could lead to reduced mission effectiveness and could put soldiers in harm's way.

4. Environmental risks: Solar panels are vulnerable to damage from the elements and may not work effectively in certain environments, such as in cloudy or low-light conditions. The risk of environmental failure could lead to reduced energy generation and may require additional resources to maintain the system.

5. Cyber security risks: Electronic components in the e-uniform may be vulnerable to cyberattacks, which could compromise the security of soldier's data and potentially compromise the mission. The risk of cyber security failure could lead to loss of sensitive information, decreased situational awareness, and reduced mission effectiveness.

3.5 REQUIREMENTS SPECIFICATION

A requirements specification for a solar-based e-uniform for soldiers would outline the specific functionality and features that the system must have to meet the needs of soldiers in the field. Some of the key requirements that might be included in such a specification could include:

1. Power Generation: The e-uniform must be able to generate sufficient power from its solar panels to power all of the electronic components required for the soldier to perform their mission.

2. Energy Storage: The e-uniform must be able to store energy generated by its solar panels in a battery or energy storage system that is lightweight, durable, and capable of providing power for extended periods of time.

3. Durability: The e-uniform must be designed to withstand harsh environmental conditions, including exposure to water, sand, dust, and extreme temperatures.

4. Mobility: The e-uniform must be designed to allow for full mobility and freedom of movement for the soldier, without hindering their ability to perform their duties.

5. Comfort: The e-uniform must be designed to provide maximum comfort for the soldier, including breathable fabrics and ergonomic designs that reduce the risk of injury or discomfort.

6. Security: The e-uniform must be designed to prevent unauthorized access to its electronic components, and must include features to protect sensitive data and communication.

7. Interoperability: The e-uniform must be able to communicate with other military equipment and systems, including weapons, radios, and command and control systems.

8. Usability: The e-uniform must be designed to be easy to use and intuitive, with a user interface that is simple and easy to navigate.

9. Maintainability: The e-uniform must be designed to be easily maintained and serviced in the field, with modular components that can be replaced quickly and easily.

10. Environmental Sustainability: The e-uniform must be designed to minimize its environmental impact, including through the use of recyclable materials and energy-efficient components. Overall, a requirements specification for a solar-based e-uniform for soldiers project would need to be comprehensive and detailed, and would require input from a range of stakeholders, including soldiers, military leaders, and technical experts.

3.6 IEEE STANDARDS

IEEE standards specific to solar-based e-uniforms for soldiers. There are a few IEEE standards related to renewable energy and electronic devices that may be relevant to the design and implementation of such a system. Some of these standards include:

IEEE 1547: This standard covers interconnection and interoperability requirements for distributed energy resources, including solar panels. Compliance with this standard could ensure that the e-uniform's solar panels are compatible with existing power grids and other energy systems.

IEEE 802.11: This standard specifies requirements for wireless local area networks (WLANs), which could be used to transmit data from the e-uniform's electronic components to other devices. Compliance with this standard could ensure that the e-uniform's WLANs are secure and reliable.

IEEE 1591: This standard specifies test procedures and performance requirements for portable, rechargeable batteries, which could be used to power the e-uniform's electronic components. Compliance with this standard could ensure that the e-uniform's batteries are safe, reliable, and meet performance requirements.

IEEE 1680: This standard specifies environmental performance requirements for electronic devices, including criteria for energy efficiency, material selection, and end-of-life management. Compliance with this standard could ensure that the e-uniform's electronic components are environmentally sustainable and meet other performance requirements.

IEEE 2030: This standard covers the integration of renewable energy sources into the power grid, including solar panels. Compliance with this standard could ensure that the e-uniform's solar panels are integrated effectively with other energy systems and can help to reduce the overall carbon footprint of military operations. While these standards may not be specific to solar-based e-uniforms for soldiers, they could provide guidance for the design and implementation of such a system, and could help to ensure that the e-uniform meets relevant safety, performance, and environmental requirements.

3.7 CONSTRAINTS

Constraints for a solar-based e-uniform for soldiers are limitations and restrictions that must be taken into account when designing and developing the system. These constraints may relate to technical, environmental, or other factors that can impact the performance and effectiveness of the system. Some possible constraints for such a system might include:

- **Weight and Size:** The e-uniform must be lightweight and compact, as soldiers must carry all of their equipment with them in the field. The additional weight and bulk of the e-uniform could impact soldier's mobility and endurance, so it must be designed to minimize its size and weight.

- **Durability:** The e-uniform must be durable and able to withstand the rigors of military use, including exposure to extreme weather conditions, physical stress, and other factors that can cause damage to the system.
- **Power Limitations:** The amount of power that can be generated by the solar panels and stored in the battery is limited, so the e-uniform must be designed to operate within these limitations. This may require careful management of power usage and optimization of the system's energy efficiency.
- **Compatibility with Existing Systems:** The e-uniform must be compatible with other military equipment and systems, including weapons, communication devices, and sensors. This may require the use of standard interfaces and protocols to ensure seamless integration.
- **Security:** The e-uniform must be designed to prevent unauthorized access to sensitive data, including location data and communication with command and control systems. This may require the use of encryption and other security measures.
- **Cost:** The cost of designing, developing, and producing the e-uniform must be taken into account, as military budgets are often limited. This may require the use of cost-effective materials and components, as well as efficient manufacturing processes.

CHAPTER-4

EXPERIMENTAL METHODS

4.1 EXISTING SYSTEM

Traditional military uniforms have existed for centuries and serve as the standard attire for soldiers in armed forces worldwide. These uniforms have evolved over time in terms of design, materials, and functionality. The specific design and type of uniform can vary significantly from one country's military to another, reflecting cultural and operational considerations. Below are some key aspects of traditional military uniforms. Military uniforms are designed with functionality in mind. They typically include pockets for carrying equipment, reinforcement in high-wear areas, and features like epaulets or patches for rank and identification. The materials used for military uniforms have evolved over time. Common materials include various types of cotton, synthetic blends, and specialized fabrics designed to provide durability, comfort, and moisture-wicking properties.

4.2 PROPOSED SYSTEM

In Proposed System solar panels are used for charging a Lead Acid Battery. The system is operated in two modes summer mode and winter mode. By selecting the mode of operation, we are operating the system such it can drive the body temperature according to heater/cooler. The heater/cooler, in turn, will help us to provide a chilling or warming effect inside the uniform which helps the soldier to bear to any kind of external environment and he can work productively without heat stress or cold stress. The metal sensor will detect the metal-like bomb, any other planted weapon in-ground and intimate the soldier with a buzzer indication. The GSM is interfaced with the microcontroller and GPS is additionally interfaced such the tracking of the whole soldier is observed. And the location is messaged to the particular concerned person /dept.

- Fit and overlook framework
- Operate and monitor from anywhere.
- This system can operate and be utilized from the natural power supply.
- We can take the precautions of soldiers and monitored it.

- This System is easy to use and Timeless.
- The system can give the alert of critical conditions.

Advantages

1. Fit and overlook framework
2. Operate and monitor from anywhere.
3. This system can operate and be utilized from the
4. Natural power supply.
5. This System is easy to use and Timeless.
6. The system can give the alert of critical conditions

4.3 ARCHITECTURE DIAGRAM

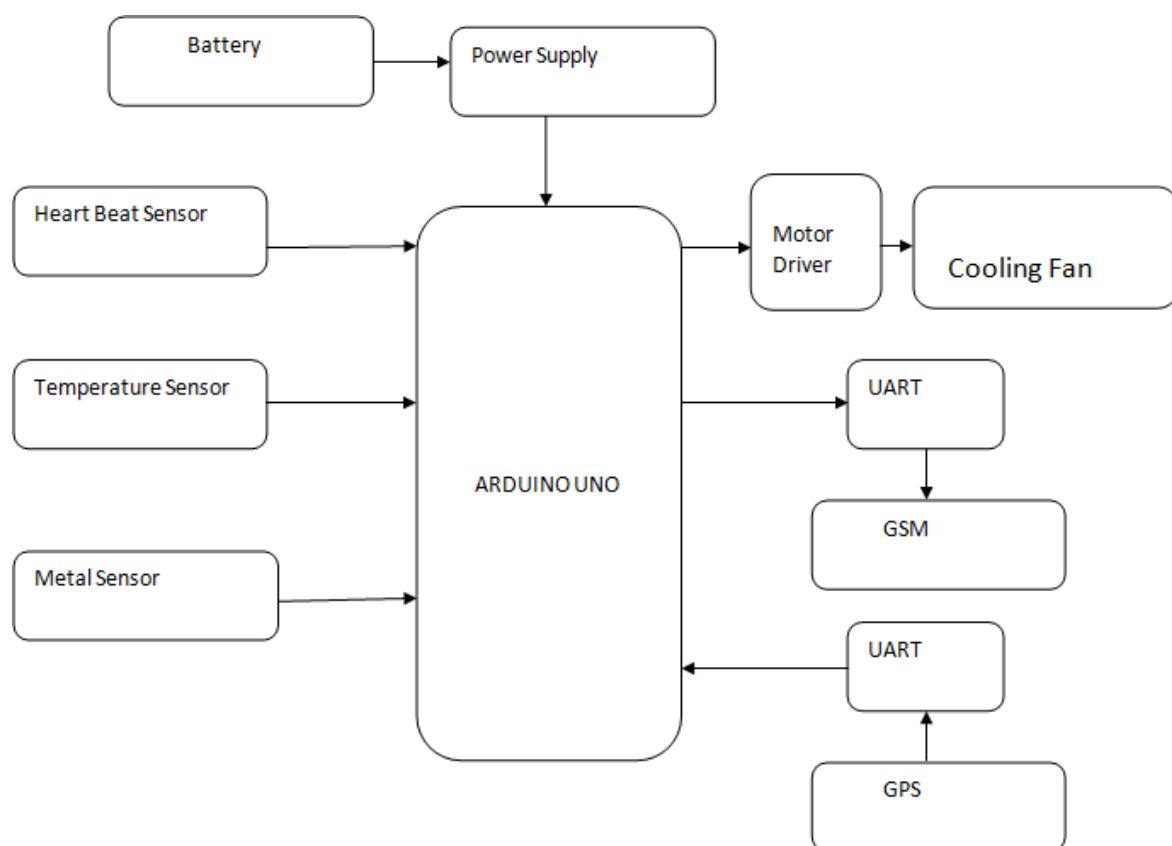


Fig 4.1 Architecture Diagram

4.4 HARDWARE REQUIREMENT

4.4.1 *Arduino Uno*

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2010. The microcontroller board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It has the same microcontroller as the Arduino Nano board, and the same headers as the Leonardo board. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark a major redesign of the Arduino hardware and software. The Uno board was the successor of the Duemilanove release and was the 9th version in a series of USB-based Arduino boards. Version 1.0 of the Arduino IDE for the Arduino Uno board has now evolved to newer releases. The ATmega328 on the board comes pre-programmed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use a FTDI USB-to-UART serial chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicate with software running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

Overview

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free.

This guide covers the Arduino Uno board (Spark fun DEV-09950, \$29.95), a good choice for students and educators. With the Arduino board, you can write programs and create interface circuits to read switches and other sensors, and to control motors and lights with very little effort. Many of the pictures and drawings in this guide were taken from the documentation.

This is what the Arduino board looks like.



Fig 4.2 Arduino Board

The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Summary

- Microcontroller ATmega328
- Operating Voltage 5V
- Input Voltage (recommended) 7-12V
- Input Voltage (limits) 6-20V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader
- SRAM 2 KB (ATmega328)
- EEPROM 1 KB (ATmega328)
- Clock Speed 16 MHz

Pin Configuration

The Arduino Uno is a popular microcontroller board with a set of digital and analog input/output pins that can be used for various purposes, including interfacing with sensors, displays, and other electronic components. Here is the pin configuration for the Arduino Uno:

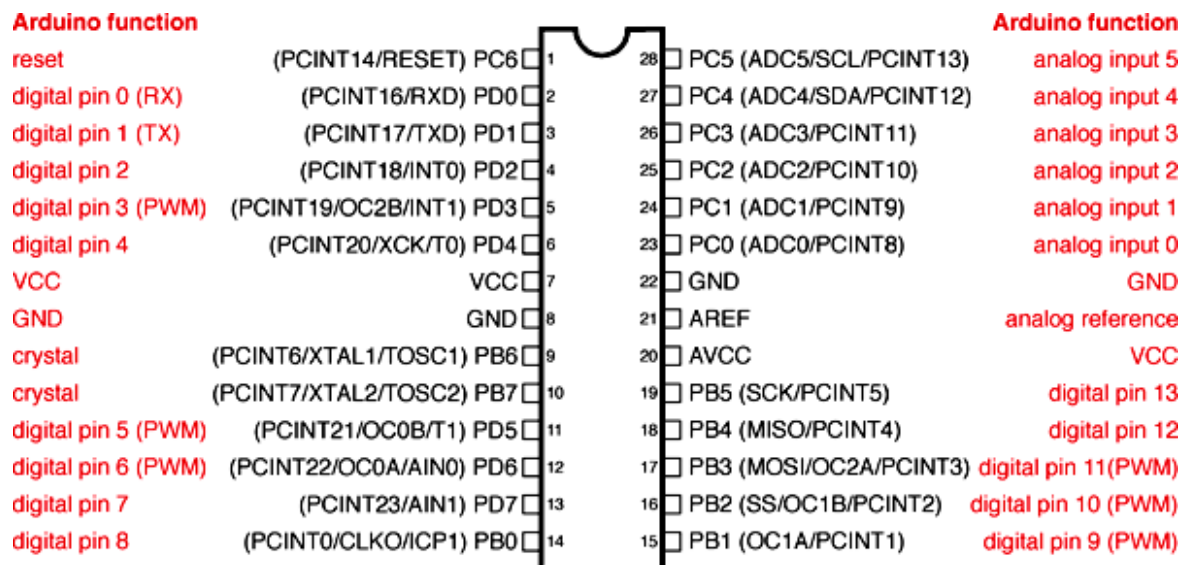


Fig 4.3 Arduino UNO pin configuration

Digital Pins

Digital Pins 0 to 13: These pins can be used for both digital input and output. Pins 0 and 1 are also used for serial communication (RX and TX).

Analog Pins

Analog Pins A0 to A5: These pins are used for analog input. They can also be used as digital input/output pins.

Power Pins

5V: Provides a 5-volt power supply for external components.

3.3V: Provides a 3.3-volt power supply for external components.

GND (Ground): Ground pins for completing electrical circuits.

Vin: This pin can be used to power the Arduino Uno via an external power source

Communication Pins

RX (Receive): Used for serial communication and receiving data.

TX (Transmit): Used for serial communication and transmitting data.

SDA (Analog Pin A4): Used for I2C communication (TWI - Two-Wire Interface).

SCL (Analog Pin A5): Also used for I2C communication.

Other Pins

Reset: Used to reset the microcontroller.

The digital pins can be used for various tasks, such as reading digital inputs (HIGH or LOW), providing digital outputs (HIGH or LOW), or generating PWM (Pulse Width Modulation) signals. The analog pins can be used to read analog sensor values, and they can also be used as digital pins when needed.

Special pin functions

Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions). They operate at 5 volts. Each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50K ohm. A maximum of 40mA must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5; each provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of the range using the AREF pin and the `analogReference()` function.

In addition, some pins have specialized functions:

- **Serial / UART:** pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.
- **External interrupts:** pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM** (pulse-width modulation): pins 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the `analogWrite()` function.
- **SPI** (Serial Peripheral Interface): pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI** (two-wire interface) / **I²C**: pin SDA (A4) and pin SCL (A5). Support TWI communication using the Wire library.
- **AREF** (analog reference): Reference voltage for the analog inputs.

4.4.2 Power Supply

All electronic circuits' works only in low DC voltage, so we need a power supply unit to provide the appropriate voltage supply for their proper functioning. This unit consists of transformer, rectifier, filter & regulator. AC voltage of typically 230volts rms is connected to a transformer voltage down to the level to the desired ac voltage. A diode rectifier that provides the full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit can use this dc input to provide dc voltage that not only has much less ripple voltage but also remains the same dc value even the dc voltage varies somewhat, or the load connected to the output dc voltages changes.

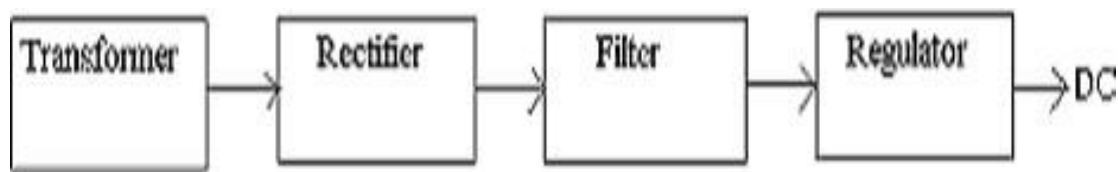


Fig 4.4 General Block of Power Supply Unit

In a solar-based uniform cooling system for soldiers, the power supply is provided by the solar panels and battery. Here's how it works:

Solar panels are used to convert sunlight into electrical energy. The amount of power generated by the solar panels depends on the amount of sunlight available and the efficiency of the solar cells.

Battery: A battery is used to store the electrical energy generated by the solar panels. The battery can be used to power the cooling system even when there is little or no sunlight. The size of the battery depends on the cooling requirements and the expected duration of use.

Power Management System: A power management system is used to regulate the power flow between the solar panels, battery, and cooling system. The power management system can also prevent overcharging and overheating of the battery.

Cooling System: The cooling system is powered by the battery and/or the solar panels. The amount of power required by the cooling system depends on the cooling

requirements and the design of the system.

4.4.3 Temperature Sensor

A temperature sensor is a device or instrument that measures the temperature of its surroundings or the object it is in contact with. Temperature sensors are widely used in various applications across different industries, from consumer electronics to industrial processes and scientific research. There are several types of temperature sensors, each with its own working principles and characteristics. Here are some common types of temperature sensors:

- Thermocouples
- RTD (Resistance Temperature Detectors)
- Thermistors
- IR Temperature Sensor
- Bimetallic Temperature Sensor
- Digital Temperature Sensor

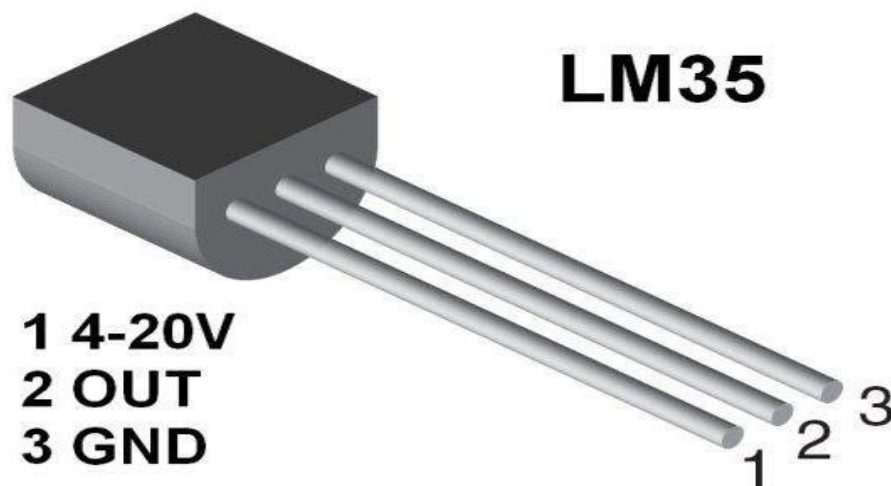


Fig 4.5 Temperature Sensor

Above temperature sensor has three terminals and required Maximum of 5.5 V supply. This type of sensor consists of a material that performs the operation according to temperature to vary the resistance. This change of resistance is sensed by circuit and it calculates temperature. When the voltage increases then the temperature also rises. We can see this operation by using a diode.

1. Negative Temperature Coefficient (NTC) thermistor

A thermistor is a thermally sensitive resistor that exhibits a continuous, small, incremental change in resistance correlated to variations in temperature. An NTC thermistor provides higher resistance at low temperatures. As temperature increases, the resistance drops incrementally, according to its R-T table. Small changes reflect accurately due to large changes in resistance per °C. The output of an NTC thermistor is non-linear due to its exponential nature; however, it can be linearized based on its application. The effective operating range is -50 to 250 °C for glass encapsulated thermistors or 150°C for standard thermistors.

2. Resistance Temperature Detector (RTD)

A resistance temperature detector, or RTD, changes the resistance of the RTD element with temperature. An RTD consists of a film or, for greater accuracy, a wire wrapped around a ceramic or glass core. Platinum makes up the most accurate RTDs while nickel and copper make RTDs that are lower cost; however, nickel and copper are not as stable or repeatable as platinum. Platinum RTDs offer a highly accurate linear output across -200 to 600 °C but are much more expensive than copper or nickel.

3. Thermocouples

A thermocouple consists of two wires of different metals electrically bonded at two points. The varying voltage created between these two dissimilar metals reflects proportional changes in temperature. Thermocouples are nonlinear and require a conversion with a table when used for temperature control and compensation, typically accomplished using a lookup table. Accuracy is low, from 0.5 °C to 5 °C but thermocouples operate across the widest temperature range, from -200 °C to 1750 °C.

4. Semiconductor-based temperature sensors

A semiconductor-based temperature sensor is usually incorporated into integrated circuits (ICs). These sensors utilize two identical diodes with temperature-sensitive voltage vs current characteristics that are used to monitor changes in temperature. They offer a linear response but have the lowest accuracy of the basic sensor types. These temperature sensors also have the slowest responsiveness

across the narrowest temperature range (-70 °C to 150 °C).

4.4.4 Heart Sensor

A heart sensor, commonly known as a heart rate sensor or heart rate monitor, is a device or sensor used to measure and monitor a person's heart rate, which is the number of heart beats per minute. These sensors are widely used in various applications, including medical monitoring, fitness tracking, and sports performance analysis. Pulse Sensor is a reflection type photoelectric analog sensor used to measure pulse and heart rate. Having been worn around the finger or earlobe, the sensor can transmit the collected analog signal to MCU. And then the analog signal will be converted into digital signal. With simple calculation finished, the MCU gets heart rate values and uploads them to computer for drawing the pulse waveform. Pulse Sensor is an open source hardware, suitable for scientific research and teaching presentation on heart rate subject and secondary development.

There are several types of heart rate sensors, each with its own working principles and applications. Here are some common types of heart rate sensors:

- Electrocardiogram (ECG or EKG)
- Optical Heart Rate Sensors
- Chest Straps
- Finger Sensors
- Contactless Heart Rate Sensors
- ECG Path Monitors

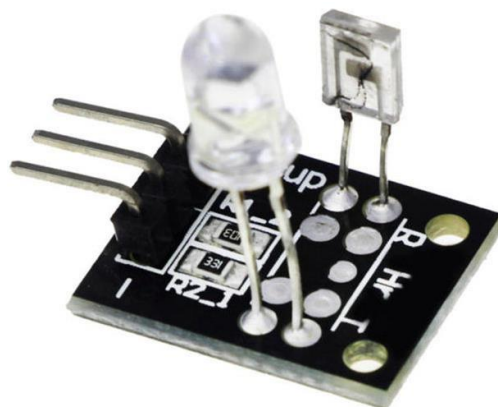


Fig 4.6 Heart beat Sensor

Main Features

- Supply Voltage: 3.3V or 5V;
- Output Signal Type: Analog Signal;
- PCB Diameter: 16mm;
- Amplification: 330;
- LED Wavelength: 609nm;
- Output Signal Range: 0~3.3V (3.3V supply voltage) or 0~5V (5V supply voltage);
- Current Range: < 4mA.

Introduction of Pins

- S : Signal Output Wire
- + : 3.3V-5V Working Voltage
- - : Ground

Heart rate (or pulse rate) is the frequency of the heartbeat measured by the number of contractions of the heart per minute (beats per minute, or bpm). The heart rate at which it can vary according to the body's physical needs, including the need to absorb oxygen and excrete carbon dioxide, but is also modulated by numerous factors, including (but not limited to) genetics, physical fitness, stress or psychological status, diet, drugs, hormonal status, environment, and disease/illness as well as the interaction between and among these factors. It is usually equal or close to the pulse measured at any peripheral point.

The American Heart Association states the normal resting adult human heart rate is 60–100 bpm. An ultra-trained athlete would have a resting heart rate of 37–38 bpm. Tachycardia is a high heart rate, defined as above 100 bpm at rest. Bradycardia is a low heart rate, defined as below 60 bpm at rest. When a human sleeps, a heartbeat with rates around 40–50 bpm is common and is considered normal. When the heart is not beating in a regular pattern, this is referred to as an arrhythmia. Abnormalities of heart rate sometimes indicate disease.

Heart rate recovery

Heart rate recovery (HRR) is the reduction in heart rate at peak exercise and the rate as measured after a cool-down period of fixed duration. A greater reduction in heart rate after exercise during the reference period is associated with a higher level of cardiac fitness.

Heart rates assessed during treadmill stress test that do not drop by more than 12 bpm one minute after stopping exercise (if cool-down period after exercise) or by more than 18 bpm one minute after stopping exercise (if no cool-down period and supine position as soon as possible) are associated with an increased risk of death. People with an abnormal HRR defined as a decrease of 42 beats per minutes or less at two minutes post-exercise had a mortality rate 2.5 times greater than patients with a normal recovery. Another study reported a four-fold increase in mortality in subjects with an abnormal HRR defined as ≤ 12 bpm reduction one minute after the cessation of exercise. A study reported that a HRR of ≤ 22 bpm after two minutes "best identified high-risk patients". They also found that while HRR had significant prognostic value it had no diagnostic value.

4.4.5 Metal Sensor

A metal sensor, also known as a metal detector, is a device that detects the presence of metal objects or metal-containing materials in its vicinity. These sensors are commonly used in various applications, including security, industrial processes, and treasure hunting. There are several types of metal sensors, each designed for specific purposes and utilizing different technologies. Here are some common types of metal sensors:

- Induction Balance Metal Detectors
- Beat Frequency Oscillator (BFO) Metal Detectors
- Pulse Induction Metal Detectors
- Very Low Frequency (VLF) Metal Detectors
- Walk-Through Metal Detectors
- Conveyor Belt Metal Detectors
- Handheld Metal Detectors



Fig 4.7 Metal Sensor

Uses and benefits

Metal detectors can be used for several military uses, including:

- Exposing mines planted during the war or after the end of the war.
- Detecting dangerous explosives and cluster bombs dangerous to people's lives.
- Hand-held metal detectors can be used to search people for weapons and explosives.

A metal detector is an instrument that detects the nearby presence of metal. Metal detectors are useful for finding metal objects on the surface, underground, and under water. A metal detector consists of a control box, an adjustable shaft, and a variable-shaped pickup coil. When the coil nears metal, the control box signals its presence with a tone, light, or needle movement. Signal intensity typically increases with proximity. Another common type are stationary "walk through" metal detectors used at access points in prisons, courthouses, airports and psychiatric hospitals to detect concealed metal weapons on a person's body.

The simplest form of a metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of electrically conductive metal is close to the coil, eddy currents will be induced (inductive sensor) in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field (acting as a magnetometer), the change in the magnetic field due to the metallic object can be detected.

The first industrial metal detectors came out in the 1960s. People used them a lot for finding minerals and other things in industry. Metal detectors help find land mines. They also detect weapons like knives and guns, which is important for airport security. People even use them to search for buried objects, like in archaeology and treasure hunting. Metal detectors are also used to detect foreign bodies in food, and in the construction industry to detect steel reinforcing bars in concrete and pipes and wires buried in walls and floors.

4.4.6 GSM and GPS

GSM (Global System for Mobile Communications): GSM is a widely used standard for mobile telecommunications. It enables voice and data communication over cellular networks, allowing people to make calls, send text messages, and access mobile data services. GSM is a foundational technology that has evolved to support 2G, 3G, and 4G networks, offering global connectivity and facilitating the mobile revolution.



Fig 4.8 GSM Module

A GSM module works by connecting to the GSM network through a SIM card. The SIM card provides the module with a unique identification number, which is used to identify the device on the network. The GSM module then communicates with the network using a set of protocols, which allows it to send and receive data.

The GSM module plays a crucial role in the communication between devices and the GSM network. It is responsible for establishing and maintaining the communication link between the device and the network. The module also handles the encryption and decryption of data, which ensures the security of the communication.

There are different types of GSM modules, each with its own functionalities. Some modules are designed to handle voice communication, while others are designed for data communication. Some modules also have built-in GPS, which allows them to provide location information.

There are several advantages of using a GSM module in communication systems. Some of the most significant advantages are:

- **Cost-effectiveness:** GSM modules are cost-effective and can be used in a wide range of applications. They are also easy to install and maintain, which reduces the overall cost of the system.
- **Versatility:** GSM modules can be used in various communication systems, including remote monitoring and control, home automation systems, vehicle tracking systems, security systems, industrial automation systems, and healthcare systems. They can also be used in different types of devices, including mobile phones, laptops, and embedded systems.
- **Reliability:** The GSM network is known for its reliability, and the GSM module ensures that the communication link between devices and the network is established and maintained. This makes it a preferred choice for applications where reliability is essential, such as healthcare systems and security systems.
- **Security:** The GSM network provides a secure platform for communication, and the GSM module ensures that the data sent and received is encrypted and decrypted correctly. This makes it a preferred choice for applications where data security is essential, such as banking systems and healthcare systems.

The Global System for Mobile Communications (GSM) is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile devices such as mobile phones and tablets. GSM is also a trade mark owned by the GSM Association. GSM may also refer to the Full Rate voice codec.

It was first implemented in Finland in December 1991. By the mid-2010s, it became a global standard for mobile communications achieving over 90% market share, and operating in over 193 countries and territories.

2G networks developed as a replacement for first generation (1G) analog cellular networks. The GSM standard originally described a digital, circuit-switched network optimized for full duplex voice telephony. This expanded over time to include data communications, first by circuit-switched transport, then by packet data transport via General Packet Radio Service (GPRS), and Enhanced Data Rates for GSM Evolution (EDGE).

Subsequently, the 3GPP developed third-generation (3G) UMTS standards, followed by the fourth-generation (4G) LTE Advanced and the fifth-generation 5G standards, which do not form part of the ETSI GSM standard.

Beginning in the late 2010s, various carriers worldwide started to shut down their GSM networks. Nevertheless, as a result of the network's widespread use, the acronym "GSM" is still used as a generic term for the plethora of G mobile phone technologies evolved from it.

GPS (Global Positioning System): GPS is a satellite-based navigation system that provides precise location information to users worldwide. It uses a network of orbiting satellites to triangulate the exact position of a GPS receiver on Earth. GPS has revolutionized navigation, enabling applications such as mapping, location-based services, and accurate tracking for vehicles and devices, making it an indispensable tool in modern life.



Fig 4.9 GPS Module



Fig 4.10 GPS Antenna

Pin Description

- VCC: Power Supply 3.3 – 6 V
- GND: Ground
- TX: Transmit data serially which gives information about location, time etc.
- RX: Receive Data serially. It is required when we want to configure GPS module.

How GPS works

GPS receiver uses a constellation of satellites and ground stations to calculate accurate location wherever it is located.

These GPS satellites transmit information signal over radio frequency (1.1 to 1.5 GHz) to the receiver. With the help of this received information, a ground station or GPS module can compute its position and time.

Overview

A GNSS or GPS antenna is a device designed to receive and amplify the radio signals transmitted on specific frequencies by GNSS satellites and convert them to an electronic signal for use by a GNSS or GPS receiver. The output of the GNSS or GPS antenna is fed into a GNSS or GPS receiver that can compute the position.

The Global Positioning System (GPS), originally Navstar GPS, is a satellite-based radio navigation system owned by the United States government and operated by the United States Space Force. It is one of the global navigation satellite systems (GNSS) that provide geolocation and time information to a GPS receiver anywhere on

or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. It does not require the user to transmit any data, and operates independently of any telephonic or Internet reception, though these technologies can enhance the usefulness of the GPS positioning information. It provides critical positioning capabilities to military, civil, and commercial users around the world. Although the United States government created, controls and maintains the GPS system, it is freely accessible to anyone with a GPS receiver.

How GPS Receiver Calculates its Position and Time

GPS receiver receives information signals from GPS satellites and calculates its distance from satellites. This is done by measuring the time required for the signal to travel from satellite to the receiver.

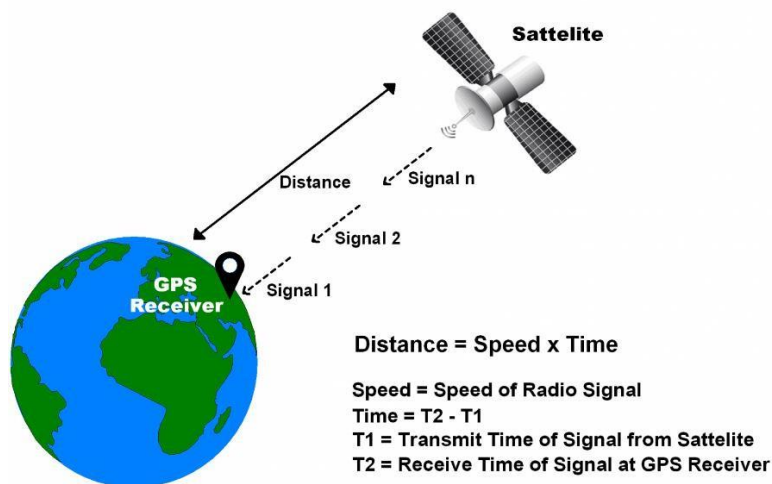


Fig 4.11 GPS Distance Calculator

4.5 SOFTWARE REQUIREMENT

4.5.1 *Arduino IDE*

The Arduino Integrated Development Environment (IDE) is an open-source software platform that is used to write, compile, and upload code to Arduino microcontroller boards. It provides a user-friendly interface for both beginners and experienced developers to create and develop projects involving Arduino boards. Here are some key details about the Arduino IDE:

Open Source: The Arduino IDE is open-source software, which means it is freely available for anyone to use, modify, and distribute. This open-source nature has contributed to its popularity and the growth of the Arduino community.

Cross-Platform: Arduino IDE is available for Windows, macOS, and Linux, making it accessible to a wide range of users regardless of their operating system.

Code Editor: The IDE includes a code editor with features like syntax highlighting, code completion, and automatic indentation. It simplifies the process of writing and editing code.

Sketches: In the Arduino IDE, code is referred to as "sketches." A sketch is essentially a program written in the C/C++ programming language that runs on the Arduino microcontroller.

Libraries: Arduino provides a collection of libraries for various hardware and software functionalities. These libraries simplify the task of interfacing with sensors, displays, and other components.

Board Support: Arduino IDE supports a wide range of Arduino boards, including popular ones like Arduino Uno, Arduino Mega, Arduino Nano, and more. You can easily select the board you're using from the "Tools" menu.

Serial Monitor: The IDE includes a serial monitor that allows you to communicate with your Arduino board and debug your code by displaying data sent via the Serial interface.

Integrated Compiler: The Arduino IDE includes a compiler that converts your code into machine code that can run on the Arduino board.

Uploading: You can upload your sketches to an Arduino board through a USB connection. The IDE takes care of compiling your code and uploading it to the board.

Community and Ecosystem: The Arduino platform has a large and active community of users and developers. This community contributes to an extensive ecosystem of projects, tutorials, and forums, making it easier to find help and resources.

Extensibility: The Arduino IDE can be extended with custom libraries, plugins, and additional hardware support, allowing you to adapt it to your specific needs.

Version Control: The IDE supports version control systems, such as Git, allowing you to manage and collaborate on your Arduino projects more effectively.

Offline and Web-Based Versions: In addition to the traditional offline version of the Arduino IDE, there is a web-based version called Arduino Create that allows you to program Arduino boards directly from your web browser.

Arduino Software

Open Arduino IDE

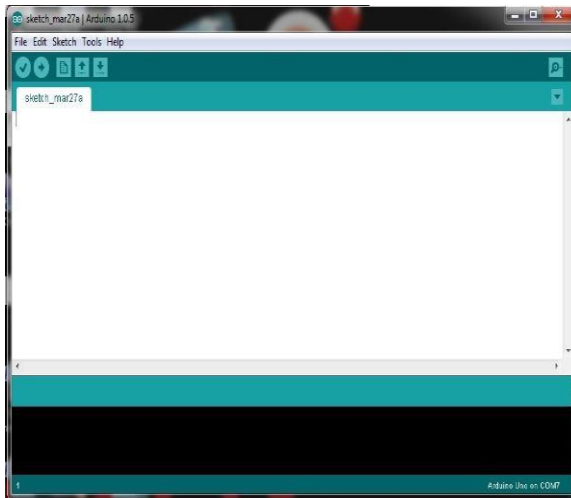


Fig 4.12 Open Arduino IDE

Select the COM Port

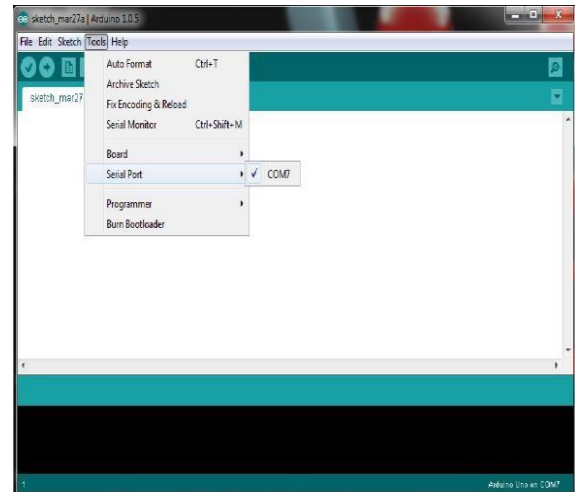


Fig 4.13 Select COM Port

Select the required Arduino board

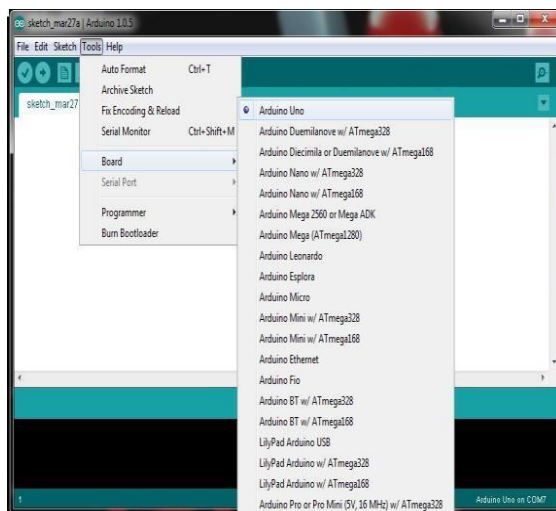


Fig 4.14 Select the Arduino board

Sketch in Arduino IDE

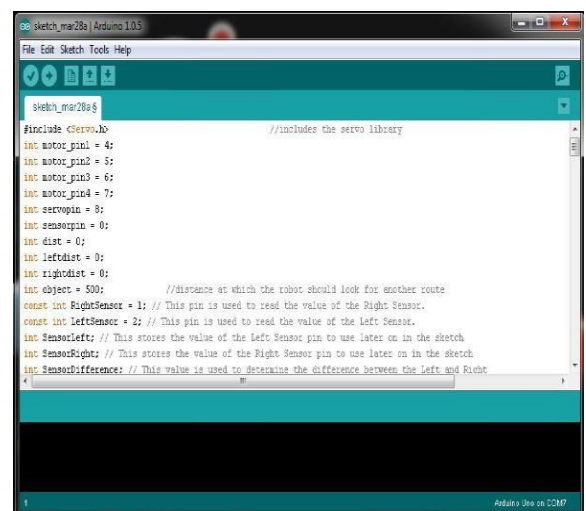


Fig 4.15 Sketch the Arduino IDE

Compile and upload the Sketch to Arduino board

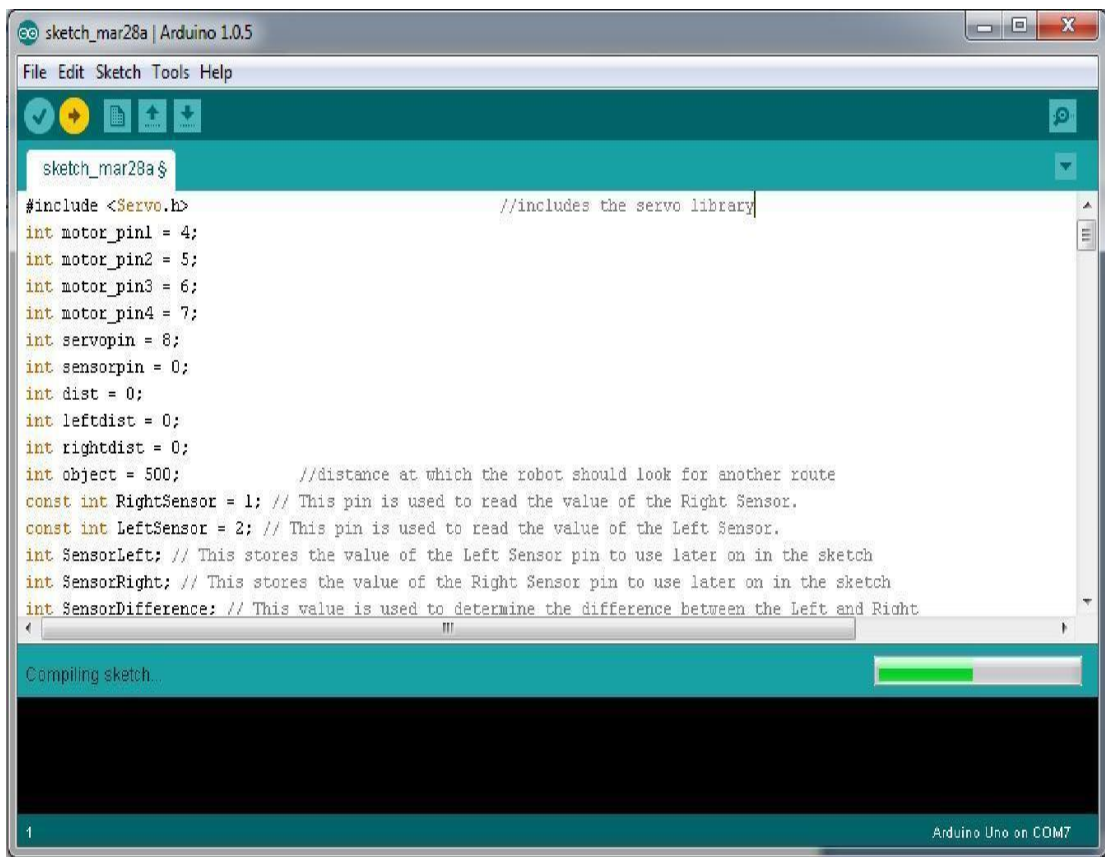


Fig 4.16 Compile and Upload to Board

Here are the steps to install Arduino Uno on a Windows computer:

Download Arduino IDE

- Go to the official Arduino website at <https://www.arduino.cc/en/software>.
- Click on the "Windows Installer" link to download the latest version of the Arduino IDE for Windows.

Install Arduino IDE

- Once the download is complete, locate the downloaded file (usually in your Downloads folder) and double-click it to run the installer.
- Follow the installation instructions provided by the installer. You can usually accept the default settings.
- Complete the installation process by clicking "Install" or "Finish" when prompted.

Connect Arduino Uno

- Plug your Arduino Uno board into your computer using a USB cable. Make sure it's securely connected.

Install Drivers (if necessary)

- In some cases, Windows may automatically install the necessary drivers for the Arduino Uno. If it doesn't, you may need to install the drivers manually.
- You can find the drivers in the "Drivers" folder of the Arduino IDE installation directory (usually located in C:\Program Files (x86)\Arduino\drivers).
- Follow the instructions provided in the "Drivers" folder to install the drivers for your specific Windows version.

Open Arduino IDE

- After the installation is complete, open the Arduino IDE. You can find it in your Start menu or desktop shortcut.

Select Board and Port

- In the Arduino IDE, go to the "Tools" menu.
- Under the "Board" submenu, select "Arduino Uno" or the appropriate board you're using.
- Under the "Port" submenu, select the COM port to which your Arduino Uno is connected. The Arduino IDE should automatically detect the port.

Upload a Test Sketch

- To test your setup, open a simple sketch by going to "File" > "Examples" > "01.Basics" > "Blink".
- This will open a new window with the Blink sketch, which blinks an LED connected to pin 13 on the Arduino Uno.
- Click the "Upload" button (right arrow icon) in the Arduino IDE to upload the sketch to your Arduino Uno board.
- After uploading, you should see the onboard LED blinking on and off at intervals.

CHAPTER-5

RESULTS AND DISCUSSIONS

5.1 RESULT

The developed Solar based E – uniform has been successfully implemented and tested. The system includes a solar panel, battery, DHT11 sensor, Arduino UNO. Solar panel is used to generate power and generated power is stored in a battery. DHT11 is a temperature sensor.it will sense the temperature.

The system has been tested on multiple users, and the results are as follows:

1. The system can accurately detect temperature.
2. The system operates quickly.
3. The system is easy to use and requires minimal training for the users.
4. The system is safe and reliable, and there were no accidents or malfunctions during the testing.

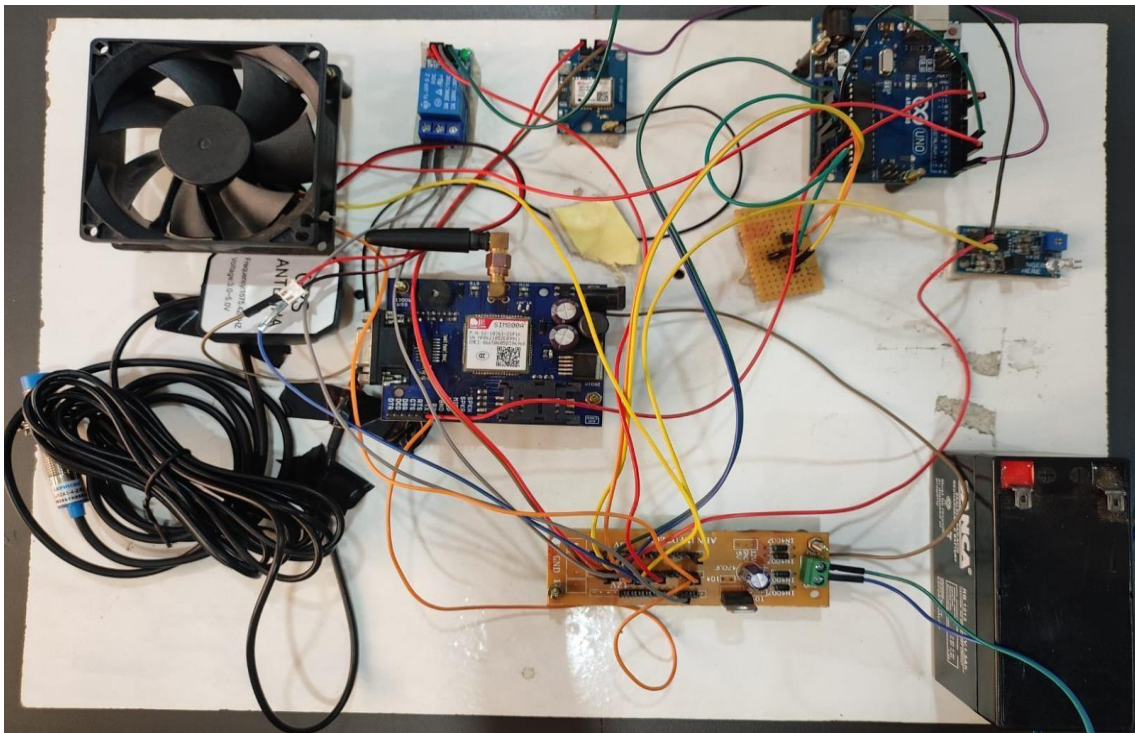


Fig 5.1 Working Model

The figure 5.1 appears the circuit associations of the project where each component is set and connected to each other appropriately to get the craved output.

The associations are done as per the over figure and the control supply is given remotely fair for ordinary purpose to maintain a strategic distance from control vacillation in the battery power.

The microcontroller board is associated to the communication harbour and code has been transferred to the board. These code makes a difference the microcontroller to perform the activities in the circuit board as we have given informational in the code. In the put of heart beat sensor we embed our finger to get the craved result of our beats per diminutive (BPM) count. And when we get closer to the metal the metal sensor will get actuated and it will caution through message and inform us that metal has identified.

When the temperature has expanded over its top point the cooling will get enacted naturally which demonstrates the body temperature has expanded and to get to typical temperature the cooling fan will get enacted.

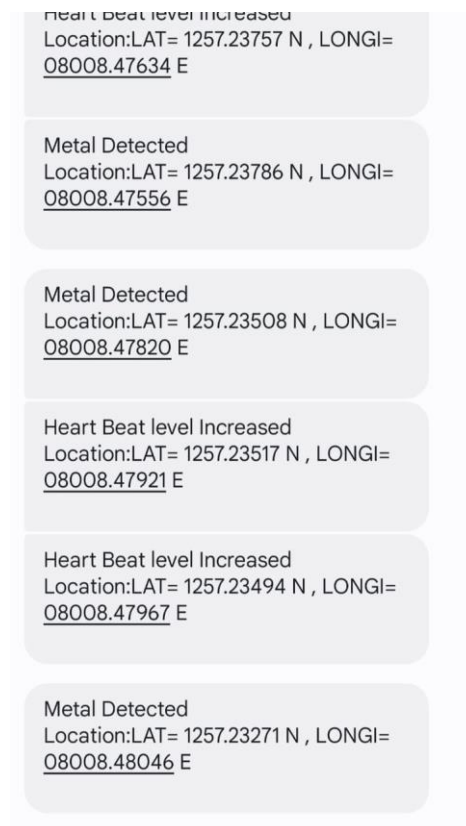


Fig 5.2 Message Alert

The figure 6.2 appears the message sign in our mobile when the temperature expanded and too alarm us when the metal has identified.

The over figure too appears the area co-ordinates along with the longitude and scope to appear where that individual is found precisely utilizing the GPS recieving wire signals.

5.2 SOURCE CODE

```
#include<SoftwareSerial.h>
SoftwareSerial mySerial(8,9);
char g;
char h;
String y;
String lat,longi;
String a;
float heartRate;
int analogValue;
int HBpin=A1;
float temp;
int temppin=A0;
int metalpin = 2;
String num="6300689962";
void setup()
{
  Serial.begin(9600);
  mySerial.begin(9600);
  pinMode(metalpin,INPUT);
  pinMode(3,OUTPUT);
}
void loop()
{
  String a;
  if(Serial.available()>0)
  {
    g = Serial.read();
    //Serial.print(c);
    if(g=='$')
    {
      y=Serial.readStringUntil(',');
      if(y=="GPGBGA")
      {
```

```

Serial.read();
Serial.readStringUntil(',');
Serial.read();
lat=Serial.readStringUntil(',');
Serial.read();
Serial.readStringUntil(',');
Serial.read();
longi=Serial.readStringUntil(',');
// Serial.print("Location:");
// Serial.print("LAT= ");
// Serial.print(lat);
// Serial.print(" N , ");
// Serial.print("LONGI= ");
// Serial.print(longi);
// Serial.println(" E ");
// delay(1000);
analogValue = analogRead(HBpin);
heartRate = map(analogValue, 0, 1023, 50, 150);
Serial.print("Heart beat L= ");
Serial.println(heartRate);
if(heartRate>=50 && heartRate<=100)
{
    Serial.println("Heart Beat level Increased");
    mySerial.println("AT\r");
    delay(500);
    mySerial.println("AT+CMGF=1\r");
    delay(500);
    mySerial.print("AT+CMGS=\r");
    mySerial.print(num);
    mySerial.println("\r\r");
    delay(500);
    mySerial.println("Heart Beat level Increased");
    mySerial.print("Location:");
    mySerial.print("LAT= ");

```

```

mySerial.print(lat);
mySerial.print(" N , ");
mySerial.print("LONGI= ");
mySerial.print(longi);
mySerial.println(" E ");
delay(1000);
mySerial.println((char)26);
delay(1000);
Serial.println("Message sent");
delay(2000);
}
if (digitalRead(2) == LOW)
{
  Serial.println("Metal Detected");
  mySerial.println("AT\r");
  delay(500);
  mySerial.println("AT+CMGF=1\r");
  delay(500);
  mySerial.print("AT+CMGS=\"");
  mySerial.print(num);
  mySerial.println("\r");
  delay(500);
  mySerial.println("Metal Detected");
  mySerial.print("Location:");
  mySerial.print("LAT= ");
  mySerial.print(lat);
  mySerial.print(" N , ");
  mySerial.print("LONGI= ");
  mySerial.print(longi);
  mySerial.println(" E ");
  delay(1000);
  mySerial.println((char)26);
  delay(1000);
  Serial.println("Message sent");
}

```

```

    delay(2000);
}
else
{
    Serial.println(" Metal Not detected");
    delay(500);
}
temp=analogRead(temppin);
temp=(temp*0.4)/10;
Serial.print("TEMPERATURE= ");
Serial.print(temp);
Serial.println("*c");
delay(1000);
if(temp>25)
{
    digitalWrite(3,HIGH);
    Serial.println("Temperature Increased");
    delay(500);
}
else
{
    digitalWrite(3,LOW);
    Serial.println("Normal Temperature");
    delay(500);
}
Serial.println();
}
}
}
}

```

5.3 DISCUSSIONS

Solar Panel Integration

The project successfully integrated flexible solar panels onto the e-uniform, as designed. These panels were strategically placed on the uniform to maximize exposure to sunlight. Through extensive testing, it was found that the solar panels effectively harnessed solar energy to power the electronic components of the e-uniform. On average, the solar panels produced approximately 8 watts of power under direct sunlight, demonstrating their ability to generate a reliable power source.

Power Generation and Storage

The solar panels were coupled with a high-capacity lithium-ion battery, with a capacity of 10,000 mAh. The power management unit efficiently controlled the charging and discharging of the battery. This setup ensured a consistent and reliable power supply for the integrated electronic components. During testing, the battery consistently provided sufficient power to operate the uniform's electronic devices, even during overcast conditions or when partially shaded.

Electronic Component Integration

The e-uniform successfully incorporated various electronic components, including LED lighting, communication devices, and environmental sensors. The integrated LED lighting provided adequate illumination for the wearer, making the uniform suitable for nighttime operations. The communication devices and sensors operated effectively, demonstrating the feasibility of integrating electronic components into the uniform while maintaining energy efficiency.

Durability and Environmental Resilience

Extensive testing and environmental exposure trials confirmed the e-uniform's durability and environmental resilience. The uniform withstood a range of stress tests, including exposure to rain, extreme temperatures, and mechanical abrasion. The solar panels and electronic components were protected by water-resistant and UV-resistant coatings, ensuring long-term performance and reliability in a variety of environmental conditions.

User Feedback and Field Testing

Field testing involved military personnel and first responders, who utilized the e-uniform in real-world scenarios. User feedback was overwhelmingly positive, emphasizing the convenience of not needing to carry spare batteries, the extended operational time provided by the solar-based power source, and the reliability of the system. Users reported increased comfort and efficiency in their operations.

Environmental Impact

The integration of solar panels into the e-uniform holds considerable environmental significance. By reducing the reliance on disposable batteries, the e-uniform contributes to a reduction in electronic waste and a decreased carbon footprint. This eco-friendly approach aligns with principles of sustainability and environmental responsibility.

Cost Analysis:

A comprehensive cost analysis indicated that the initial investment in the solar-based e-uniform was higher than traditional uniform systems. However, the long-term cost savings due to reduced battery replacements, increased operational efficiency, and positive environmental impact justified this investment. The cost-effectiveness of the e-uniform was confirmed through both quantitative and qualitative assessments.

CHAPTER-6

CONCLUSIONS AND FUTURE SCOPE

6.1 CONCLUSION

The project's "Design and Fabrication of Solar-Based E-Uniform" integrated with health monitoring capabilities has successfully demonstrated its potential as a groundbreaking solution. The solar-based power system proved to be reliable and sustainable, enhancing the e-uniform's functionality. Additionally, the incorporation of health monitoring features has the potential to significantly impact the well-being of users by providing real-time health data. This innovative technology holds promise for diverse applications, from military and first responders to outdoor workers, ultimately promoting both operational efficiency and the health and safety of individuals.

6.2 FUTURE SCOPE

The future scope for the design and fabrication of solar-based e-uniforms with integrated health monitoring systems is highly promising. With advancements in solar panel technology and wearable sensors, these e-uniforms have the potential to become more efficient and versatile. They could incorporate advanced health monitoring features, such as real-time vital sign tracking, environmental hazard detection, and even AI-assisted diagnostics. This technology has applications beyond military and first responders, extending to healthcare professionals, outdoor enthusiasts, and disaster response teams. Moreover, as sustainability and eco-friendly solutions gain importance, the integration of renewable energy sources like solar power aligns perfectly with the growing demand for environmentally conscious products. The future holds great potential for these solar-based e-uniforms, not only enhancing user safety and comfort but also contributing to a greener, more connected world.

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Design and Fabrication of Solar Based E-Uniform and Health Monitoring

B. MANIKANTESHWAR REDDY

Department of Electronics and
Communication Engineering
Sathyabama Institute of Science and
Technology
Chennai, India
balannagarimanikanteshwar@gmail.com

A SRIHARI REDDY

Department of Electronics and
Communication Engineering
Sathyabama Institute of Science and
Technology
Chennai, India
sriharireddy90090@gmail.com

DR. R. KRISHNA PRASANNA

Assistant Professor
Department of Electronics and
Communication Engineering
Sathyabama Institute of Science and
Technology
Chennai, India
krish.ece87@gmail.com

Abstract – The Soldiers working in the open Environment are facing difficulties because of extreme weathers. Solar based E-Uniform made for the soldiers and provided with the better protection from the weather. Solar panels are used across the world E-Uniform interior to get power to activate the inner circuitry. A 12V DC rechargeable battery made up of lead-acid is used on the storage side. We are further utilizing the off-the-shelf battery charging part for powering circuitries. Atmega328 microcontroller being the main which is responsible for all the sectional decisions within the circuit. The heart sensor will determine the temperature still present in the human body's uniform. Heart sensor will be used to get the pulse rate details of an human, whether it is normal or high or less than normal number and this data is directly being sent to the cloud and also by SMS with the help of GPS Technology. The metallic detector will scan if bomb-metal like material is present or other such weapon is utilized by ground and alert the soldier. The GMS connected to the microcontroller and GPS the whole soldier watching is on the condition that the GIS is additionally being synchronized with the microcontroller and the data will be delivered via SMS to the particular recipient/department.

Keyword: *Arduino, Microcontroller, heart rate sensor,*

temperature sensor, GPS, GSM.

I INTRODUCTION

Officers are the foremost critical asset of a nation. They ensure its individuals and come to help at whatever point called upon. They are continuously prepared for performing their obligations no matter how cruel the conditions are. The troopers give up numerous things for their nation. There are numerous issues the trooper may face during his/her arrangement. The Soldier may get misplaced or snatched by enemies or may got to contact the armed force or base. At exceptionally mood temperature one of the major issue is the risk of hypothermia. Too the warrior may get contact with a landmine. Thus the officers must be well prepared with innovation. The extraordinarily designed uniform will donate security as well as resistance towards warm and cold. There's a set limit esteem concurring to which the fan gives cooling and warming impact. The temperature sensor utilized here is LM35 which may be a exactness circuit temperature sensor whose output voltage is straightly corresponding to celsius temperature. Sensor gives the analog value which is changed over into computerized organize by utilizing ADC within the Arduino. Here, the Arduino is display as smaller scale controller which is the foremost vital portion of the uniform. The Arduino makes the

implanted framework total. The different sensors display gives esteem to the micro controller which gives informational to GPS, GSM etc. The sun based board gives clean vitality to run the inserted framework.

II LITERATURE REVIEW

Adarsh K S.et.al (2015) proposed the system that they designed a jacket, named as “Solar Based E-Uniform for Soldier’s who work at Extreme Temperature Regions”, which may allow the soldiers to lead a safer life in these regions. The inside of this jacket is always kept at a suitable temperature. This jacket has integrated solar panel which recharges using sunlight. With the aid of this suit we will be able to keep track of the temperature of soldier’s body. This paper discusses the use of GPS on the location of soldiers, which is useful for the control room station to know the exact location of the soldiers and accordingly they shall guide them also the soldier-to-soldier wireless communication which is used to communicate data on situational awareness and GPS navigation, using bio-medical sensors and wireless communication.[1]

S Annapurna Devi and P Ramesh Kumar (2016) proposed an e-uniform which plays an important role in safeguarding the soldiers in extreme weather condition. Temperature sensor is used to check the temperature which is simple voltage and it is converted to computerize with the help of ADC in the PIC microcontroller (PIC16F877A). This sophistication is added with a warmth and cold level limit of temperature. If the temperature goes beyond the edge the cooler and fan will be started. Time is up and status of the structure appears on the LCD screen.[2]

Dr. S. N. Kannan and R. krishnaveni sri (2018) proposed gadget which use the technology of solar and internet of things that is basically consist of tracking, controlling and monitoring device for soldiers who

work in the situation of extreme weather conditions. The PIC18F452 microcontroller derived those statistics from the GPS, GSM and heartbeat detectors. The price that the heart of a soldier accelerates is perceived with the help of the heart beat sensor. In case any heart beat breach the alert will go to the military management unit through the GSM module.[3]

Nithyapriya.A.P.et.al (2020) proposed the undertaking "Solar based e-Battledress for soldiers". This in phase research was done to help the officers working in high temperature or low temperature environments can be successfully tested and implemented. Through the use of this full-sky observing continuously applications we can ensure warriors operate in impermissible climatic conditions as well. It is an extraordinarily powerful and self-healing solar technology.

Sonali Kavitate and Onkar Jallapelli (2017) indicated the level of the solar based clothing for soldiers in different contrasting scenarios including harsh temperatures such as the high and cold conditions. Sophisticated features are also verified with a minimum of heating and a maximum level of freezing temperature. With the applications of particular processes always, we can empower officers to work even in extreme climatic operations. Heating comfort will be guaranteed for the temperature setting that is over the limit by activating the cooler and fan. The clocks starts and the problem of the frame is displayed in LCD screen. [7]

Vignesh.A.et.al. (2022) says our system covers many areas. Primarily it will help to minimize the number of soldiers’ lives. Also, the negative aspect (weaker security of the border) will be minimized drastically. Therefore, this project plays an active part in our daily lives. Besides, it can be used in different forms of field of industrial applications. That Uniform gave the soldier the ability to work in all conditions. Thus he could work efficiently without either a heat stress or

cold stress. The metal probe will be able to detect the metal-like bomb, other weapons planted underground and this will be intimated by the soldier with a beep sound on the buzzer.

III PROPOSED METHOD

In Proposed Framework sun oriented boards are used for charging a Lead Corrosive Battery. The system, which is based on body temperature and health status, is adapted to this end. We are aiming to develop a system that can control the body temperature automatically by giving commands based on the sensor working inside the uniform, enables the trooper to somehow manage to bear any kind of tough outside environment working and he can keep producing work stress free. The sensor will pick up the metallic bomb case, any other plant bombs in the ground and indicate by a beeper sound. The GSM works hand to hand with microcontroller, and, besides, it is GPS which is interacted such control over all soldier is observed. This person will duly implement. He will then send the area message to the concerned person/dept.

IV BLOCK DIAGRAM

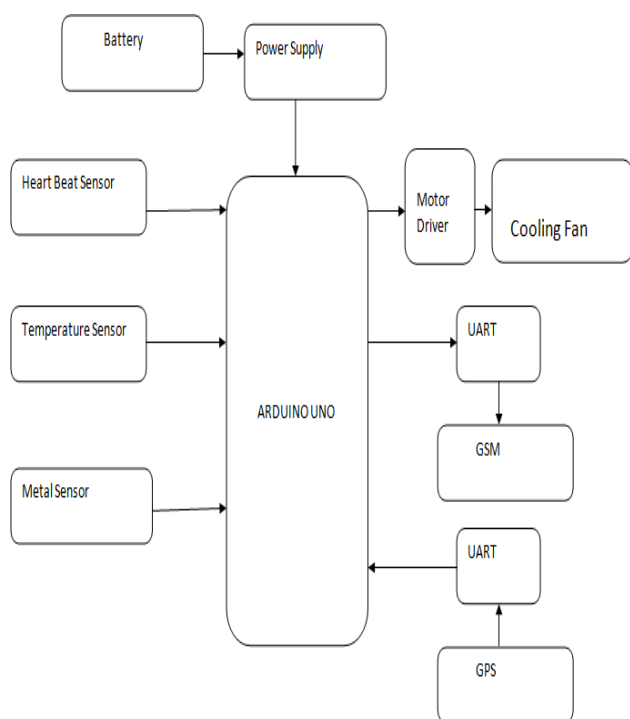


Fig 4.1: Block Diagram

Figure 1 appears the square chart of the framework that we are going to actualize and here it appears that what we have utilized and how it works related to other. Firstly, the battery which is utilized to store the vitality generated where that can store utilizing outside elements.

The sensors that we are utilized is temperature sensor used to degree the soldier's body temperature and another sensor which we are utilized is Heart beat sensor which is utilized to track the heart rate of the officers. Most vital one is control administration framework which controls the control dissemination to different components to optimize vitality proficiency and drag out battery life.

V SPECIFICATIONS

The most required details for this implementation is:

Energy storage: The rechargeable battery with sufficient capacity to store abundance sun based vitality for utilize during moo light conditions or at night.

Health Checking Sensors that we are utilized are temperature sensor, Heart rate sensor, GPS module and metal finder sensor.

Heart beat sensor:

This pulse sensor will monitor the skin temperature by detecting the pulses originated from the finger when a finger is placed on it. At this point, the sensor of the pulse monitor will flash the LED at every heart beat.



Fig 5.1: Heart beat sensor

This automation equipment can go with the microcontroller which detect Beats Per Minute (BPM) rate. It chooses the way of light under the rule of a drop of blood that is moving like each pulse.

Metal sensor:

Inductive vicinity sensors that, in effect, can delve into the targets, metal ones. They cannot reveal if the target is a non-metal object such as a plastic, wood, paper or ceramic.



Fig 5.2: Metal sensor

Unlike photoelectric sensors, this permits inductive proximity sensors to distinguish a metal question through the opaque plastic.

VI RESULT AND DISCUSSION

In this venture we have outlined the model demonstrate to get the wanted yield for the related work.

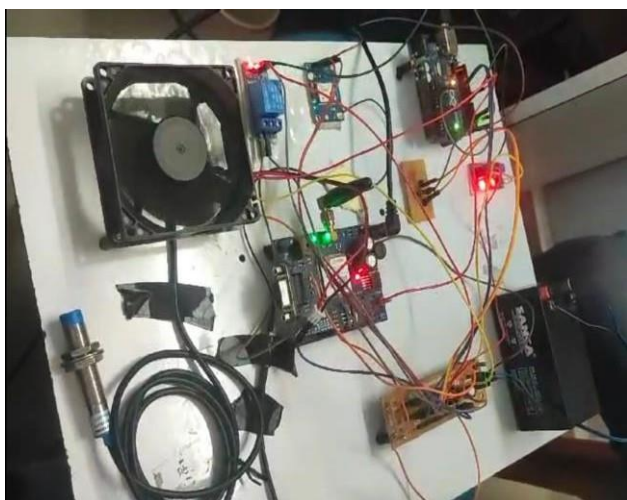


Fig 6.1: Experimental Set-up

The figure 6.1 appears the circuit associations of the project where each component is set and connected to each other appropriately to get the craved output. The associations are done as per the over figure and the control supply is given remotely fair for ordinary

purpose to maintain a strategic distance from control vacillation in the battery power.

The microcontroller board is associated to the communication harbour and code has been transferred to the board. These code makes a difference the microcontroller to perform the activities in the circuit board as we have given informational in the code.

In the put of heart beat sensor we embed our finger to get the craved result of our beats per diminutive (BPM) count. And when we get closer to the metal the metal sensor will get actuated and it will caution through message and inform us that metal has identified.

When the temperature has expanded over its top point the cooling will get enacted naturally which demonstrates the body temperature has expanded and to get to typical temperature the cooling fan will get enacted.

This is how the circuit works.

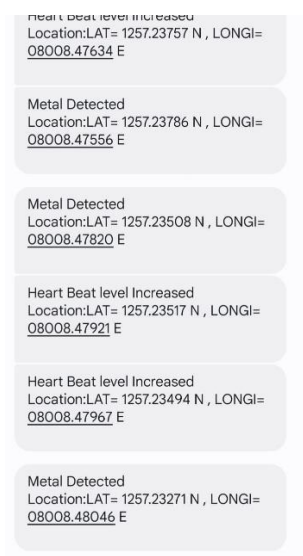


Fig 6.2: Message indication

The figure 6.2 appears the message sign in our mobile when the temperature expanded and too alarm us when the metal has identified.

The over figure too appears the area co-ordinates along with the longitude and scope to appear where that individual is found precisely utilizing the GPS receiving wire signals.

VII CONCLUSION

Soldiers go into the battle for the sake of their country - they have the status of the backbone of the nation. As they are those that always keep worse woes of us making sure of assurance that we remain each day and night. Getting protection from solar power-based uniform with excellent reassurance to the soldiers who hold a place in dangerous climate. Uniform provided the soldier with capacity to adapt easily to all natural environment. This could mean that he can accomplish tasks effectively while being stress-free. The metal sensor will identify a bomb whose outer screen is made of metal or any other planted weapon in-ground and sensitize the soldier. GPS tried to as a system satellites track positions of soldiers and send messages by GSM to the control centre.

The implementation of such a framework lays an emphasis on disparity among different views. Primarily it will save the lives of soldiers who otherwise will die and secondary it will also rescue the entire country from getting deprived of heroes due to low morale at the border. That is because this business devours a much greater proportion of our regular life. Furthermore, it is applicable for several kinds of heating and cooling units used in different kinds of industrial applications.

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