DESIGN & IMPLEMENTATION OF AN INDUSTRIAL HEALTH AND SAFETY MONITORING AND PREVENTION SYSTEM USING RADIO FREQUENCY TECHNOLOGY

Final Year Project Report Submitted to
Kampala International University in Partial Fulfillment
Of the Requirements for the Award of the Degree

0f

Bachelor of Science in Electrical Engineering

By

BWAMBALE JOSEPH

1153-03114-03196

Email:josephmarybwambale@gmail.com

Contact: +256784563157, +256703182867

SCHOOL OF ENGINEERING & APPLIED SCIENCES [SEAS]
DEPARTMENT OF ELECTRICAL & TELECOMMUNICATIONS ENGINEERING

AUGUST 2019

DECLARATION

I hereby declare that all the information in this final year project report has been obtained and presented in accordance with the academic rules and ethical conduct. More so, pertinent to the requirements of these rules and conduct, I declare to have fully cited and referenced all material and results that are not original to this study.

BWAMBALE JOSEPH

Signature: …………………………………

Date: ………………………………………..

APPROVAL

This is to certify that Bwambale Joseph has successfully presented his final year project entitled "Design and implementation of an industrial health and safety monitoring and prevention system using RF technology" under the supervision of;

Signature: .... Date: ....

Mr. Adabara Ibrahim

Project coordinator

Ibrahim.adabara@kiu.ac.ug

www.rootiancenter.com

www.eduraryschool.com

ACKNOWLEDGMENT

I thank the Almighty God for giving me all the substantial strengths, knowledge, wisdom, financial and moral ability to complete this project report.

I sincerely wish to express my heartfelt gratitude to everyone who assisted me to complete this project report in their distinguished ways. My primary obligation is to thank Kampala International University, my Supervisors ADABARA IBRAHIM for his useful comments, criticisms, and suggestions on the original manuscript of this project report. Sincere thanks go to all the Lecturers of KIU especially from the department of electrical and telecommunications engineering for providing me with a friendly atmosphere of knowledge that enabled me to complete this report.

TABLE OF CONTENTS

LIST OF ABBREVIATION

LED	Light Emitting Diode
RF	Radio Frequency
LCD	LIQUID CRYSTAL DISPLAY
SMS	Short Message Service
PCB	Printed Circuit Board
RF	Radio Frequency
EM	Electromagnetics
DC	Direct current
RX	Receiver
TX	transmitter
AC	Alternating current
EM	Electromagnetic waves
LCC	Leadless chip carrier

ABSTRACT.

An intelligent system is a system that uses information technology to monitor its environment, controls the accessories and communicates with the outside world. Smart industry is a multi-disciplinary technology, at the same time it is developing. An intelligent industrial system has been developed to automatically achieve some activities performed frequently in daily working life to achieve more comfortable, accident free as well as easier working environment. A sample intelligent industrial Health and Safety Monitoring and Prevention System Using Radio Frequency technology that is one branch of the intelligent system is addressed in this study. The system is based on the proteus and Arduino software and can act as an accident prevention system for any working environment including permanent and temporary workstations, sites and institutional work offices. The system is monitoring the weather employees are correctly using personal protective equipment using radio frequency, monitors overload in industrial setups using current sensor as well as preventing accidents related to cutting machines driven by conveyor belts in industries using a capacitive touch sensor and the pertinent actuators. The system also has internet connection to monitor and control the factory equipment's working conditions. This study involves the hardware implementation of a multiplatform control system for an industrial Health and Safety Monitoring and Prevention System Using Radio Frequency technology and Arduino software and this system belongs to a domain usually named smart systems. The approach used herein combines hardware and software technologies. Test results of the system have shown that it can be easily used for the smart workplace applications.

Key words; Remote monitoring, protection, artificial intelligence, sensor technology and automation, radio frequency technology.

CHAPTER ONE

1.0 INTRODUCTION.

Electrical energy is one of the most fundamental driving elements of the worlds' development and substantial for any nations' progress. The electrical energy is delivered through a power system that consists of generation, transmission, and distribution subsystems consisting mainly of power generators, transformers, and the protecting assemblies. The efficiency of factories in the entire world continue to be enhanced because of the Avast prevailing electric energy as industries presently utilize Heavey duty machines and boilers to do a lot of their industry based operations. The machines used here incorporates also the cutting machines, conveyor belts as well as cutting and gridding tools being operated with the significant main power. Though these machines provide substantial benefits to the economy, operating them in the absence of sufficient training subsequently renders harmful effects to the human resource workers as well as leading to severe death as workers accidently come into contact with moving machines. These effects can as well result into machine damage which subjects the factory and other commercial companies into an unforgettable loss and debts. Meanwhile overloading the factory electrical control subsequently results into excessive current overheating the facility power system as well as under voltage cases which both puts the facility motors at a risk of shutting down. For safety considerations, powered electronic facilities such as motors or even power lines usually require the capability of overload protection. [2] A circuit breaker is the most widely applied device to protect an electrical circuit from damage caused by over-current, overload, or short circuit. [3] It is the reason that the Institute of Electrical and Electronics Engineers (IEEE) Standards announced the IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems in 2007. However, it was applied in a short-circuit situation. Another approach was focused on the design of a protection system for power semiconductor devices (PSDs) as applied to inverters and converters.[4]However, this proposed system is used specifically for variable speed AC and DC drives, and it may not be suitable for general cases. An overload protection model based on heat effects was reported using a motor internal temperature-rise model. [1 and 6] To combat facility inefficiencies, substantial systems that ensures safety for human resource as well as facility equipment needs to be employed and this should be based on Radio Frequency technology. The complete set of safety package here incorporates the safety warning and notification system for both the management and the technical team in which in case the field worker attempts to remove part of the safety gears, the management is notified and the worker warned. More so, as the above overload protection systems can fail to shut down the overloaded section, a system that can give a notification as well as shutting down only the additional loads without shutting down the entire facility has been designed and implemented affirm to proposal.

1.1 BACKGROUND OF THE STUDY.

An increasing growth in world economics has posted a tremendous demand for electrical power. The short-circuit fault current is, probably, the most destructive event in the power distribution systems. The current can abruptly rise more than 20 times the maximum nominal value. Malfunctioning of the protection system causes loss of service, under voltage, or overvoltage transients, and loss of synchronization. Moreover, in a serious case, an extreme surge of power may penetrate the equipment and sequentially cause explosion or fire. Additionally, workers in almost all factories tend to be ignorant about wearing the personal protective equipment even when they are provided at their disposal.

The potential of major industrial accidents has become more significant in production of storage and use of hazardous substances increased. In the ever increasing mechanization, electrification, chemicalisation and sophistication have made industrial jobs more and more complex and intricate. This has led to increased dangers to human life in industries through accidents and injuries. To protect employees/workers from the danger or risk of industrial accidents, as well as maintaining and improving factory performance, the concept of Radio Frequency technology based automated prevention of industrial accidents. By using this, the loss of life and many injuries as well as attaining substantial growth. The recent industrial practices have provided many safety measures to workers, even though many accidents continue to occur due to the technical causes and human causes. These industrial accidents can be prevented using the IOT based automated prevention of industrial accidents.

1.2 PROBLEM STATEMENT.

Majority of the factories in the world such as Hima Cement Factory located in Kasese District use Heavey duty machines for them to achieve their commercial goals. Though these machines are very significant to it, they can subject the workers into fatal accidents as well as human loss of life and company income loss if substantial training is not provided to plant attendants or even at the expense ignorance of plant attendants/workers. More so, factories experience complete shutdown when their load centers are overloaded. This affects the economic growth of these factories as they spend a lot of money in compensating the victimized workers/ or employees as well as putting a considerable number of factory operating units to an un planned shut-down operation.

Although these factories in the world such as Hima Cement Factory are adopting the use of circuit breakers and administrative control measures whereby workers are provided with helmets, overalls and safety shoes, these are not reliable as these overload protection systems usually lead to complete facility shutdown and the workers/ or employers tend to be ignorant about the use of these personal protective equipment as continuous factory work makes the workers tired and bored leading to them accidently encroaching on the moving machines working space which renders most of them being crushed by the moving machines such as conveyor belts and other spinning machines. Since the concept of Radio Frequency technology is at the disposal of current scientists therefore the researcher has come up with an industrial health and safety monitoring and prevention system.

1.3 OBJECTIVES OF THE STUDY.

1.3.1 Main objective.

The main objective of this study has been to design and implement an industrial health and safety monitoring and prevention system using Radio Frequency technology.

1.3.2 Specific Objectives

I. To design an automatic overload protection system.

II. To design an electronic personal protective equipment for the employees.

III. To design a moving machine interrupter system.

IV. To design a transceiver safety monitoring and notification system for the management.

V. To interface the RF transmitter and receiver with the Atmega328.

1.4 RESEARCH QUESTIONS.

I. How to design an automatic overload protection system.
II. How to design electronic personal protective equipment for the employees.
III. How to design a moving machine interrupter system.
IV. How to design a transceiver safety monitoring and notification system for the management.
V. How to interface the RF transmitter and receiver with the Atmega328.

1.5 SIGNIFICANCE OF THE PROJECT

I. The Project is cost effective, efficient, pollution free and environment friendly since its operations do not involve release of any waste product.

II. In the long run the maintenance cost is very less when compared to the present systems.

1.6 SCOPE THE STUDY.

Geographical scope.

The system is designed for industries, homes, hospitals, and learning institutions.

Content scope

In this project, the aim is designing and implementing electronic personal protective equipment, a moving machine interrupter system for mitigating labor-machine crush and an automatic control mechanism of loads using Radio Frequency technology.

Time scope.

The whole process of designing and implementing an industrial health and safety monitoring and prevention system using Radio Frequency technology has taken a substantial duration of five months

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION.

It is industrially and economically reported that any other industry of firm cannot meet its organizational goals at the expense of unsecured working environment. It is very paramount to soundly manage the working conditions that is pertinent to workers and working tools as well as machines. This chapter summarizes all the related literatures about the existing intelligent industrial health and safety monitoring and prevention system, concept of their operation, their limitation gaps and techniques used therein.

2.1 CONCEPTS, DEFINITIONS AND DESCRIPTIONS.

Industrial work environment

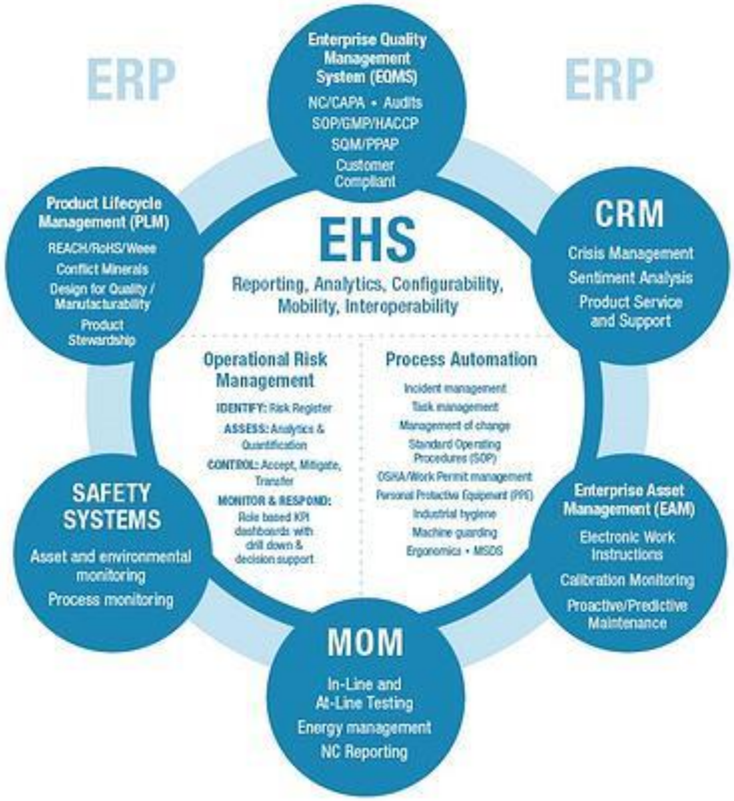
Not only does a good work environment ensure the well-being of employees, it is also a legal requirement, it reduces costs and it improves productivity, quality and employee commitment.

Deficiencies in the work environment can have serious consequences for the individual. In the workplace these deficiencies give rise to increased costs as a result of absence due to illness, rehabilitation, personnel turnover and production stoppages, damage to equipment, poor quality and underutilized potential.

An investment in a good work environment has a positive effect on morale and fosters greater employee commitment. A good work environment is also an important competitive advantage, since it attracts young people to jobs in industry. An intelligent approach to industrial work environment by combining improvements in a material or manufacturing process with improvements in the work environment.

This may refer to the safety-related aspects of a manufacturing process such as casting, ergonomics with respect to assembly work, or how work at a specific machine affects job tasks/content, sound and vibrations. Several working methods and tools and, are employed by following the work flow, individual job tasks are improved as well as entire the production systems.

At a high level, EHS management encapsulates the use of end-to-end business processes and requirements that are designed to systematically achieve continuous improvement in EHS performance. These processes reflect the role of EHS performance in the larger overall goals of sustainability performance and operational excellence, taking into account the planning, processes, procedures, and implementation of EHS initiatives. In turn, these directives should be rooted in an established methodology designed to achieve performance, evaluate results, and provide mechanisms for acting on recommended actions. While there are other concepts and specifics that can fall under EHS management, the above is a compendium of what LNS Research sees as the EHS management space and its function within a manufacturing operation.



The Genesis of EHS Management

Changing Workplace Conditions with the Rise of Mass Production

From a worker standpoint, the transition from agricultural to industrial society was marked in large part by automated production and large, potentially dangerous machinery. The evolution of these conditions gave rise to increasingly severe worker health and safety catastrophes, giving birth to formalized safety programs and procedures which were the beginnings of what we think of today as EHS management.

The Evolution of EHS Management and Technology

Within the internal EHS sphere, like other operational areas, EHS management has changed dramatically with the development of technology resources. While its existence as a corporate activity has been around for decades, it has only been since the turn of the most recent century that we've begun to see the convergence of finely tuned and widely adopted EHS management process frameworks and management standards, improved Web-based EHS management software, and a better understanding of corporate culture's role in boosting EHS performance. Another important factor in this is the increased public expectation of Corporate Social Responsibility (CSR) on the part of global enterprise, which has grown from the aforementioned worker/ examples into the present day.

Evolving Outlook and Emerging Technological Trends

Whereas EHS management in the past could be considered primarily motivated by the proverbial stick, today's companies are really starting to see the carrot come into the picture. Market leaders are seeing that EHS performance has an inseparable tie to bottom-line performance, and have begun to view it no longer as a collection of independent programs isolated from other management programs across the enterprise.

Indeed, the advancing technical trends of the past 15 or so years, with Web-based systems and real-time transactions, have allowed companies to view EHS management at a much more immediate and detailed level, shifting decision making from reactive to proactive over time.

2.2 RELATED LITERATURE.

Safety in industrial setup is always achieved administratively at the expense of minimum engineering controls. However, several scientists from the past years have tried to come up with projects to achieve a reliable anIndustrial Health and Safety Monitoring and Prevention System and these are as follows:

In July. 2017, Collision Accidents Byng-Wan Jo, Yun-Sung Lee, Jung-Huon Kim, Do-Keon Kimand Pyung-Ho Choicame up with a Proximity Warning and Excavator Control System for Prevention of Collision Accidents. This system contained an RFID tag, RFID reader, alarm device, camera, a display device (the Around View Monitor), and excavator control technology. A field test demonstrated successful performance of the proposed system. It is widely applicable in small construction fields alongside excavators and other equipment because this system does not require additional communication infrastructure, such as servers.

In January, 2019, Byung-Wan Jo, Yun-Sung Lee, Rana Muhammad Assad Khan, and Jung-Hoon Kim1andDo-Keun Kim came up with a fully revised Robust Construction Safety System (RCSS) for Collision Accidents Prevention on Construction Sites. The developed robust construction safety system (RCSS), which can activate warning devices and automatically halt heavy equipment, simultaneously, to prevent possible collision accidents. The proximity detection of this proposed system mainly relies on ultra-wideband (UWB) sensingtechnologies, which enable instantaneous and simultaneous alarms on (a) a worker 's personal safety(personal protection unit (PPU)) device and (b) hazard area device (zone alert unit (ZAU)). This system also communicates with electronic control sensors (ECSs) installed on the heavy equipment to stopits maneuvering. Moreover, the RCSS has been interfaced with a global positioning system communication unit (GCU) to acquire real-time information of construction site resources and warning events. This enables effective management of construction site resources using an online user interface. The performance and effectiveness of the RCSS have been validated at laboratory scales well as at real field (construction site and steel factory). Conclusively, the RCSS can significantly enhance construction site safety by pro-actively preventing collision of a worker/workers with heavy equipment.

In December, 2014, Mohamed M. El Rayes1, and Tamer M. Nasser designed and developed capacitive touch sensing safety system for electric adjustable beds. The developed protection system for electric adjustable beds to ensure the safety of the users and their pet animals when using these beds. This safety system utilizes capacitive touch sensing methodology on all metal parts of the bed base in addition to the perimeter of the bed frame to stop the bed if a human or an animal touches these parts. Enabling capacitive touch sensing on this large metal surface besides manufacturing constrains, is a challenging problem. Mohamed et al, addressed the design of this embedded safety system and illustrates solution of the problems associated with implementing capacitive touch sensing technique in electric adjustable beds.

In September, 2014, Mariella Sole, Claudia Musu, Fabrizio Boi, Daniele Giusto, and Vlad Popescu designed an RFID Sensor Network for Workplace Safety Management. This project was driven by the factor that large industrial environments are inherently complex systems to be monitored and controlled, given the presence of vehicles, people and industrial plants. In a context dominated by strict regulations for workplace safety, systems for monitoring and preventing workplace risks can have a particular importance. This paper describes the work in progress on designing and implementing an RFID-based sensor network for workplace safety management. The RFID Sensor Network for Workplace Safety Management was based on Body Area Networks and passive RFID tags and sensors. The goal of the proposed system was to offer a detailed, constantly updated overview of an industrial environment in terms of workplace safety.

In May 2016, Shweta hugar1, Basavaraj Amarapur came up with a system that offers Protection of Induction Motor using Microcontroller. Three-phase induction motors are industry's workhorses and widely used as electromechanical energy conversion devices. Although induction machines are considered relatively reliable and robust due to their simple design and well-developed manufacturing technologies, failures do occur and may severely disrupt industrial processes and even lead to disastrous accidents. To prevent these failure happen, many techniques have been developed for early condition monitoring. The computer based protection methods are costlier and the electrical parameters cannot be visualized by Programmable Logic Controller (PLC) based method. The old classical methods are complex. Hence to protect an Induction motor easily, a microcontroller based fault detection and protection of Induction motor is proposed. This paper tends to develop for protection of three phase induction motor from over voltage and under voltage, over current, over speed, temperature, Line frequency and phase failure with their sensing circuits. The proposed system was tested with the setting of various preset values of parameters. From the results, it is observed that the results are satisfactory, reliable, gives quick response, cost effective and highly versatile.

In August, 2018, Mohamed. F. Kotb, Magdi El-Saadawi, and Eman H. El-Desouky designed and implemented an Over Current Protection relay using Arduino Uno for Future Renewable Electric Energy Delivery and Management (FREEDM) System. The FREEDM (Future Renewable Electric Energy Delivery and Management) system is a smart grid that enables wide integration between the Distributed Renewable Energy Resources (DRER) and Distributed Energy Storage Devices (DESD) with the conventional distribution system. This paper presents the design and implementation of an Arduino Uno microcontroller-based overcurrent relay with different characteristics (inverse, very inverse and extremely inverse) for FREEDM systems. An open source model with simple utilization of both hardware and software was created. A practical printed circuit board was designed with the required inputs and outputs to monitor and protect the branch connecting solid state transformer (SST) to the closed loop zones in the FREEDM system. A special program was designed using Proteus software package and easily integrated to the hardware card.

In February, 2018, Hamzah M. Marhoon, and Ihsan A. Taha designed and implemented an intelligent circuit breaker for electrical current sensing and monitoring. The sudden increase in electrical current due to increased load or electric short circuit lead to the control panel damage in homes and companies or other institutions, and may also cause damage in the electric wires which carries the electric current, which may cause to electrical seam and then lead to the connected appliances damage to the same system as well as lead to the fire. In this, system an intelligent circuit breaker was build based on Arduino and necessary sensors such that current and voltage sensor and with help of LCD can print the result of voltage and current, the intelligent circuit breaker monitored and controlled the consumption current due to various domestic loads or short circuit. In short, circuit condition the current is very large and the voltage approximately equal to zero, the Arduino received these values from sensors then compared it with the threshold values to make the proper decision to protect system from damage and the same principle with increasing the load limit**.**

In January, 2013, Jelka Geršak, Milan Marčič, Maribor, and Slovenia came up with a complex design concept for functional protective clothing. Over the last two decades extensive work has been carried out by a number of institutes with the aim of developing efficient protective clothing for industrial workers, as well as for the armed forces. The primary requirement for both civil and defense applications is protection, respectively need for protection - for saving valuable humans faced with various hazards and climatic conditions. This contribution presents certain peculiarities of a complex design concept for protective clothing, as an important component of personal protective equipment. The requirements for protective clothing are given according to their purposes, functions, respectively type of protection, as well as the system's approach to the design, development and implementation of protective functional clothing. The research core focus in the grounded model development as the progression from initial product design goals, i.e. problem recognition, through the idea development in view of technical solution to the developed product - prototype, and finally, to evaluation of the final solution and implementation of the functional protective clothing, and certification procedures

2.3 OBSERVATIONS IN THE MOST RECENT PROJECT.

I have learnt that an Industrial Health and Safety Monitoring and Prevention System Using Radio Frequency technology has been done in the above elaborated ways and the most recent project of implementing an based Industrial Health and Safety Monitoring and Preventionsystem which wouldmonitor and prevents industrial accidents based on an Radio Frequency technology foundation. Here the systemincorporated different sensors such as the current sensor, touch sensor for preventing overload and intrusion accidents pertinent to moving machines. These systems used the stated modules separately thereby ignoring the human body damage that could be managed by a safety monitoring system.

The system is an industrial accident management system which is remotely monitored and controlled. This system could help in monitoring working conditions as well as transmitting notification to the management team.

2.4 WEAKNESS OF RECENT PROJECTS.

The majorly and seemingly persistent challenge encountered by factory managers is accident resulting from ignorance of the workers by not adhering to company principles in regards to personal protective equipment and sometimes the unsafe use of materials. And according to the most recent project, factory management teams used administrative accident control measures at the greater expense of compensation costs. More so, factories used the overload protection system in which the entire demand load is cut off. This overload protection system subjects firms into great losses especially when the entire load is shutdown.So in such situations, the previous project may be affect the tremendous growth of factories as re-staring up again of heavy factory loads such as induction motors consume a lot of power thereby making the firm to be penalized for the extra power consumed.

To prevent these failures from happening, many techniques have been developed for early condition monitoring. The computer based protection methods are costlier and the electrical parameters cannot be visualized by Programmable Logic Controller (PLC) based method. The old classical methods are complex. Hence to protect an Induction motor easily, a microcontroller based fault detection and protection of Induction motor should be designed.

Also the use of Radio Frequency Identification Cards is too inconveniencing for the employees at all times hence a new system that utilizes the same Radio Frequency technology to detect any unconscious use of personal protective equipment and notifies both the user and the managerial team.

2.5 ADVANCEMENT OF THE RECENT PROJECT.

The improved system can soundly monitor overload scenarios by making use of the Hall Effect current sensor and trips only the extra added load. This will subsequently saves the firm from extra startup cost of electricity that would result when the entire system is shutdown. As moving machines as well as cutting ones continue to subject plant technicians into a slap of accidents and making them loose some of their body parts as a result of monotonous work, the new system employs a capacitive touch sensing element that will be able to detect just a minutest slip of the worker with the tools and machines and then subsequently halts the machine from crashing anybody who will be in contact with it. Finally the system will also cater for cases of ignorant workers who may putt of some of their safety protections equipment pertinence to discomfort. The system will notify the worker by alarming and displaying the status of the personal protective equipment and concomitantly lets the supervisory team of the incomplete and complete personal protective equipment.

CHAPTER THREE.

METHODOLOGY

3.0 INTRODUCTION.

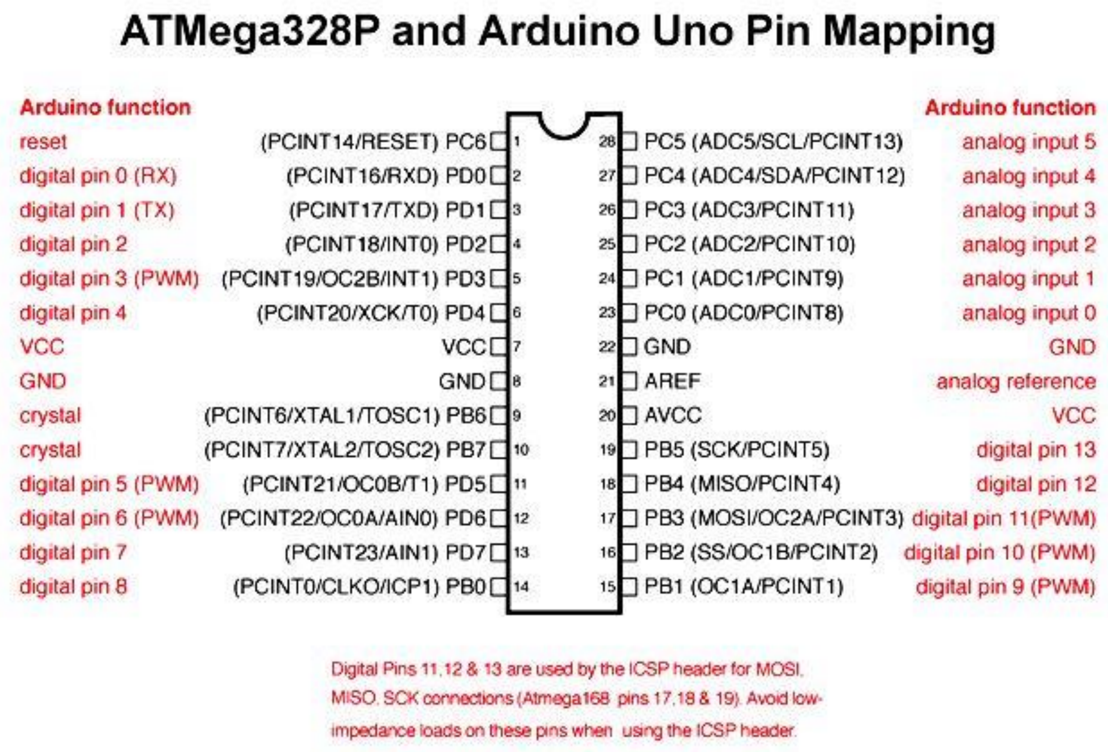
The high risks of unexpected dangerous accidents as well as huge operational and repair and maintenance costs calls for immediate solutions of automatic systems that can soundly monitor the firms working conditions reliably and less costly. A Low cost and reliable sensor and radio frequency based workplace accident management which can soundly monitor the working as well as the machine operational conditions has been achieved through the use of capacitive touch sensor, hall effect current sensor and the radio frequency modules interfaced with the microcontrollers for the transceiver subsystems to effectively monitor safety.

3.1 INSTRUMENTATION/ MAJOR COMPONENTS USED.

A microcontroller.

A microcontroller is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor. A primary microcontroller incorporates all the memory storage devices and interfaces needed for a simple application. A microcontroller is a single integrated circuit with the following fundamental features: Central processing unit - ranging from small and simple 8-bit processors to sophisticated 32- or 64-bit processors, input/output interfaces such as serial ports, peripherals such as timers, RAM for data storage, ROM, EEPROM or Flash memory for program storage, clock generator often an oscillator for a quartz timing crystal and resonator or RC circuit. This integration drastically reduces the number of chips and the amount of wiring and Printed Circuit Board (PCB) space that would be needed to produce equivalent systems using separate chips.

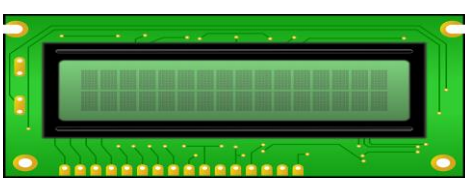
ATMEGA328P is high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in ARDUINO boards.



Liquid Crystal Display

An Lcd Jhd162ais a flat panel, an electronic visual display that uses the light modulating properties of liquid crystals. Liquid crystal does not emit light directly. The working of LCD depends on two sheets of polarizing material with a liquid crystal solution in between them. When an electric current is passed through the liquid, it causes the crystals to align so that it blocks out light and does not allow it to pass. Each crystal behaves like a shutter; it either allows light to pass through or blocks the light.

It can function properly in the temperature range of -10°C to 60°C and has an operating lifetime of longer than 50000 hours (at room temperature without direct irradiation of sunlight).



Mode of operation of the liquid crystal display.

LCD in 4-Bit means 4 Lines of data bus are used instead of using 8 Line data bus. In this Method, Data is splinted in Nibbles. If a Microcontroller is successfully interfaced with LCD with 4 Pins. Then 4 Lines of Microcontroller can be saved, which pins can be used for other purpose.

LCD Pin Description in 4bit mode

Pin No	Symbol	I/O	Description
1	Vss	-	Ground
2	Vcc		+5V
3	Vee		Contrast Control
4	RS	Input	Command/Data Register
5	R/W	Input	Read/Write Register
6	E	Input/Output	Enable
7	DB0	Input/Output	Not Used in 4-Bit Mode
8	DB1	Input/Output	Not Used in 4-Bit Mode
9	DB2	Input/Output	Not Used in 4-Bit Mode
10	DB3	Input/Output	Not Used in 4-Bit Mode
11	DB4	Input/Output	Data Bus in 4-Bit Mode
12	DB5	Input/Output	Data Bus in 4-Bit Mode
13	DB6	Input/Output	Data Bus in 4-Bit Mode
14	DB7	Input/Output	Data Bus in 4-Bit Mode
15	Vcc	-	For LCD Back Light
16	Vss	-	For LCD Back Light

Buzzer system.

Buzzer is used for alerting purpose. It convert electrical energy into sound energy by using transistor and capacitor. It produces high frequency for hearing purpose.

When the required angle is achieved, the microcontroller takes quick action to activate or sound the alarm.

Current sensor

A current sensor is a device that detects electric current in a wire, and generates a signal proportional to that current. The generated signal could be analog voltage or current or even a digital output. The generated signal can be then used to display the measured current in an ammeter, or can be stored for further analysis in a data acquisition system, or can be used for the purpose of control.

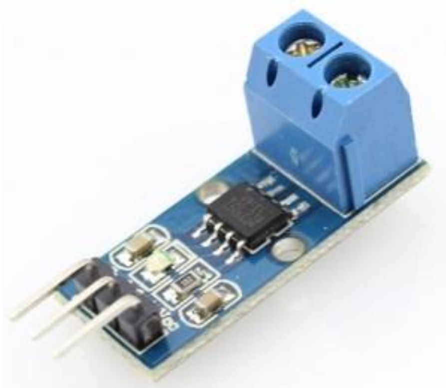
The sensed current and the output signal can either be an Alternating current input, analog output, which duplicates the wave shape of the sensed current, bipolar output, which duplicates the wave shape of the sensed current, unipolar output, which is proportional to the average or RMS value of the sensed current. Or Direct current input, which consists of unipolar, with a unipolar output, which duplicates the wave shape of the sensed current digital output, which switches when the sensed current exceeds a certain threshold.

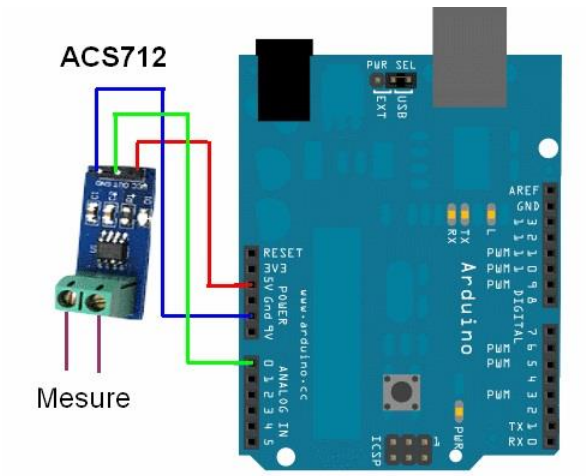
Closed loop sensors. The probe placed in the air gap of the magnetic circuit, provides a voltage proportional to this flux. The electronic circuit amplifies the signal from the primary current Ip or voltage up flowing across the sensor and generates a current into the secondary Is. This secondary current multiplied by the number of turns Ns of secondary winding cancels out the primary magnetic flux that created it. The global flow is equal to zero. The formula Np x Ip = Ns x Isis true at any time which means the measuring of instantaneous values.

The secondary output current Isis exactly proportional to the primary current and can be passed through a measuring resistance Rm. The measuring voltage Vm at the terminals of this resistance is therefore proportional to the primary current Ip.

Reading Sensing and Controlling current flow is a requirements in a wide variety of application including, over-current protection circuits, switching mode, battery chargers, power supplies, digital watt meter and programmable current source, etc.. The ACS721 current reading module is based on ACS712 Sensor which can detect AC, DC current signal accurately.

The maximum AC / DC can be detected using ACS712 will reach 30 amp and present current signal can read via analog IO port of Arduino, Product available for this module are 30A, 20A, 5A. For this demonstration the ACS712 30A has been used.

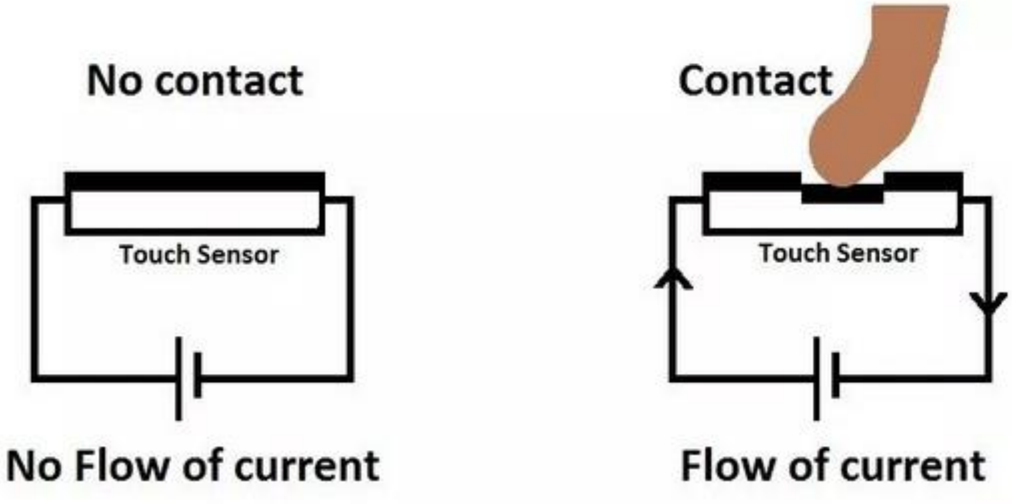




Capacitive touch sensor

The Touch Sensor are sensitive to touch, pressure as well as force. The Touch Sensor works similar to that of a simple switch.

When there is contact or a touch on the surface of the Touch Sensor. It acts like a closed switch and allows the current to flow through it. When the contact is released it acts similar to the opened switch and hence there is no flow of current. The mode of operation of acapacitive touch sensor is as shown below



The Capacitive touch sensors are very popular since they are more robust, durable and user friendly. Moreover, it is also cost-effective when compared resistive touch sensors.

The capacitive sensor is made just similar to the normal capacitor. There are two conductors separated with the insulator.

In case of the sensor the metal plates are used as the conductors. The capacitance of the sensor can be expressed as below.

$C = \varepsilon_0 \text{ x } \varepsilon_r \text{ x } A / d$

Where,

ε_0 represents the permittivity of free space

ε_r represents the relative permittivity or dielectric constant

d represents the distance the parallel plates and A represents the area of the plates.

We know that if the plate has more area the more capacitance it will produce and the more distance between the two plates are the less capacitance will become.

In the Capacitive touch sensor there are the two parallel plates which form a capacitor with the capacitance value represented as C_0. As we touch the sensor through our finger, our finger acts like a conductive object and hence produces a capacitance value of C_T as shown in the figure below.

In the application of a sensor the capacitance C_0 is measured continuously with the help of capacitance measurement circuit. There will be uncertain increase in the capacitance if any conductive object such as our finger touches the plate. The capacitance measuring circuit will detect the change in the capacitance and will convert it into a signal.

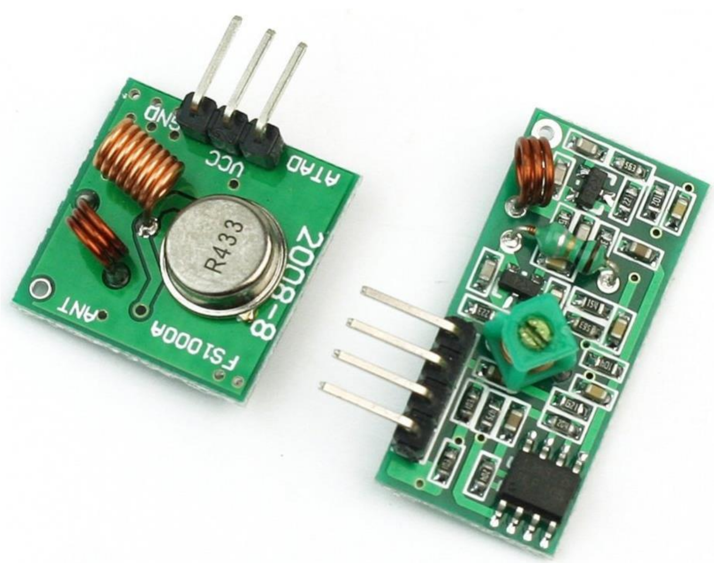
RF transmitter and receiver modules

In generally, the wireless systems designer has two overriding constraints: it must operate over a certain distance and transfer a certain amount of information within a data rate. The RF modules are very small in dimension and have a wide operating voltage range i.e. 3V to 12V.

Basically the RF modules are 433 MHz RF transmitter and receiver modules. The transmitter draws no power when transmitting logic zero while fully suppressing the carrier frequency thus consume significantly low power in battery operation. When logic one is sent carrier is fully on to about 4.5mA with a 3volts power supply. The data is sent serially from the transmitter which is received by the tuned receiver. Transmitter and the receiver are duly interfaced to two microcontrollers for data transfer. The performance of RF modules is affected by many factors as elaborated; As compared to the other radio-frequency devices, the performance of an RF module will depend on several factors like by increasing the transmitter's power a large communication distance will be gathered. However, which will result in high electrical power drain on the transmitter device, which causes shorter operating life of the battery powered devices. Also by using this devices at higher transmitted power will create interference with other RF devices.

RF modules were used in this project for transmit and receive the data because it has high volume of applications than IR. RF signals travel in the transmitter and receiver even when there is an obstruction. It operates at a specific frequency of 433MHz.

RF transmitter receives serial data and transmits to the receiver through an antenna which is connected to the 4^{th} pin of the transmitter. When logic 0 applied to transmitter then there is no power supply in transmitter. When logic 1 is applied to transmitter then transmitter is ON and there is a high power supply in the range of 4.5mA with 3V voltage supply.



The wiring for the transmitter was based only on three connections. Connect the VCC pin to 5V pin and GND to ground on the Arduino. The Data-In pin should be connected to Arduino's digital pin.The wiring for the receiver was as easy as the transmitter was as it also involved connecting the VCC pin to 5V pin and GND to ground on the Arduino. Any of the middle two Data-Out pins was connected to digital pin on the Arduino microcontroller.

The primary factor in path loss is the decrease in signal strength over distance of the radio waves themselves. Path loss is the reduction in power density that occurs as a radio wave propagates over a distance. Radio waves follow an inverse square law for power density: the power density is proportional to the inverse square of the distance. When distance doubled then, only one-fourth the power is received. This means that every 6-dBm increase in output power doubles the possible distance that is achievable.

Besides transmitter power, another factor affecting range is receiver sensitivity. It is usually expressed in –dBm. Since both output power and receiver sensitivity are stated in dBm. The antenna was coiled so as to attain maximum power transfer.

The wavelength of a frequency was calculated as follows;

$$Wavelength\ of\ the\ frequency = \frac{transmission\ speed}{transmission\ frequency}$$

In air, speed of transmission is equal to the speed of light, which is 299,792,458 m/s to be precise. So, For the 433 MHz band the wavelength is

$$frequency\ wavelength = \frac{299{,}792{,}458}{433{,}000{,}000}$$

$$= 0.6924\ metres$$

$$= 69.24\ cm$$

As full wave 69.24 cm antenna is a pretty long antenna, it was not very practical to be used hence an option for a quarter wave antenna which worked out to about 17.3 cm or 6.8 inches.

Data collection.

Experimental data collection method was used in this project. Experimentation normally involves the testing of a hypothesis about the relationship between the cause and an effect. In the natural sciences, this control is enhanced by use of a laboratory. Any change in the participant's behavior should be the result of the change introduced by the experimenter.

3.2 METHODS USED

Examine the existing system

Experimentation:

This involves the deliberate manipulation of an intervention in order to determine its effects.

Reason why experimentation was used.

An experiment may compare a number of interventions with each other, or may compare one (or more) to a control group

Issues of generalizability (often called 'external validity') are usually important in an experiment, so the same attention must be given to sampling, response rates and instrumentation as in a survey (see above). It is also important to establish causality ('internal validity') by demonstrating the initial equivalence of the groups (or attempting to make suitable allowances), presenting evidence about how the different interventions were actually implemented and attempting to rule out any other factors that might have influenced the result.

3.3 DEVELOPING A NEW IMPROVED SYSTEM.

Experimentation:

This involved the deliberate manipulation of an intervention in order to determine its effects.

Reason experimentation was used.

An experiment may compare a number of interventions with each other, or may compare one (or more) to a control group

Issues of generalizability (often called 'external validity') are usually important in an experiment, so the same attention must be given to sampling, response rates and instrumentation as in a survey. It is also important to establish causality ('internal validity') by demonstrating the initial equivalence of the groups (or attempting to make suitable allowances), presenting evidence about how the different interventions were actually implemented and attempting to rule out any other factors that might have influenced the result.

Testing/validating the developed system Experimentation:

This involved the deliberate manipulation of an intervention in order to determine its effects.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 INTRODUCTION

As stated initially indicated in the up sequent chapters, this Industrial Health and Safety Monitoring and Prevention Systememployees the Radio Frequency technology to communicate between the transmitting section and the receiving section for the monitoring of the personal protective equipment. The transmitter section is used for sending notification tothe receiver section which is the microcontroller. A microcontroller in the control unit is utilized totrip off the additional load that does not meet the power set or provided by the utility companyand more so the same control unit micro controller is used to put the cutting machine at a halt in the case of a worker becoming in contact with it as well as receiving notifications that are pertinent to status of use of the personal protective equipment by the employee(s). In this chapter, the process of implementing the study project and the pertinent results are fully discussed.

4.1 RESULTS

System design.

The system is designed with the use of a combination of tools. These tools are categorized as hardware tools and software tools as indicated below:

Hardware System Components

- Voltage Regulator LM7805.
- RF modules
- Microcontrollers Arduino ATMEGA328P.
- LCD JHD16X2A.
- RF modules (2)
- Hall effect current sensor ACS712
- Power supply section which contains a transformer, rectifier, filter, regulator which ensures a constant +5V.
- Crystal oscillator.

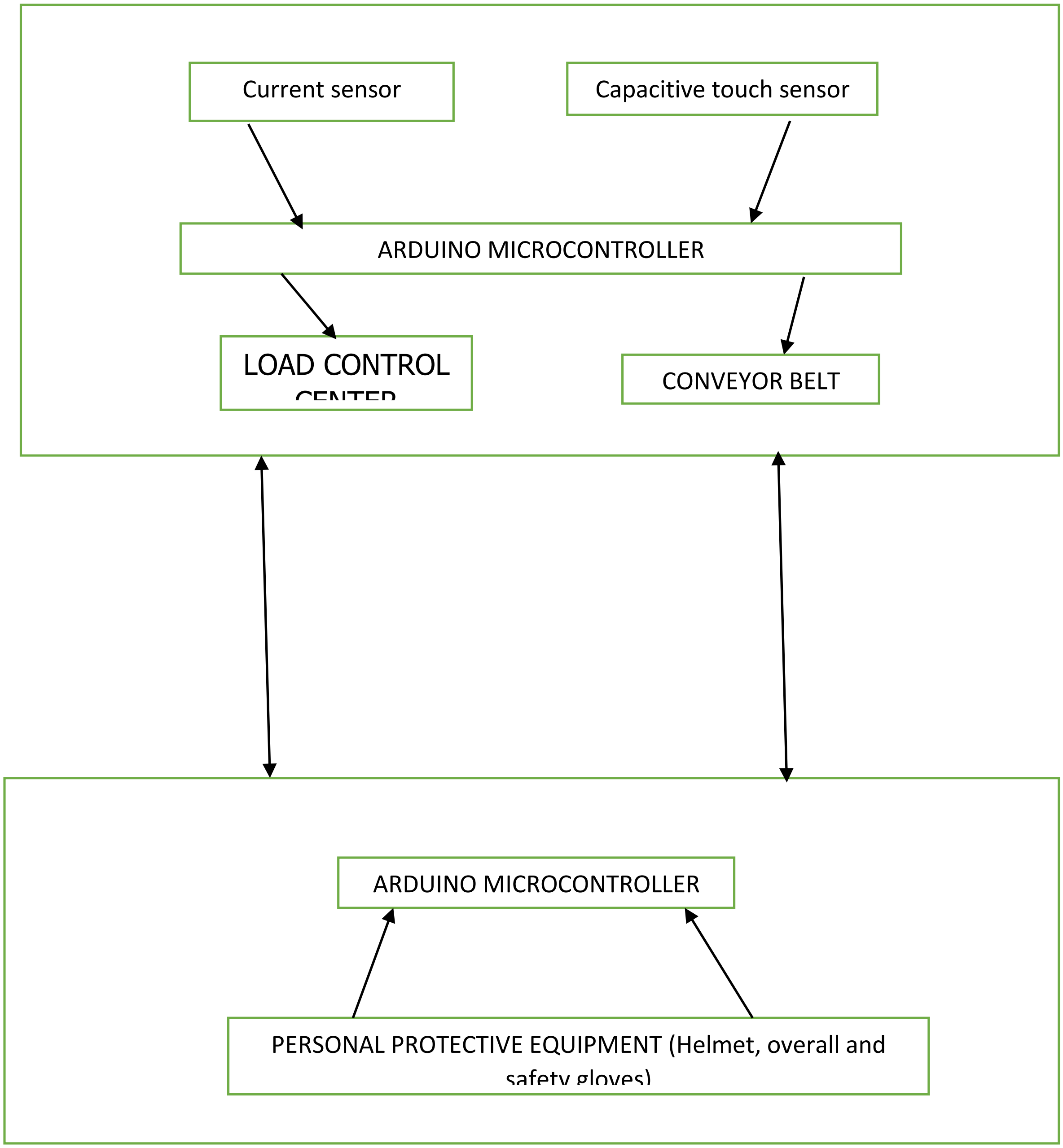
- Ceramic capacitors.
- Potentiometer
- Male to female jumpers.
- Wooden casing.
- Semiconductor diodes.
- Terminal blocks.
- Capacitors.
- Resistors.

Software

- Proteus
- Arduino IDE.

4.2 CONCEPTUAL DESIGN.

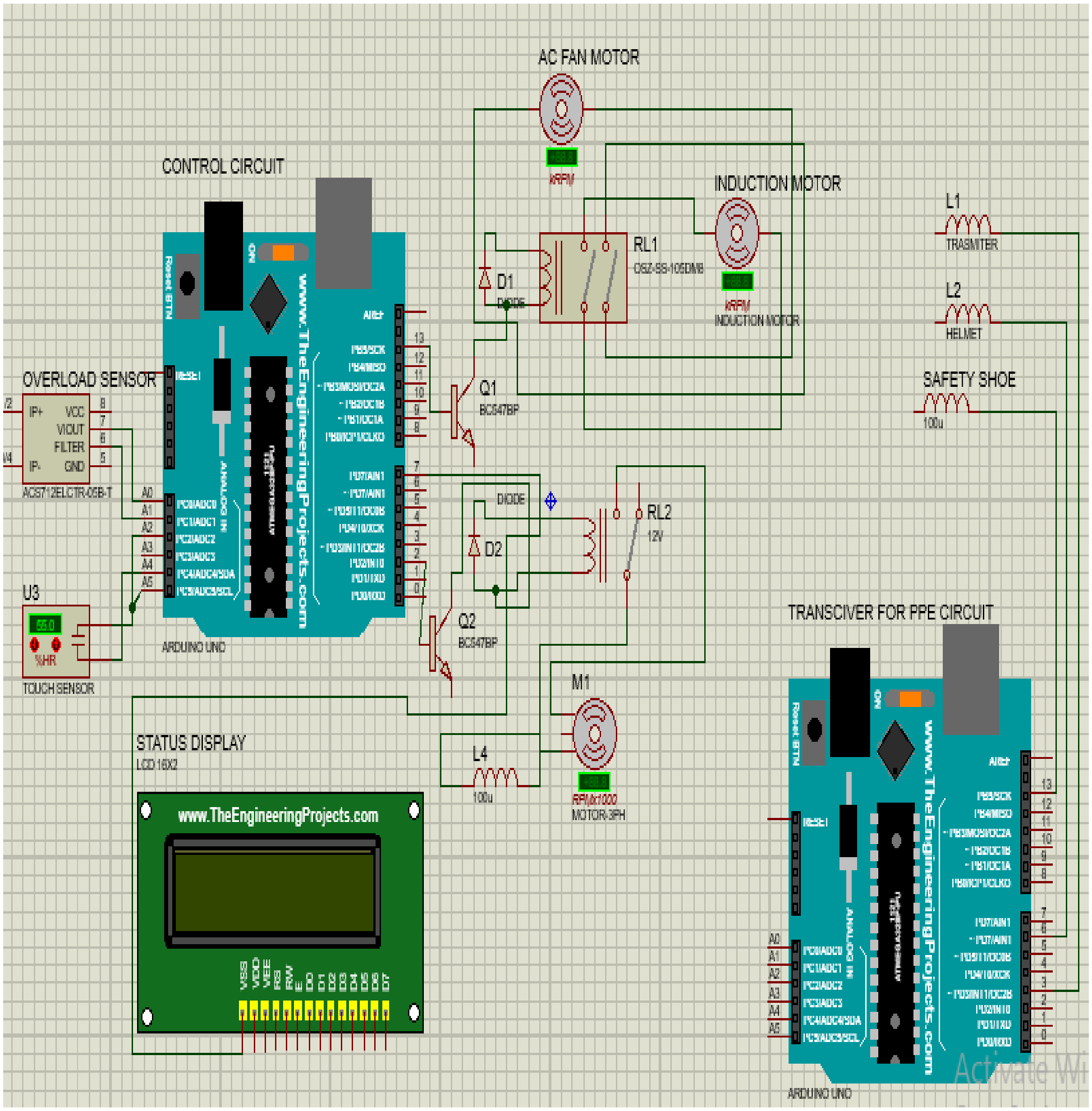
The block diagram encapsulate the Receiver and transmitter subsystems as subsequentlyillustrated below



4.3 WORKING PRINCIPAL OF THE PROJECT.

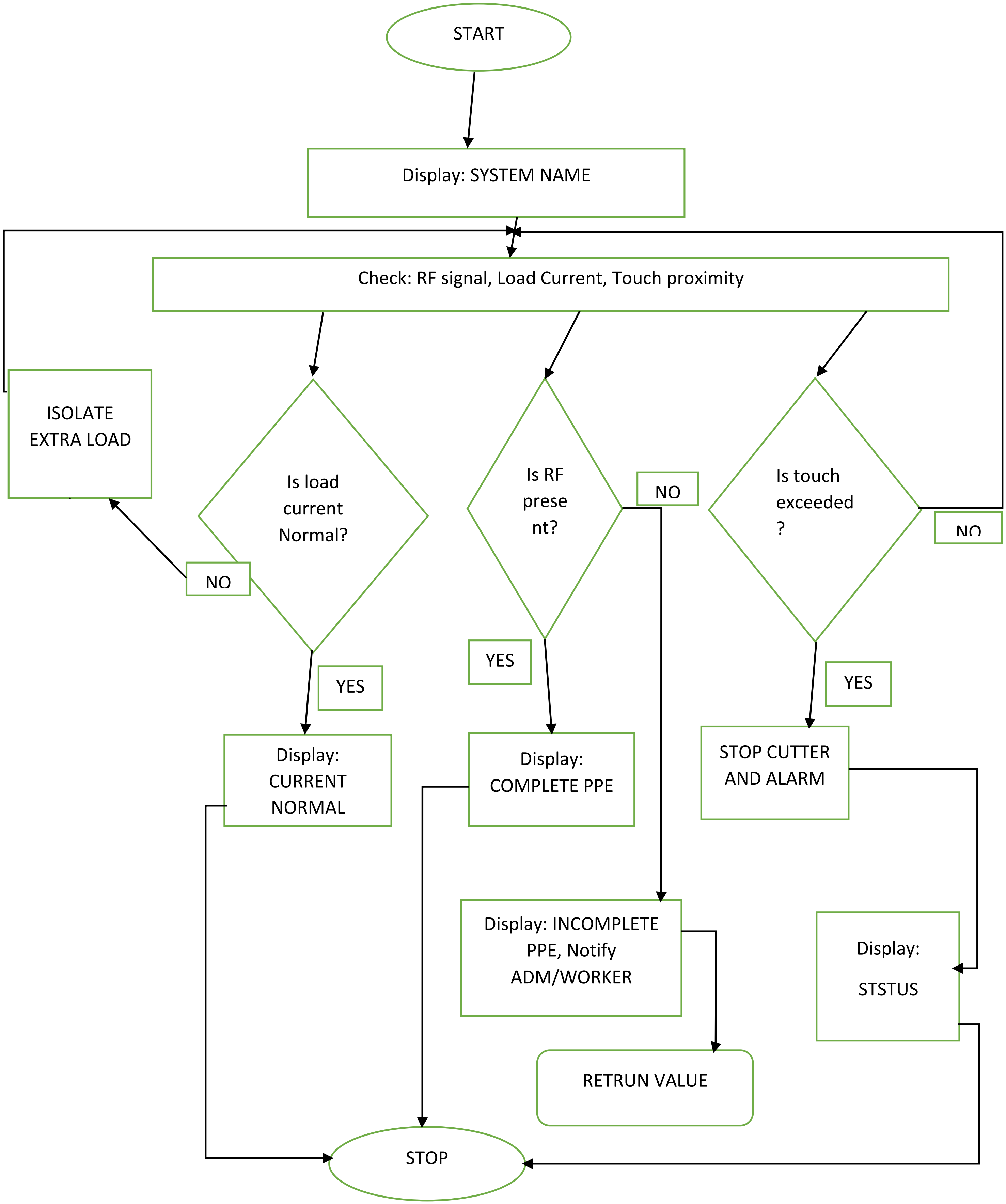
The project consists of the receiver and transmitter sub systems with the receiver performing an extra primary monitoring role. The control unit has a microcontroller uploaded with a command program to take actions that are pertinent to overload conditions as well as cutting tools slippage accidents. A fast and simple electronic overcurrent protection circuit based on the current-adjustable sensing method. First, the load current is sensed and converted to a voltage signal using Hall sensor. Then, the signal is amplified and compared with the predefined threshold value, that is, the maximum tolerance current, using amplifier and customized program in the microcontroller, respectively. The generated pulse signal is used as an input to trigger the load relay center circuit for rapidly switching off alternating current power once the load current exceeds the tolerance value. Additionally, when the touch is sensed by the capacitive touch sensor, a signal is send to the microcontroller to immediately stop the machine so as to prevent the victim from encroach machine accident. On the other hand, the transmitter uses the Radio frequency module to communicate with the control unit. It incorporates the inputs as the overall, safety gloves, and helmet and an alarm and liquid crystal display as outputs. In the event of either of the safety protective units being undressed, a signal is generated and its send to the microcontroller which then commands the alarm to sound and display the status of the personal protective equipment for both the worker and the control or management team of the personal protective equipment status.

CIRCUIT DIAGRAM.



4.4 SYSTEM PROGRAMMING

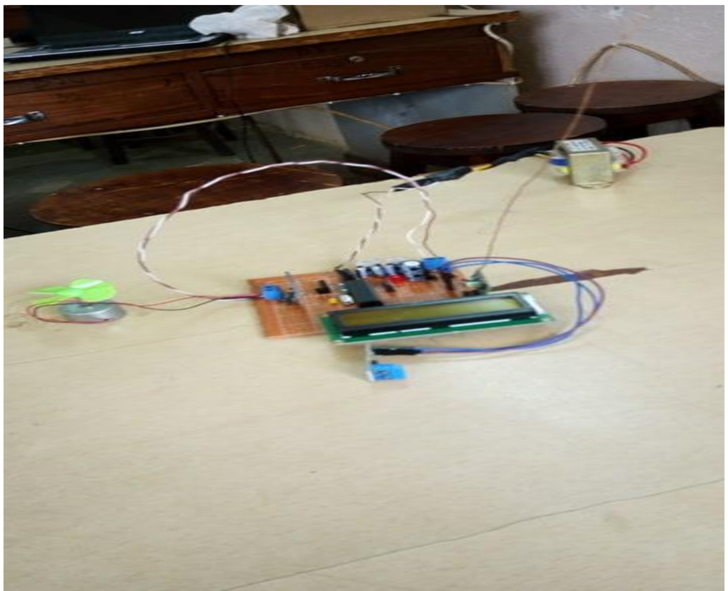
All these functions were coordinated by a C code running in an Arduino Integrated Development Environment. This software uses a programming board called Arduino Uno which programs AVR microcontrollers like ATMEGA32. Below is a flow program control implementation chart.

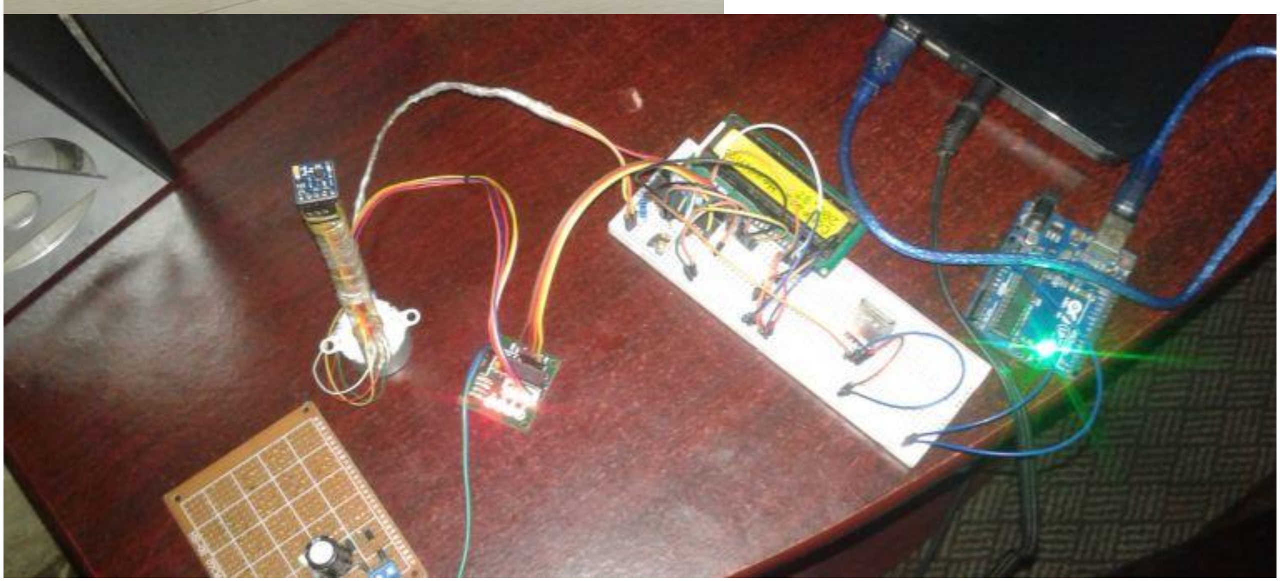

START
Display: SYSTEM NAME
Check: RF signal, Load Current, Touch proximity
ISOLATE EXTRA LOAD
Is load current Normal?
NO
YES
Is RF present?
NO
YES
Is touch exceeded ?
NO
YES
Display: CURRENT NORMAL
Display: COMPLETE PPE
STOP CUTTER AND ALARM
Display: INCOMPLETE PPE, Notify ADM/WORKER
Display: STSTUS
RETRUN VALUE
STOP

Breadboard components assembling.

Pertinent to this, initially, all components are assembled on the breadboard, and the concept of the project operation tested before finally transferring the components to a printed circuit board (PCB).

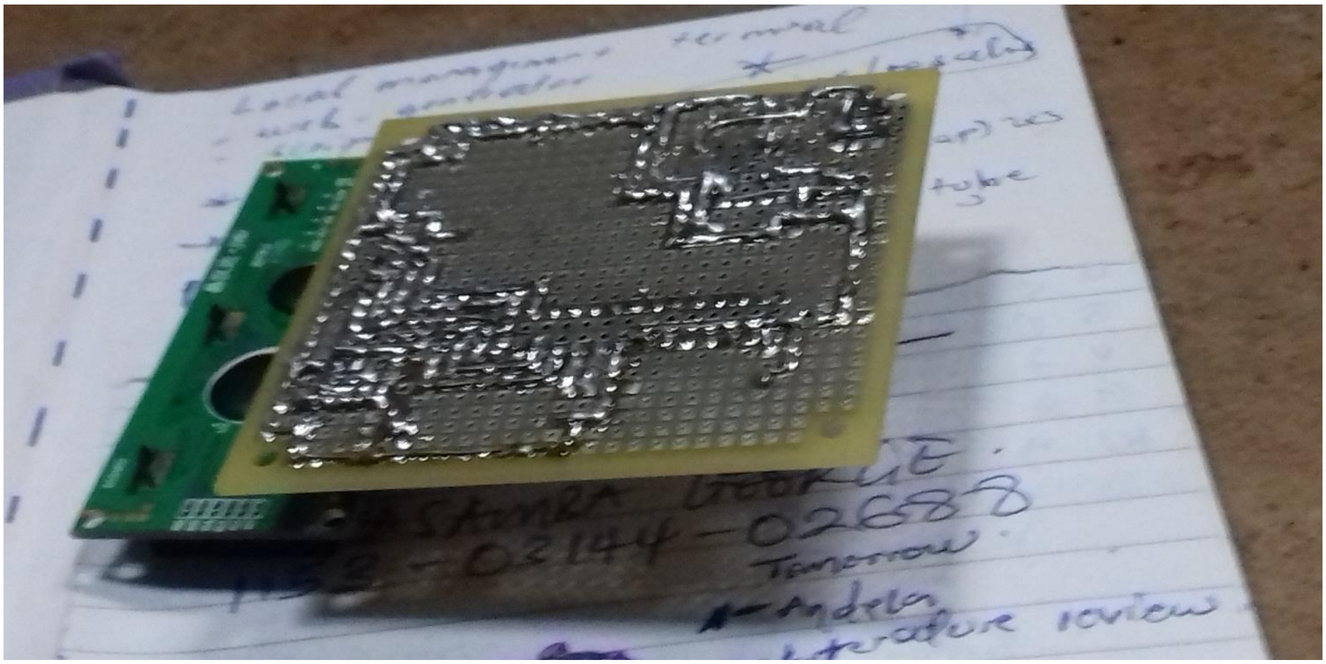
The results were positive as all components performed their tasks as expected, right from the +5v power source tapped from the laptop with the aid of Arduino Uno power cable (USB), through the board to all other components.





Soldering on printed circuit board.

This involved, placing components on a PCB and soldering them on with the aid of a soldering gun and lead. This marked a strong continuous outline of the circuit whereby all components were connected from point to point, from Vcc to ground and microcontroller connections.



Soldering safety.

Soldering Iron

- Never touch the element of the soldering iron....400°C!
- Hold wires to be heated with tweezers or clamps.
- Keep the cleaning sponge wet during use.
- Always return the soldering iron to its stand when not in use. Never put it down on the workbench.
- Turn unit off and unplug when not in use.

Solder, flux and cleaners

- Wear eye protection. Solder can “spit”.
- Use rosin-free and lead-free solders wherever possible.

- Keep cleaning solvents in dispensing bottles.
- Always wash your hands with soap and water after soldering.

Lead exposure

- Lead can give rise to serious chronic health effects. Exposure will primarily be through accidental ingestion from your skin, wear gloves if directly handling solder. Limited fumes may be generated by soldering.

Rosin exposure

- Rosin (colophony, resin) is a resin contained in solder flux. Flux generates the visible fumes seen during soldering. Exposure to rosin can cause eye, throat and lung irritation, nose bleeds and headaches. Repeated exposure can cause respiratory and skin sensitization, causing and aggravating asthma. Rosin is a serious occupational health hazard.

Control of fumes

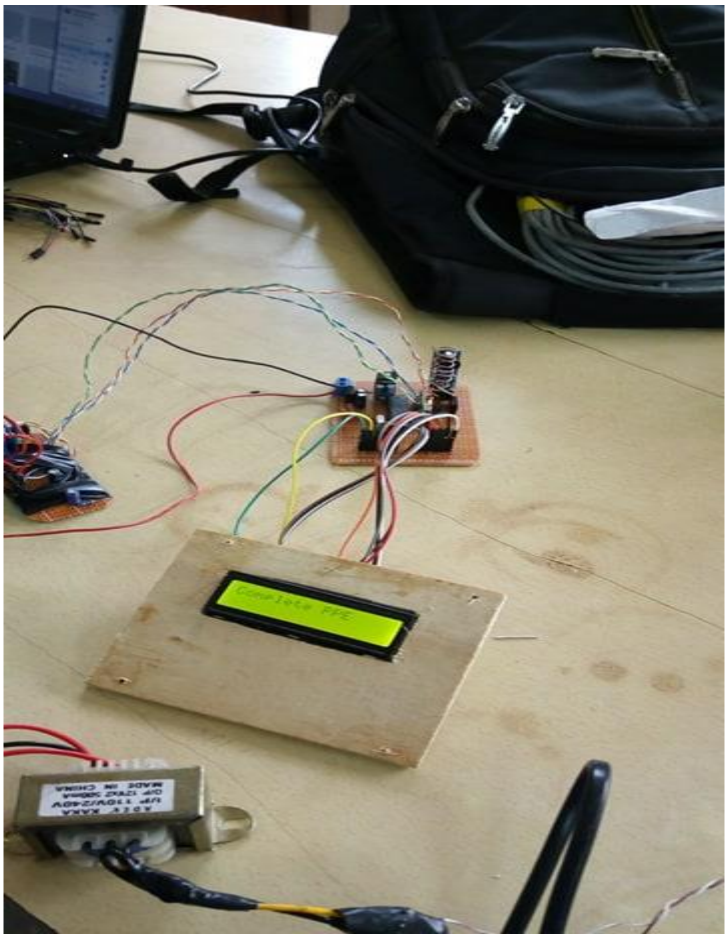
- **Soldering using rosin is only permitted in strictly controlled conditions after discussion with the Safety Office where there is no effective alternative**. Fume extraction should be through an enclosed hood (preferred) or tip extraction. Ideally these should vent to the outside. Tip extract units that use filter boxes should include both activated carbon and HEPA filters.
- Bench top filter extract systems may be used for rosin-free soldering in well ventilated areas (i.e. large volume work space or with mechanical air changes. Placement of these is important to performance, if in doubt ask.
- All extract systems should be tested at least annually and maintained (i.e. change filters regularly). Keep a log of filter changes or mark date on filter/system.
- Do not solder if extract is not working properly and report immediately.

Continuity testing.

After soldering was done, the continuity test was crucial for testing whether a line was continuous from one point to another and also to ensure there are no short circuits as a result of continuity between Vcc and ground.

Results on PCB.

A successful continuity test gave a go forward to power the circuit and hence all components successfully performed as anticipated.



CHAPTER FIVE

RECOMMENDATIONS AND CONCLUSION

5.1 CONCLUSION.

This system having been designed and implemented proves to be an efficient system unit for monitoring and managing safe working conditions reliability. It was tested several times and its performance was perfect.

5.2 RECOMMENDATIONS.

I recommend all project managers and project executors to halt the use of the previous version of safety administrative measures to prevent industrial accidents and use the developed new improved version of the system.

5.3 FUTURE SCOPE.

The sound capability of the system to detect any field worker and uses the cameras to take photos of the victim for transmitting to the management team for critical analysis of the situation and counselling actions in as far as the pertinent benefits of safety are concerned both on part of the employee himself and the firm.

In future accident intrusion prevention system can be advanced in a way that it can intelligently remove the victim from the machine so as to stop the plant shutdown as this slows down the total growth and economies of scale of the firm. In this way the system can also be remotely controlled using robots in case angular employee in question is in accidental contact with the moving machine.

CHAPTER SIX

REFERENCES

1) Hyeonwoo Kim, Eunggi Lee, Dongwoo Kwon, and Hongtaek, (2017).Chemical Laboratory Safety Management Service Using IoT Sensors and Open APIs in proceeding International Conference on Wireless Communications.

2) M. Berger and D. Korff: Adv. Mater. Res. **1018** (2014) 357.

3) D. L. Ransom and R. Hamilton: IEEE Trans. Ind. Appl. **49** (2013) 2471.
    A. Hazi and G. Hazi: Proc. 2014 Int. Conf. Exposition Electrical and Power Engineering (2014) p. 968.

4) Marinetti L, Patron L, Vilei A, (2011).Evolution of wireless sensor networks towards the Radio Frequency technology: A survey. In Software, Telecommunications and Computer Networks (SoftCOM), 2011 19th International Conference

5) C. Y. Zhang, Y. Chun, and W. Yan, (2007). Recommended Practice for Applying Low Voltage Circuit Breakers Used in Industrial and Commercial Power Systems–Corrigendum, **543** (2014) 1219.

6) Byng-Wan Jo, Yun-Sung Lee, Jung-Huon Kim, Do-Keon Kimand Pyung-Ho Choi, (2017), Collision Accidents with a Proximity Warning and Excavator Control System for Prevention of Collision Accidents

7) Byung-Wan Jo, Yun-Sung Lee, Rana Muhammad Assad Khan, and Jung-Hoon Kim1andDo-Keun Kim (2019). Design and analysis of a fully revised Robust Construction Safety System (RCSS) for Collision Accidents Prevention on Construction Sites

8) Mohamed M. El Rayes1, and Tamer M. Nasser, (2014), design and development of capacitive touch sensing safety system for electric adjustable beds

9) Mariella Sole, Claudia Musu, Fabrizio Boi, Daniele Giusto, and Vlad Popescu (2014). Design and implementation of an RFID Sensor Network for Workplace Safety Management

10) Basavaraj Amarapur, Shweta hugar1, (2016), critical analysis a system that offers Protection of Induction Motor using Microcontroller

11) Hamzah M. Marhoon, and Ihsan A. Taha (2018) designed and implemented an intelligent circuit breaker for electrical current sensing and monitoring

12) Prof. **Jelka Geršak**, Prof. **Milan Marčič**, PhD and Maribor, Slovenia**, (**2013) **a complex design concept for functional protective clothing.**

APPENDICES

APPENDIX A,I: SOURCE CODE FOR MONITORING SYSTEM.

```
// Include RadioHead Amplitude Shift Keying Library

#include <RH_ASK.h>

// Include dependant SPI Library

#include <SPI.h>


// Create Amplitude Shift Keying Object

RH_ASK rf_driver;

 #include <LiquidCrystal.h> //LCD Library

LiquidCrystallcd(5, 6, 7, 8, 9,10);

Constant touch=4;

Constant motor=3;

staticint input_1=0;

staticint input_2=1;

staticint input_3=17;



int output_1=14;

constint output_2=15;

constint output_3=16;
```

```
/*CURRENT SENSOR VARIABLES*/

constintanalogchannel = A5; //Connect current sensor with A0 of Arduino

int sensitivity = 185; // use 100 for 20A Module and 66 for 30A Module

floatadcvalue= 0;

intoffsetvoltage = 2500;

double Voltage = 0; //voltage measuring

doubleecurrent = 0;// Current measuring

float voltage=240;

floatenergy_cum,avgamps,totamps,energy,watt,amphr;


void setup()

{

  // Initialize ASK Object

rf_driver.init();

  // Setup Serial Monitor

Serial.begin(9600);

rf_driver.init();

lcd.begin(16, 2);

lcd.setCursor(0,0);

lcd.print("EHS Monitoring   ");

lcd.setCursor(0,2);

lcd.print("System....  ");

delay(3000);
```

```
pinMode(touch,INPUT);
pinMode(motor,OUTPUT);
digitalWrite(motor,LOW);

pinMode(input_1,INPUT);
pinMode(input_2,INPUT);
pinMode(input_3,INPUT);

pinMode(output_1,OUTPUT);
pinMode(output_2,OUTPUT);
pinMode(output_3,OUTPUT);

digitalWrite(output_1,HIGH);
digitalWrite(output_2,HIGH);
digitalWrite(output_3,HIGH);

lcd.clear();
}

void loop()
```

```
{
capacitive_sensor();
}

voidcapacitive_sensor()
{
intc_touch=digitalRead(touch);
if(c_touch==HIGH)
  {
lcd.clear();
lcd.print("Touch detected!!");
lcd.setCursor(0,2);
lcd.print("Cutter down");
digitalWrite(motor,LOW);
delay(1000);
  }
else
  {
```

```
current_sensing();


  }

}

voidcurrent_sensing()

{

  // Set buffer to size of expected message

uint8_tbuf[17];

uint8_tbuflen = sizeof(buf);

    // Check if received packet is correct size

if (rf_driver.recv(buf, &buflen))

    {

longmilisec = millis(); // calculate time in milliseconds

long duration=milisec/1000; // convert milliseconds to seconds


unsignedint temp=0;

floatmaxpoint = 0;

int i=0;

for(i=0;i<500;i++)

 {

if(temp = analogRead(analogchannel),temp>maxpoint)

 {

maxpoint = temp;
```

```
 }
 }
adcvalue = maxpoint;
 Voltage = (adcvalue / 1024.0) * 5000; // Gets you mV
ecurrent = ((Voltage - offsetvoltage) / sensitivity);
ecurrent = ( ecurrent ) / ( sqrt(2) );
if(ecurrent>1.33)
{

lcd.clear();
lcd.setCursor(0,0);
lcd.print("System is");
lcd.setCursor(0,1);
lcd.print("Overloaded!");
delay(1000);
digitalWrite(output_3,HIGH);
digitalWrite(motor,LOW);
delay(2000);


}
else
{
```

```
lcd.clear();

lcd.setCursor(0,0);

lcd.print((char*)buf);

lcd.setCursor(0,1);

lcd.print("Current:");

lcd.print(ecurrent);

lcd.print(" A");

digitalWrite(motor,HIGH);

delay(200);

 /* LOAD 1*/

if(digitalRead(input_1)==LOW)

 {


digitalWrite(output_1,LOW);


 }

if(digitalRead(input_1)==HIGH)

 {

digitalWrite(output_1,HIGH);


 }


/* LOAD 2*/
```

```
if(digitalRead(input_2)==LOW)
 {

digitalWrite(output_2,LOW);

 }
if(digitalRead(input_2)==HIGH)
 {
digitalWrite(output_2,HIGH);

 }

/* LOAD 3*/
if(digitalRead(input_3)==LOW)
 {

digitalWrite(output_3,LOW);

 }
if(digitalRead(input_3)==HIGH)
 {
digitalWrite(output_3,HIGH);
```

```
 }



}

 }

}
```

APPENDIX A, II: SOURCE CODE FOR MONITORING SYSTEM.

```
#include <LiquidCrystal.h> //LCD Library

LiquidCrystallcd(5, 6, 7, 8, 9,10);

#include <RH_ASK.h>

// Includedependant SPI Library

#include <SPI.h>


// Create Amplitude Shift Keying Object

RH_ASK rf_driver;

int led=19;

inthelmate=15;

intover_roll=16;

int gloves=17;

int boots=18;

void setup()

{

lcd.begin(16, 2);

lcd.setCursor(0,0);

lcd.print("Safe Protective");

lcd.setCursor(0,2);

lcd.print("Equipment mon_tr..");

delay(3000);
```

```
lcd.clear();


pinMode(helmate,INPUT);
pinMode(over_roll,INPUT);
pinMode(gloves,INPUT);
pinMode(boots,INPUT);
pinMode(led,OUTPUT);
digitalWrite(led,HIGH);
   // Initialize ASK Object
rf_driver.init();


}


void loop()
{


if((digitalRead(helmate)==LOW)&&(digitalRead(over_roll)==LOW)&&(digitalRead(gloves)==
LOW)&&(digitalRead(boots)==LOW))
  {
const char *msg = "Complete PPE                                        ";
rf_driver.send((uint8_t *)msg, strlen(msg));
rf_driver.waitPacketSent();
lcd.clear();
```

```
lcd.setCursor(0,0);

lcd.print("Complete PPE");

digitalWrite(led,HIGH);

delay(9);

   }

else

   {

const char *msg = "Incomlete PPE                                   ";

rf_driver.send((uint8_t *)msg, strlen(msg));

rf_driver.waitPacketSent();

lcd.clear();


lcd.setCursor(0,0);

lcd.print("Incomlete PPE");

digitalWrite(led,LOW);

delay(200);

digitalWrite(led,HIGH);

delay(200);

   }


}
```

APPENDIX B: GANTT CHART SHOWING THE PROJECT TIMELINE

Table 1 showing the project timeline

ANDROID BASED AUTOMATIC SECTOR ANTENNA POSITIONING	**MAY**	**JUNE**	**JULY**	**AUG**
DEFFENDING PROPOSAL				
SIMULATION				
GATHERING OF COMPONENTS				
DESIGNING A PROGRAM				
PUTTING TOGETHER HARDWARE COMPONENTS				
TEST				
IMPLEMENTATION				
PRESENTATION				

APPENDIX C: PROJECT BUDGET

Table 2 showing project budget

Item No.	**Item Description**	**Type**	**Quantity**	**Unit Price UGsh**	**Total Cost UGsh**
1	Microcontroller Embedded Module Board	ATMEGA328P	2	50,000	100,000
2	Current sensor	ACS712	1	40,000	40,000
3	Capacitive touch sensor		1	50,000	50,000
4	Buzzer	ION 820	1	5,000	5,000
5	Reset Bottom Switch	Digital	1	1,000	1,000
6	Light Emitting Diodes (LED's)	RED	2	500	1000
7	Voltage Regulator	7805V	1	5,000	5,000
8	Diodes		8	1,000	8,000
9	Capacitor		6	1,500	9,000
10	LCD Module		2	40,000	80,000
11	Bolts and Nuts		20	100	2,000
12	Conveyor motor set		2	60,000	120,000
13	transformer		1	30,000	30,000
Total					**575,500**