بسم الله الرحمن الرحيم

SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ENGINEERING

SCHOOL OF ELECTRICAL AND NUCLEAR ENGINEERING

Intensive Care Unit Control System

نظام التحكم في غرفة عناية مركزة

A Project Submitted In Partial Fulfillment Forthe Requirement of the Degree of B.Sc. (Honor) In Electrical Engineering

Prepared by:

1.Umniya Hassan BosharaAlnour

2.MohamodAbdalwahabMohamad Ahmed

3. Khalid ALtejani Ahmed Turki

4. AlssadigA.bagi Osman Alhaj

Supervised By :

UstGaffarBabiker Osman

October 2015

الآيـة

بسم الله الرحمن الرحيم

قال الله تعالي:

(شهد الله انه لا اله الا هو والملائكة واولو العلم قائما بالقسط لا اله الا هو العزيز الحكيم)

صدق الله العظيم

سورة آل عمران الآية ١٨

Dedication

To our parents who always inspiring and advising us, nothing of this could be done without them, may Allah saves them always for us. To our dears, all family members who always be there when we need them To our best friends and colleagues who are always with us step by step, supports us to go forward To everyone who is an integral part of our support group, We dedicate this work.

Acknowledgment

The greatest thanks to Allah always before and after .We would like to express our deep gratitude to everyone who helps us throughout this work at any step of it .Most grateful and appreciation to our supervisor **UstGaffarBabiker Osman**For his expertise support and endless valuable advices which guided us throughout this work and our engineering career life.We also would like to thanks the administration of **MOHAMMED ALAMAIN HOSPITAL** and the **(SHARE3 ALHAWADITH) Orgenization** . thanks all our teachers in the school of electrical and nuclear engineering for all the help and knowledge that they gave to us .and finally thankful be to everyone helped and contributed us from the beginning until to the completion of the B.Sc. degree , We hope improving reward and success for all .

ABSTRACT

Intensive care unit is very important facility for its critical circumstance that patient required a sensitive care treatment according to this it should designed to accomplish this mission .

Design ICU’s system necessitate specific performance specifications in which the environment would be helpful ,comfortable and save to the patient .

In this project heart rate alarm will be developed to guaranty fast response

Also the HVAC, security and lighting system using microcontroller and the compiler is Micro C and bascom.

مستخلص

غرفة العناية المكثفة وحدة مهمة للعناية بالحالات الحرجة التي تستدعي عناية مركزة ومراقبة مستمرة وطبقا لذلك يجب ان تصمم لتحقق هذه المهمة بكفاءة عالية .

تصميم غرفة العناية المكثفة يتتطلب مواصفات أداء معينة بحيث تتوفر بيئة صحية ومريحة تساعد على رعاية مريض العناية الحرجة .

في هذا المشروع سيتمتطوير نظام مراقبة نبضات القلب لضمان استجابة فورية

والتحكم في نظام التبريد والتكييف ، الاضاءة والعزل في غرفة العناية المكثفة.

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LIST OF ABBREVIATIONS

ICU	Intensive care unit
AC	Alternative current
DC	Direct Current
HR	Heart Rate
HVAC	Heating ,Ventilating, and Air Conditioning
AHU	Air Handling Unit
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
RFID	Radio Frequency IDentification
WPAN	Wireless Personal Area Networks
CRI	Color Rendering Index
HMI	Human Machine Interface
LED	Light Emitting Diode
ADC	Analogue to Digital Convertor
NC	Normal Close
NO	Normal Open
RAM	Random Access Memory
LCD	Liquid Crystal Display

CHAPTER ONE
INTRODUCTION

1.1 Background

The constructions of the ICU required specific type of equipment to provide the best environment , the light intensity , the temperature , isolation are all considered to be carefully selected for better environment.Suitable and safe air quality must be maintained at all times. A minimum of six total air changes per room per hour are required, with two air changes per hour composed of outside air. For rooms having toilets, the required toilet exhaust of 75 cubic feet per minute should be composed of outside air. Central air-conditioning systems and recirculated air must pass through appropriate filters. Airconditioning and heating should be provided with an emphasis on patient comfort. For critical care units having enclosed patient modules, the temperature should be adjustable within each module [1]

1.2 ProblemStatment

The critical state of patients needs a continuous observation couldn't be accomplish through human being , so it is necessary to develop a system that can provide continuously observation to notice any change of the patients state and this can be achieved by sending the patient's monitor sights to an observation room using microcontroller.

Also its need a specific performance specifications (HVAC, isolation and lighting) in which the environment would be helpful ,comfortable and save to the patient

1.3 Objectives

The main objectives of this research is :

- Study the construction of the ICU and its control element (HVAC light security and heart rate alarm)
- Develop a heart rate alarm to improve the response
- Simulate the security ,HVAC and HR alarm

1.4 Methodology

- Modeling the heart rate alarm and HVAC system
- Simulating security, heart rate alarm and HVAC system using microcontroller and compiling via micro C and bascom

1.5 Project Layout

This research consists of an abstract and five chapters as follow

Chapter one deals with an introduction that contains of background, problemstatment ,objectives and methodology.

Chapter two consist of HVAC and lighting containsof overview function operation and control strategies.

Chapter three consist of security and heart rate alarm introduction functions and control method .

Chapter four consist of applications that contain of the hardware component , system modeling , software and simulation.

Chapter five consist of conclusion and recommendations .

CHAPTER TWO

HEART RATE ALARM AND HVAC

2.1 Introduction

Heart rate, or heart pulse, is the speed of the heartbeat measured by the number of contractions of the heart per unit of time typically beats per minute. The heart rate can vary according to the body's physical needs early warning systems are used to provide timely detection of patient deterioration outside of critical care areas, but with little data from the general ward population to guide alarm limit settings. Monitoring systems used in critical care areas are known for excellent sensitivity in detecting signs of deterioration, but give high false positive alarm rates, which are managed with nurses caring for two or fewer patients. On general wards, nurses caring for four or more patients will be unable to manage a high number of false alarms. Physiological data from a general ward population would help to guide alarm limit settings. [1]

When the heart beats, a pressure wave moves out along the arteries at a few meters per seconds (appreciably faster than the blood actually flows). This pressure wave can be felt at the wrist, but it also causes an increase in the blood volume in the tissues.Many alarms, as they now exist in most monitoring systems, are usually perceived as unhelpful by medical staff because of the high incidence of false alarms; that is, alarms with no clinical significance. This research gives an overview of the problems related to the current design of alarms, and the objectives of monitoring. The current approaches used to improve the situation are then presented from two main standpoints organizational and behavioral on the one hand, and technical on the other. ‘Organizational’ refers to the definition of a compromise between the use of heavy monitoring that induces many false alarms and the use of light monitoring that can lead to the tardy detection of an adverse incident. This orientation is approached through recommendations such as those published by the learned societies. The other standpoint concerns the development of technical solutions: improvement in the technology of some sensors to reduce artifacts, and the use of multi parametric analysis to reduce the number of false-positive alarmsAlarms are currently generated on crossing a limit. This notion of limit is of course useful in determining physiological limits of variation of a parameter but it is probably not the best method of event detection. The information that theclinician wants most of the time is the detection of relevant abnormalities or changes in a patient's condition. This is not easily reflected in a value crossing a limit but rather by the simultaneous evolution of different parameters the problem is not merely technical but involves the function and objectives of monitoring. A very interesting review of goals and indications for monitoring is "Monitoring is making repeated or continuous observations or measurements of the patient, the physiological function and the function of life support equipment, for the purpose of guiding management decisions, including when to make interventions and assessment of those interventions". The physiological function is supposed to be monitored through physiological parameters that reflect that function more or less precisely. Monitoring then serves the purpose of maintaining a parameter within 'normal' values. In practice , the observation wide variations in a given parameter without alteration of the physiological function. That is what is generating false alarms: in spite of being true for the monitoring device (the parameter did cross the limit) they have no clinical significance. [1]

2.2 HVAC Systems

HVAC systems are classified as either self-contained unit packages or as central systems. Unit package describes a single unit that converts a primary energy source (electricity or gas) and provides final heating and cooling to the space to be conditioned. Examples of self-contained unit packages are rooftop HVAC systems, air conditioning units for rooms, and air-to-air heat pumps.With central systems, the primary conversion from fuel such as gas or electricity takes place in a central location, with some form of thermal energy distributed throughout the building or facility.

Central systems are a combination of central supply subsystem and multiple end use subsystems. There are many variations of combined central supply and end use zone systems. The most frequently used combination is central hot and chilled water distributed to multiple fan systems. The fan systems use water-to-air heat exchangers called coils to provide hot and/or cold air for the controlled spaces. End-use subsystems can be fan systems or terminal units. If the end use subsystems are fan systems, they can be single or multiple zone type. The multiple end use zone systems are mixing boxes, usually called VAV boxes.

Another combination central supply and end use zone system is a central chiller and boiler for the conversion of primary energy, as well as a central fan system to delivery hot and/or cold air. The typical uses of central systems are in larger, multistoried buildings where access to outside air is more restricted. Typically central systems have lower operating costs but have a complex control sequence. The HVAC system can be represented in figure 2.1

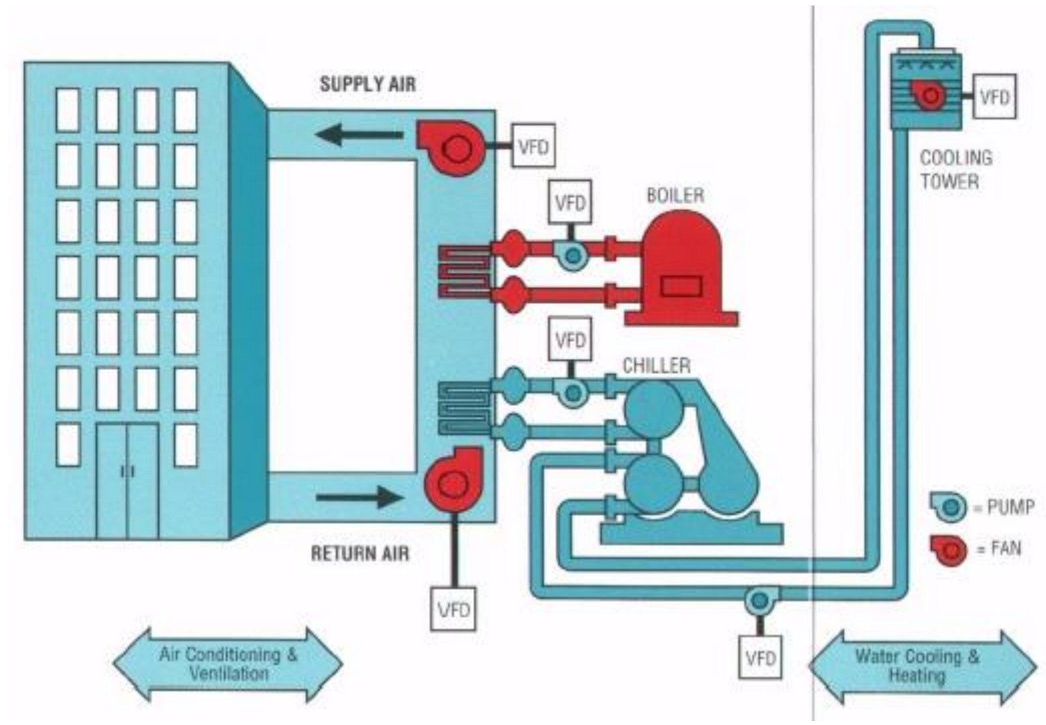

Figure 2.1: HVAC system

A heater is an object that emits heat or causes an other body to achieve a higher temperature. In a household or domestic setting, heaters are usually appliances whose purpose is to generate heat (i.e. warmth) for the building.

Other types of heaters are ovens and Furnaces. Heaters exist for all states of matter, including solids, liquids, and gases. Heat can be transferred by convection, conduction, and radiation. The opposite of a heater (for warmth) is an air cooler (for cold) used to lower the ambient temperature.

Ventilation is the process of changing or replacing air in any space to control temperature or remove any combination of moisture, smoke, heat, dust, air borne bacteria, or carbon dioxide, and to replenish oxygen. Ventilation includes both the exchange of air with the outside as well as circulation of air with in the building. It is one of the most important factors for maintaining acceptable indoor air quality in buildings.

An air conditioning system, or a standalone air conditioner, provides cooling and humidity control for all or part of a building. Air conditioned buildings often have sealed windows, because open windows would work against the system intended to maintain constant indoor air conditions.Outside, fresh air is generally drawn into the system by a vent into the indoor heat exchanger section, creating positive air pressure. The percentage of return air made up of fresh air can usually be manipulated by adjusting the opening of this vent. Typical fresh air in take is about 10% .Air conditioning and refrigeration are provided through the removal of heat. Heat can be removed through radiation, convection, or conduction. Refrigeration conduction media such as water, air, ice, and chemicals are referred to as refrigerants. A refrigerant is employed either in a heat pump system in which a compressor is used to drive thermodynamic refrigeration cycle, or in a free cooling system which uses pumps to circulate a cool refrigerant (typically water or a glycol mix).and the HVAC contains of

2.2.1 Chillers

A chiller is a machine that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle. This liquid can then be circulated through a heat exchanger to cool air or equipment as required.

2.2.2 Pumps

The hydraulic machine is to provide energy to a liquid or gas as it passes through them; leading to raise the pressure of a fluid or gas or increasing its speed or lifting fluid from a certain level to an other level higher than.

- Type of pumps:
    - Main pump
    - Auxiliary
- Type of pipes:
  - Hot water pipe.
  - Cold water pipe

2.2.3 Cooling towers

Cooling towers are heat removal devices used to transfer process waste heat to the atmosphere. Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature or in the case of "Close Circuit Dry Cooling Towers" rely solely on air to cool the working fluid to near the dry-bulb air temperature. Common applications include cooling the circulating water used in oil refineries, chemical plants, power stations and building cooling.

2.2.4 Central heating system

A heating system is a mechanism for maintaining temperatures at an acceptable level; by using thermal energy with in a home, office, or other dwelling. Often part of an HVAC system. A heating system may be centralized or distributed.

2.2.5 Air Handling Units (AHU)

An air handler, or air handling unit (often abbreviated to AHU), is a device used to condition and circulate air as part of a heating, ventilating, and air-conditioning (HVAC) system. An air handler is usually a large metal box containing a blower, heating or cooling elements, filter racks or chambers, sound attenuators, and dampers. Air handlers usually connect to ductwork that distributes the conditioned air through the building and returns it to the AHU.[2]

2.3 Central Air-Conditioning System Operation

Cooling Cycle (chilled water system): The supply air, which is approximately 20° F cooler than the air in the conditioned space, leaves the cooling coil through the supply air fan, down to the ductwork and into the conditioned space. The cool supply air picks up heat in the conditioned space and the warmer air makes its way into the return air duct back to the air handling unit. The return air mixes with outside air in a mixing chamber and goes through the filters and cooling coil. The mixed air gives up its heat into the chilled water tubes in the cooling coil, which has fins attached to the tubes to facilitate heat transfer. The cooled supply air leaves the cooling coil and the air cycle repeats.

The chilled water circulating through the cooling coil tubes, after picking up heat from the mixed air, leaves the cooling coil and goes through the chilled water return (CHWR) pipe to the chiller's evaporator. Here it gives up the heat into the refrigeration system. The newly "chilled" water leaves the evaporator and is pumped through the chilled water supply (CHWS) piping into the cooling coil continuously and the water cycle repeats.

The evaporator is a heat exchanger that allows heat from the CHWR to flow by conduction into the refrigerant tubes. The liquid refrigerant in the tubes "boils off" to a vapor removing heat from the water and conveying the heat to the compressor and then to the condenser. The heat from the condenser is conveyed to the cooling tower by the condenser water. Finally, outside air is drawn across the cooling tower, removing the heat from the water through the process of evaporation.[2]

2.4 HVAC Control

The capacity of the HVAC system is typically designed for the extreme conditions. Most operation is part load/off design as variables such as solar loads, occupancy, ambient temperatures, equipment & lighting loads etc keep on changing through out the day. Deviation from design shall result in drastic swings or imbalance since design capacity is greater than the actual load in most operating scenarios.Without control system, the system will become unstable and HVAC would overheat or overcool spaces.

In simplest term, the control is defined as the starting, stopping or regulation of heating, ventilating, and air conditioning system. Controlling an HVAC system involves three distinct steps:

- Measure a variable and collect data
- Process the data with other information
- Cause a control action

The above three functions are met through sensor, controller and the controlled device.

HVAC control system, from the simplest room thermostat to the most complicated computerized control, has four basic elements: sensor, controller, controlled device and source of energy.

- Sensor measures actual value of controlled variable such as temperature, humidity or flow and provides information to the controller.
- Controller receives input from sensor, processes the input and then produces intelligent output signal for controlled device.

– Controlled device acts to modify controlled variable as directed by controller. Source of energy is needed to power the control system. Control systems use either a pneumatic or electric power supply.

Figure 2.2 illustrates a basic control loop for room heating. In this example the thermostat assembly contains both the sensor and the controller. The purpose of this control loop is to maintain the controlled variable (room air temperature) to some desired value, called a setpoint. Heat energy necessary to accomplish the heating is provided by the radiator and the controlled device is the 2-way

motorized or solenoid valve, which controls the flow of hot water to the radiator.

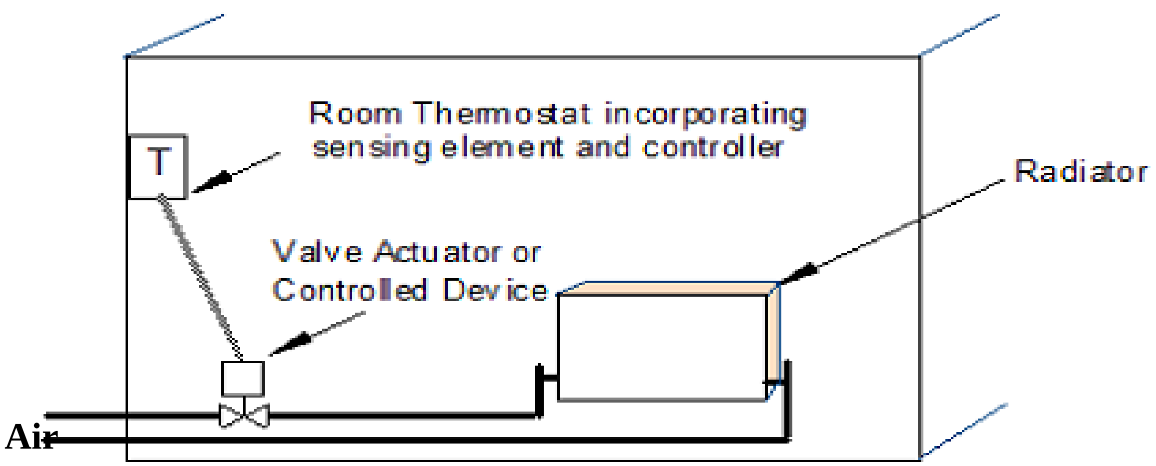

Figure 2.2: Room temperature control

2.3.5 The HVAC control parameters

A proper environment is described with four variables: temperature,humidity, pressure and ventilation.

– Temperature :

While no single environment can be judged satisfactory by everybody, it varies between people, regions and countries. Uniformity of temperature is important to comfort. The temperatures should not vary within single zone or change suddenly or drastically.

– Humidity

Humidity is the presence of water vapor in air and it affects human comfort. recommends the Relative Humidity (RH) to be maintained between 25 and 60%. Usually air is humidified to between 25 -45% during winter and dehumidified to below 60% during summer. Any figure outside this range shall produce discomfort and Indoor Air Quality (IAQ) problems.

– Ventilation:

Ventilation for acceptable indoor air quality recommends minimum ventilation rates per person in the occupied spaces. In many situations, local building codes stipulate the amount of ventilation required for commercial buildings and work environments. There commended value of outside air is typically 20 CFM for each occupant.

– Pressure:

Air moves from areas of higher pressure to areas of lower pressure through any available openings. A small crack or hole can admit significant amounts of air, if the pressure differentials are high enough (which may be very difficult to assess). The rooms and buildings typically have a slightly positive pressure to reduce outside air infiltration. This helps in keeping the building clean. Typically the stable positive pressure of .01-.05” is recommended. Pressure is an issue that comes in to play in buildings where air quality is strictly watched for example hospitals.[2]

2.3.6 HVAC Control Strategies

The simplest control in HVAC system is cycling or on/off control to meet part load conditions. If building only needs half the energy that the system is designed to deliver, the system runs for about ten minutes, turns off for ten minutes, and then cycles on again. As the building load increases, the system runs longer and its off period is shorter.One problem faced by this type of control is short-cycling which keeps the system operating at the inefficient condition and wears the component quickly. A furnace or air-conditioner takes several minutes before reaching "steady-state" performance.The longer the time between cycles, the wider the temperature swings in the space. Trying to find a compromise that allows adequate comfort without excessive wear on the equipment is modulationor proportional control. Under this concept, if a building is calling for half the rated capacity of the chiller, the chilled water is supplied at half the rate or in case of heating furnace; fuel is fed to the furnace at half the design rate: the energy delivery is proportional to the energy demand. While this system is better than cycling, it also has its problems. Equipment has a limited turn-down ratio. A furnace with a 5:1 turn-down ratio can only be operated above 20% of rated capacity. If the building demand is lower than that, cycling would still have to be used.[2]

CHAPTER THREE
SECURITY AND LIGHTING

3.1 Introduction

Security and safety have always been of prime concern to every individual or an organization Safety is the guarantee for the most essential existent of human beings. Security is the condition of being protected against danger, loss, and criminals. In the general sense, security is a concept similar to safety. The slight difference between the two is an added importance on being protected outside threats or dangers. Individuals or actions that go or act against the general rules of protection are responsible for the breach of security.

Security has to be compared and contrasted with other related concepts

- Safety Continuity
- Reliability

The key difference between security and reliability is that security must take into account the actions of people attempting to cause destruction. There is an immense literature on the analysis and categorization of security.

A security system is necessary for a building or an area to guarantee the safety of the residents and property. The security system has gone through single route monitor system, control loop monitor system, and processor plus multimedia monitor system eras in the past twenty years.

The digital monitor system which used abroad today is the fourth era production of the security system.

It's very annoying that all of the security systems show many shortcomings such as the signals transmitted through cable network, wiring network is a severe time-consuming and high-load work, and it always blocks the progress of the engineering, the information can be watched only in monitoring chamber. It's very difficult to extend system, because the wire connection is fixed, high energy consuming system and the after-effect is very serious if the cable be cut.

No matter if the building is a corporate setup, home, a public place or a factory, it has become imperative to secure it against potential dangers such as theft, crime, and fire etc. An intelligent system is therefore required which should not only detect but also pre-empt such hazards. Today it has to be updated with the rapidly changing technology to ensure vast coverage, remote control, reliability, and real time operation. Deploying wireless technologies for security and control in security systems offers attractive benefits along with user friendly interface.

The advancements in security and information technologies have led to availability of many off the shelf products. Unfortunately the conventional solutions such as CCTV security solutions, IP network video solutions and fire alarm systems are too costly in terms of deployment and power efficiency; they are application specific, making them void to provide all in one. [3]

3.2 Fundamental Security Properties

The fundamental security properties on which nearly every higher level property can be based are those of confidentiality and integrity.

3.2.1 Confidentiality

An asset that is confidential cannot be copied or stolen by a defined set of attacks. This property is essential for assets such as passwords and cryptographic keys.

3.2.2 Integrity

An asset that has its integrity assured is defended against modification by a defined set of attacks. This property is essential for some of the on-device root secrets on which the rest of the system security is based, and for the security software once it is running.

3.2.3 Authenticity

In some circumstances a design cannot provide integrity, so instead provides the property of authenticity. In this case the value of the asset can be changed by an attacker, but the defender will be able to detect the change before the asset is used and hence before the attack can cause a security fault. This property is essential for security software. If an attacker can tamper with the program code before it is loaded into a safe execution location, without being detected, then the security provided by the software can be bypassed. [3]

3.3 Security Systems Technology

There are many technologies used in security system likes radio frequency identification and zigbee.

3.3.1 Radio frequency identification

Radio Frequency Identification (RFID) is a new technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object, animal, or person. There is a wide research and development in this area trying to take maximum advantage of this technology, and in coming years many new applications and research areas will continue to appear. This massive growth in RFID also brings about some concerns, mainly the security and privacy of those who work with or use tags in their everyday life. RFID technology is much more secure compared to other networks. RFID technology consist of RFID reader and RFID tags. RFID tags are also called RFID transponders and they are divided into passive and active RFID tags.

This technology allows the system nodes or tags to exchange data via radio frequency signal communication. After receiving a radio signal, the tags process this information in order to answer back the basic data required for identifying the tag uniquely. This data is processed in the reader side with the help of software tools such as an auxiliary database or some other communication system. Some of the most popular applications of the RFID technology include, object and good authentication, access control for vehicles and humans, race timing, animal identification, product tracking and inventory systems, etc.

3.3.2 Zigbee

ZigBee is one of the typical short-range wireless communicationtechnologies, which has been widely used in a certain application areas including the family network, control network, mobile phones and other mobile terminals in foreign countries. ZigBee is a software standard that sits on top of the IEEE802.15.4 low data rate wireless standard. The ZigBee (IEEE 802.15.4) is a new technology that permits the implementation of Wireless Personal Area Networks (WPAN). It is very suitable for wireless sensor networks due to the very low power consumption.

The selection of the Radio Frequency (RF) communication modules used for the wireless transmission part in this project is based on several criteria. They are range of communication, power consumption, ease of integration and the cost. So, for this project the XBee PRO wireless modules is chosen which conform to the IEEE 802.15.4 standard.

This system uses ZigBee to build transmission network, which is used for the transmission of sensor data, and uses customized wireless transmission protocol, which is designed based on simplicity and reliability. In the protocol, considering simplifying microcontroller functions of RFID &ZigBee node and reducing system cost, the wireless transmission protocol mainly achieves the capabilities of error checking, data framing, conflict mechanisms such as retransmission etc.[3]

3.4 lighting

One important thing in every building is the lighting system, whether it is a window passing the sunlight into the room or a lamp lighting it up. But having some amount of light is just not enough, the lighting system has to fulfill some characteristics to provide us with the right Illuminance (lux, lm=m2), colour temperature (Kelvin) and colour rendering index, CRI. The CRI is often denoted as Ra and indicates how accurately the light source renders colours compared to the ideal light source , When lighting up a building there are numerous light sources available, both natural and artificial

No single lighting system can be said to be the only choice in a given instance, on the contrary, the designer normally has a choice of at least two systems that, if utilized properly, yield illumination of adequate quantity and good quality. However, other factors, such as harmonization with the architecture and economics, usually tip the balance in favour of one or the other. [4]

3.4.1 Generic types of lighting system

the generic types are classified into indirect ,semi indirect, diffuse indirect, semi direct and direct lighting

- Indirect lighting

Between 90% and 100% of the light output of the luminaries is directed to the ceiling and upper walls of the room. The system is called indirect because practically all the light reaches the horizontal working plane indirectly, that is via reflection from the ceiling and upper walls.

Therefore, the ceiling and upper walls in effect become the light source, and if these surfaces have a high-reflectance finish, the room illumination is highly diffuse (shadow less).

- Semi-indirect lighting

Between 60% and 90% of the light is directed upward to the ceiling and upper walls. This distribution is similar to that of indirect lighting, except that it is some how more efficient and allows higher levels of illumination without undesirable brightness contrast between the luminaries and its background, along with lower ceiling brightness.

- Diffuse direct–indirect lighting

Direct–indirect lighting provides an approximately equal distribution of light upward and downward, resulting in a bright ceiling and upper wall. For this reason, luminance ratios in the upper-vision zone are usually not a problem.

As the ceiling is an important although secondary source of room illumination, diffuseness is good, with resultant satisfactory vertical-plane illumination.

- Semi-direct lighting

With this type of lighting system, 60% to 90% of the luminaire output is directed downward, and the remaining upward component serves to illuminate the ceiling . If the ceiling has a high reflectance, this upward component is normally sufficient to minimize direct glare from the luminaires,depending on eye adaptation level.

- Direct lighting

In this system essentially all the light is directed downward. As a result, ceiling illumination is entirely due to light reflected from floor and room furnishings. This system, then, more than any other, requires a light, high reflectance, diffuse floor unless a dark ceiling is desired from an architectural or decorative view point .

. Occasionally, the ceilings are deliberately painted a dark color and pendant direct fixtures used to lower the apparent ceiling of a poorly proportioned room or hide unsightly piping, ductwork, and so on.

Rationalization of energy consumption for lighting

To reduce the energy consumption should be implemented the following procedures:

- First procedure

To take advantage of natural lighting and installing window blinds to light from the outer surface while the reflective light from the inner surface , and this procedure will result in the day to enter the amount of lumens from abroad.

- Second procedure

Measuring lumen often are not installing lighting in a scientific capacities and are often in excess of the required.

- Third procedure

Plating the walls and ceilings in light colors , preferably white , bringing the reflection coefficient up to 90 %.

- Fourth procedure

Installation of the sensors to provide various types of waste delicate movement of people can be used in places that are not occupied by man for long periods , for example, in the long hallways in large buildings and large halls and in the bathrooms of public places.

- Fifth procedure

Replace regular light bulbs with an other energy-saving

3.4.2 Lighting control systems

A lighting control system could in it simplest form just be one manual switch for turning the lights on and off. Here we will however refer to more sophisticated system when we discuss Lighting Control System, often known as ’Smart Lighting Control System’ or ’Robust Lighting System’.

The objectives of such a system are to

- Provide visual comfort;
- Minimize the energy consumption;
- Preserve the quality of the work environment.

Figure (3.1) shows the structure of a Lighting Control System with one controller, often a microcontroller that has some embedded control algorithm. External devices, such as sensor to detect light level or occupancy and timing device for scheduling are connected to the controller. Human machine interface, HMI , where the user can interact with the system can be a button, display or even a computer program are also connected to the controller. The controller then sends signals to ballasts and actuators that control the lights. [5]

Figure 3.1: Example of robust lighting control system

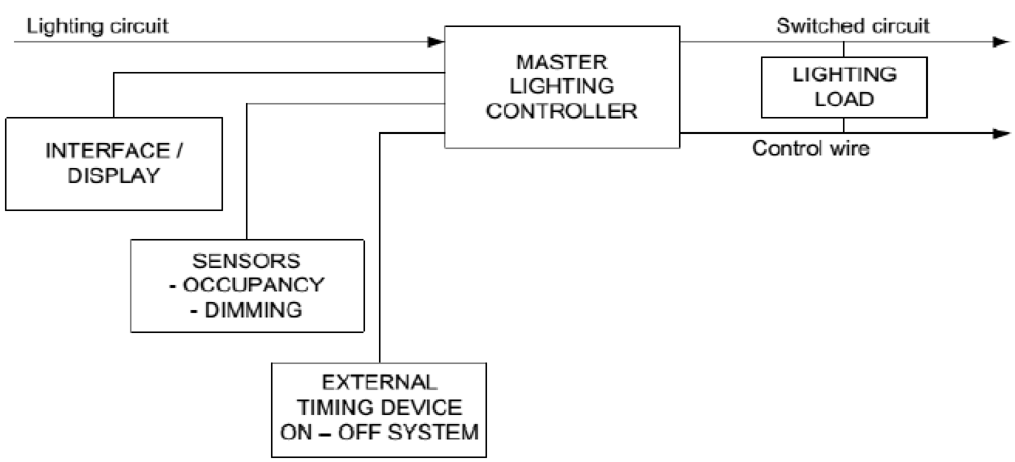

Figure 3.1: Example of robust lighting control system

3.4.3 Lighting control strategies

The desired functionality of the lighting control system is very dependent on the installation regarding location, operation, complexity, etc. It is therefore convenient to classify these systems according to their main functions.
There are six of the most common strategies used in advanced lighting control

- Day lighting

The main concept of Day lighting is reducing or eliminating the use of artificial lighting when there is an adequate contribution of daylight within a space to maintain recommended light levels, i.e. lighting the building using the sky. The traditional way is to use fluorescent lamps with dimmable electronic ballast along with light control sensors (photocell). This method is ideal for offices, classrooms and factory-floors where one or more sides of the room passes the daylight in through windows. To maximize the efficiency of this method, a so called Modular Control can be applied. In modular control, the control system is able to dim small sectors of room independently. Measurements of the light energy savings when using daylight dimming varies a lot and different experiments show savings from around 30% to 70% but there are factors such as location and orientation that will affect the amount of daylight in the room. For new installations, the designer might consider to redirect the sunlight into the building with special mirrors to maximize the daylight and minimize artificial lighting. This type of control system might be one of the most costly due to the number of dimmable ballasts, light sensors and controllers .

- Occupancy

The concept of the Occupancy control is to limit the use of artificial lighting when there is no occupancy. This method is often used in small rooms or restrooms and then as a standalone system and also in larger areas with some central controller. Almost any lamps can be used with this type of control system, especially in systems where the light is either turned on or off. In larger systems it is possible that dimmable ballasts for fluorescent lamps would be used for dimming the system to a certain value when that area is unoccupied. Tests show up to 20% energy savings using this system and it can also be very inexpensive and simple .

- Personal control

Many modern lighting control systems offer the user the possibility to manually adjust the amount of dimming they prefer in their offices or work areas within globally set system limits. The user controls the system through individual software clients, web-based interfaces or remote controllers. The actuators may be dimmable ballasts or simple relays. The energy saving of this method depends partly on the user but since he may often choose to use less light-output than is defined by standards the saving might be considerable.

- Time scheduling

Time scheduling can provide the appropriate light level for different parts of the building during work days, holidays and through different seasons by using advanced scheduling .

- Task tuning

In modern office buildings it has become more common that the same room is used for different types of work and therefore the lighting requirements vary a lot. Task Tuning allows lighting designers to control lighting according to task and working environments and save energy by designing it in the way that the system only uses the energy needed for each task. This method is often referred to as scenes and is quite popular in conference rooms, bigger offices, etc.

- Variable load control

In some cases it can be very efficient to reduce power consumption caused by lighting for a specific time in order to reduce the overall energy consumption. Load shedding is a method to reduce the building electrical consumption during demand peaks or energy price spikes. The system will then, based on either fixed priority or dynamic response, shed the lighting loads selectively and in varying degrees for different areas of a building .

- Other types

In addition to what was previously mentioned there are some other strategies in lighting control which are not directly related to savings or at least not energy saving. One is the so called Dynamic Lighting, where the idea is to let the artificial interior lighting, both brightness and warmness, follow the rhythm of the light outside. Employees experience the dynamics indirectly and they feel good and active. Combinations of lighting control system with HVAC systems is also possible and could be very interesting. Regarding load control it is powerful to have control over as many power consuming parts of the building as possible. One possible interaction is between passing as much light as possible through a window to reduce artificial lighting but on the other hand we might have to increase ventilation and air-conditioning because of heat passing through the uncovered window. It would then be the lighting controller's job to optimize the position of sun curtains, ventilation and light-output to minimize the cost. [5]

CHAPTER FOUR

APPLICATIONS

4.1 Introduction

Designing the actual model for ICU's system with all its operating system ,(heart rate alarm , HVAC system , lighting and security) need secured control to achieve comfort for the patient .it is a huge project need many expert designers ofvarious disciplines .

The modelingconsists of HVAC system & heart rate alarm

4.2 The System Components

The system is compromised from microcontroller ATMEGA16 PIC16f887, relays , resistors, leds,lm35 , diode 1n4001 ,stepper motor and modulo RF

4.2.1 Microcontroller PIC16F887

the PIC16F887 is one of the lastest products from Microchip . it features all the componenets whichmodren microcontrollers normally have . for its low price wide range of applications ,high quality and easy availability ,its an ideal solution in applications as :the control of different processes in industry machine control devices measurement of different values .

The PIC16F887 is shown in figure 4.1

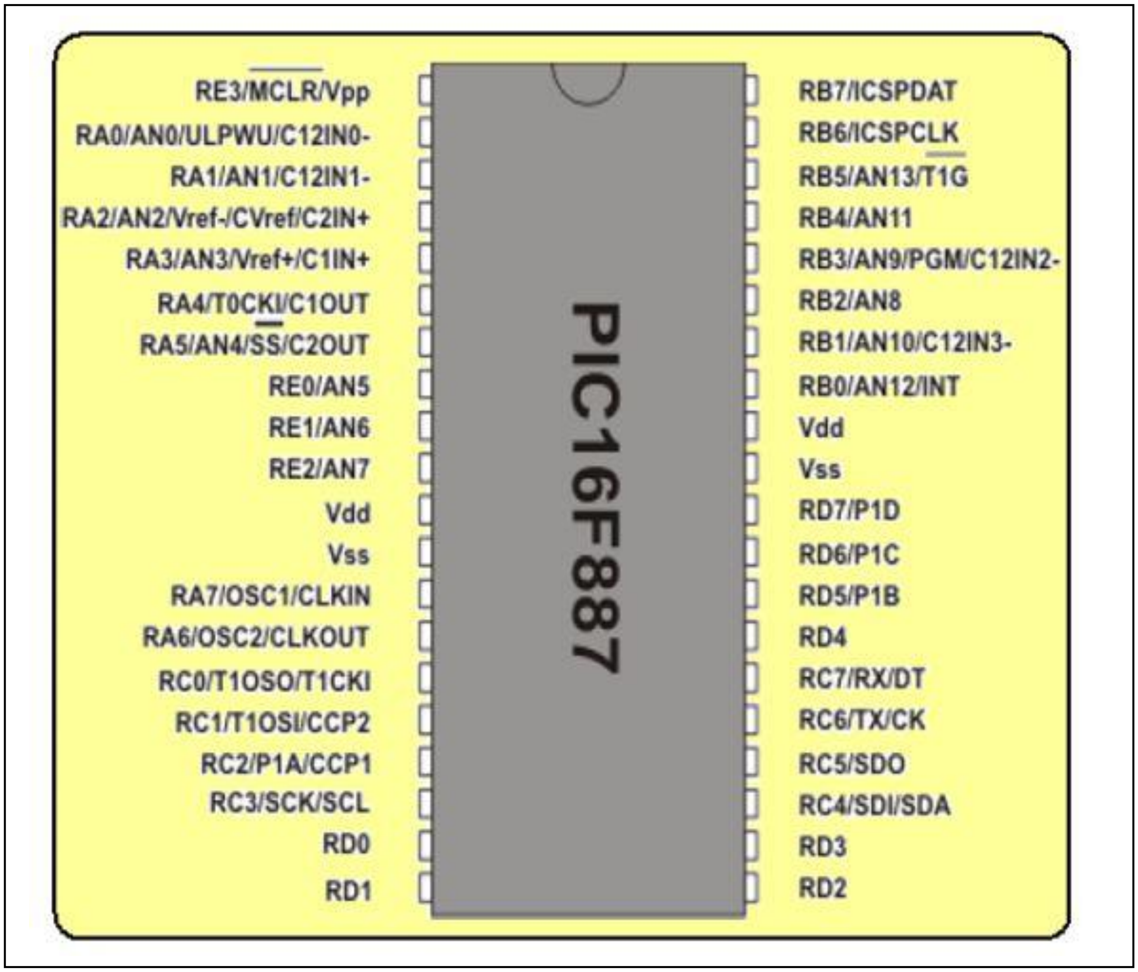

Figure 4.1 PIC16F887 microcontroller

-some of its main features are listed below

- ✓ RISC architecture
  - only 35 instructions to learn
- all single-cycle instructions except branches
- ✓ operating frequency 0-20 MHZ
- ✓ precision internal oscillator
  - factory calibrated
  - software selectable frequency range of 8 MHZ ti 31 KHZ

- ✓ power supply voltage 2-5.5V
    - consumption: 220uA (2.0,4MHZ), 11 uA (2.0 v, 32 KHz)

50nA (stand bymode)

- ✓ power-saving sleep mode
- ✓ brown-out Reset (BOR) with software cotrol option
- ✓ 35 input/output pins
    - high current source/sink for direct LED drive
    - software individually programmable pull-up resistor
    - interrupt-on-change pin
- ✓ 8KB ROM memory in FLASH technology
    - chip can be programmed up to 100.00 times
- ✓ in-circuit serial programming option

- chip can be programmed even embedded in the target device

- ✓ 256 bytes EEPROM memory
- Data can be writtrn more than 1,000,000 times
- ✓ 368 bytes RAM memory
- ✓ A/D converter:
    - channels
    - 10-bit resolution
- ✓ 3 independent timers/counters
- ✓ watch-dog timer
- ✓ Analogue comparator module with
    - two analogue comparators
    - fixed voltage reference (.6V)
    - programmable on-chip voltage refreence

- ✓ PWM output steering control
- ✓ Enhanced USART module
  - supports RS-485, RS-232 and l1N2.0
  - auto-baud detect
- ✓ Master synchronous serial port (MSSP)
  - support SPI and 12C mode

4.2.2 ATMEGA16

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

- **Pin Descriptions**
  - VCC digital supply voltage.
  - GND ground.
  - Port A (PA7..PA0)

Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

– Port B (PB7..PB0)

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

– Port C (PC7..PC0)

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs.

– Port D (PD7..PD0)

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

– RESET reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.

- XTAL1 Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.
- XTAL2 Output from the inverting Oscillator amplifier.
- AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.
- AREF is the analog reference pin for the A/D Converter.
- The ATMEGA can be represented in figure 4.2

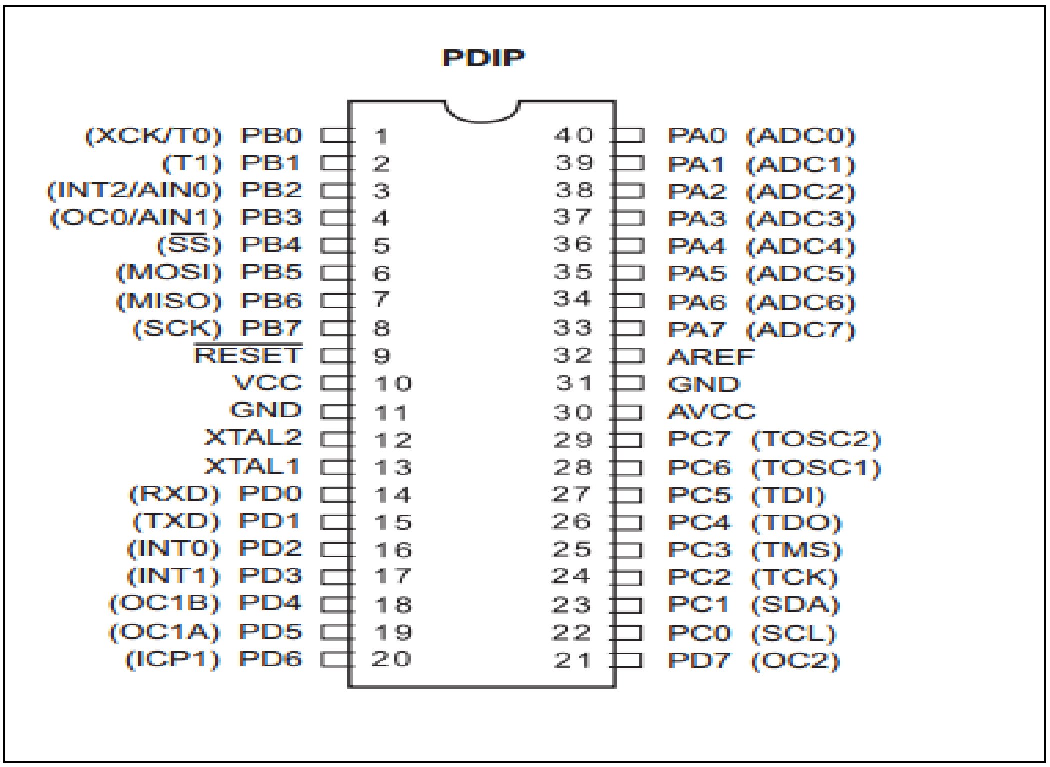

Figure 4.2 : ATMEGA16

4.2.3 Modulo RF

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D, HT640-HT648, etc. are some commonly used encoder/decoder pair ICs.

The Modulo is shown in figure 4.3

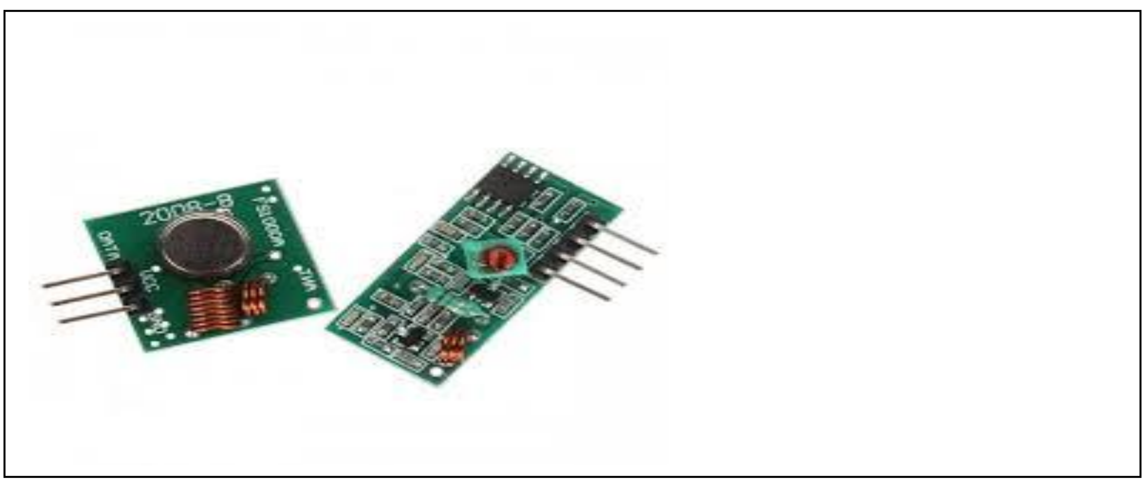

Figure 4.3 : modulo TX/RX

4.2.4LM35

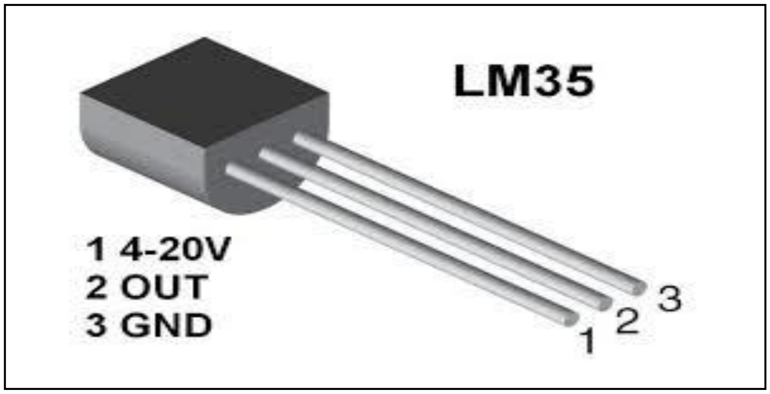

Figure 4.4 : LM35

LM35 is a transistor with a high sensitivity to changes in temperature as the transistor made of silicon material, which varies the extent of its ability to deliver electricity where the temperature change is increasing the electric current passing .

- Sensor contain of three legs as follow
  - ✓ Vcc Port is connected income and a constant voltage between 2.2V and 5.5V.
  - ✓ Output port which is the port that read the sensor.
  - ✓ Ground port is connected to any ground point.

The lm35 thus has an advantage over linear temperature sensors calibrated in Kelvin (◦K), as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling . The LM35's low output impedance, linear output , and precise inherent calibration make interfacing to read out or control circuitry specially easy.

It can be used with single power supplies , or with plus and minus supplies .

As it draws only 60 µA from its supply ,it has very low self-heating ,less than .1◦c in still air .the lm35C is rated for a -40◦ to +110◦ range (-10◦ with improved accuracy).

4.2.5Resistors

Resistors are perhaps the most common component in electronic circuits. The main function is to limit current flow or reduce the voltage in a circuit. The resistance may be either fixed or variable ,the basic unit of resistance is ohm(**Ω**).

Variable resistance usually have their maximum resistance stamped on them

4.2.6 Relays

A relay is an electrically operated switch current flowing through the coil of the relay creates a magnetic field, which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switches positions and they are double throw (change over) switches .

Relays allow one circuit to switch a second circuit ,which can be completely separated from the first . for example ,a low voltage battery circuit can use a relay to switch a 230V AC mains circuit . there is no electrical connection inside the relay between the two circuit s, the link is magnetic and mechanical.

The coil of a relay passes a relatively large current ,typically 30mA for 12V relay but it can be as much as 1oomA for relays designed to operate from lower voltages . Most ICS(chips) can not provide this current and a transistor is usually used to amplify the small IC current to the large value required for the relay coil .the maximum out put current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for examples , relays with 4 sets of changeover contacts are readily available .for further information about switch contact and the terms used to describe them . most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay . the supplier's catalogue should show you the relay's connections either way round . relay coils produce brief high voltage (spikes) when they are switched off and this can destroy transistors and ICs in the circuit .to prevent damage you must connect a protection diode a cross the relay coil.

The animated picture shows a working relay its coil and switch contacts. You can see lever on the left being attracted by magnetism when the coil switch on .this lever moves the switch contacts .there is one set of contacts (SPDT) in the foreground and another behind them , making the relay DPDT.

The relay's switch connections are usually labeled COM, NC and NO.

- ✓ COM=common ,always connect to this ,it is the moving part of the switch .
- ✓ NC=normally closed ,COM is connected to this when the relay coil is on.
- ✓ Connect to COM and NO if you want the switched circuit to be on when the relay coil is on.
- ✓ Connect to COM and NC if you want the switched circuit to be on when the relay coil is off.

4.2.7 LEDs

A light-emitting diode (LED) is a special kind of diode that glows when electricity passes through it .Most LEDs are made of semi-conducting materials called gallium arsenide phosphate.LEDs can be bought in a range of colors .they can also be bought in forms that will switch between two colors (bi-color),three colors (tri- color) or emit infra-red light . in common with all diodes , the Led will only allow current to pass in one direction . the cathode is normally indicated by a flat side on the casing and the anode is normally indicated by a slightly longer leg. The current required to power an LED is usually around 20 mA.

4.2.8 Diode 1N4001

The 1N4001 series (or 1N4000 series[2]) is a family of popular 1.0 A (ampere) general purpose silicon rectifier diodes commonly used in AC adapters for common household appliances. Blocking voltage varies from 50 to 1000 volts. This diode is made in an axial-lead DO-41 plastic package.The 1N5400 series is a similarly popular series for higher current applications, up to 3 A. These diodes come in the larger DO-201 axial package. These are fairly low-speed rectifier diodes, being inefficient for square waves of more than 15 kHz. The series was second sourced by many manufacturers. The 1N4000 series were in the Motorola Silicon Rectifier Handbook in 1966, as replacements for 1N2609 through 1N2617.[6] The 1N5400 series were announced in Electrical Design News in 1968, along with the now lesser known 1.5 A 1N5391 series.

4.2.9 Uln2003a

ULN2003A are high voltage,high current darlingtonarrays each containing seven open collector darlington pairs with common emitters. Each channelrated at 500mA and can withstand peak currents of600mA.Suppression diodes are included for inductive load driving and the inputs are pinned oppositethe outputs to simplify board layout.It useful for driving a widerange of loads including solenoids, relays DC motors, LED displays filament lamps, thermal print heads and high power buffers.

The 2003Aand 2004A are supplied in 16 pin plastic DIP packages with a copper lead frame to reduce thermal resistance. They areavailable also in small outline package (SO-16) asULN2001D/2002D/2003D/2004D.

– Main specifications:
  - ✓ 500 mA rated collector current (single output)
  - ✓ 50 V output (there is a version that supports 100 V output)
  - ✓ Includes output flyback diodes Inputs compatible with TTL and 5-V CMOS logic

4.2.10 Stepper motor

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motors rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied.One of the most significant advantages of a stepper motor is its ability to be accurately controlled in an open loop system. Open loop control means no feedback information about position is needed. This type of control eliminates the need for expensive sensing and feedback devices such as optical encoders. Your position is known simply by keeping track of the input step pulses. Figure 4.5 represent stepper motor connected to uln2003a.

– Features
  - ✓ The rotation angle of the motor is proportional to the input pulse.
  - ✓ The motor has full torque at standstill(if the windings are energized)

✓ Precise positioning and repeatability of movement since good stepper motors have an accuracy of – 5% of a step and this error is non cumulative from one step to the next.

✓ Excellent response to starting/stopping/reversing.

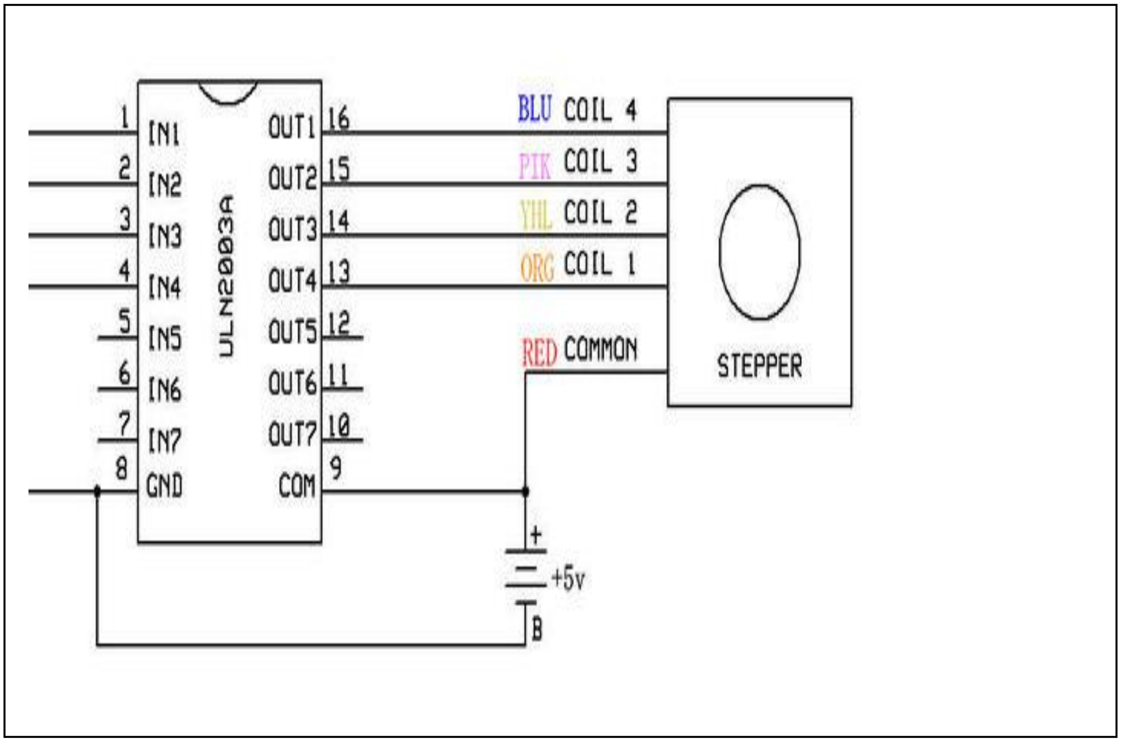

Figure 4.5 : ULN2003A connected to stepper motor

4.2.11 LCD 16*2

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

The figure(4.6) represent the LCD

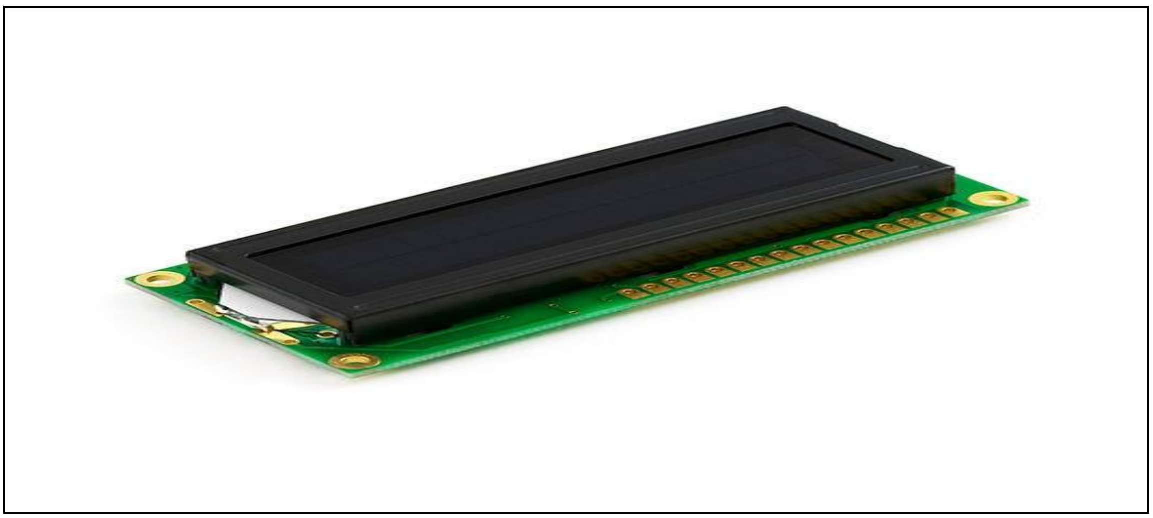

Figure 4.6 : LCD 16*2

4.3 System ModelingAnd Simulation

The system modeling consist of two circuit HVAC and HR circuit and security and lighting control circuit.

4.3.1 Heart rate alarm and HVAC

the circuit operations depend on that the normal HR of human being is 72 beat per minute in normal condition and as we talk about patient in critical unit

so when her or his heart collapse its need immediate response and this depend on the efficiency of monitoring alarm and also the response of observation team

whom have to be inside the ICU all the time .

the designed system will transfer the monitoring reading to an observation room at the hospital .

in this circuit we use a signal generator to simulate the HR monitor .

the controller in this circuit is ATMEGA 16 via proteus as shown in figure (4.7)and the compiler is bascomavr.

For HR the operation begins with continuous observation of patient's heart beat

And transfer it for the observation room where it will be displayed on the screen

Ones the patient's heart beat collapse or incremented validly the system will run on the alarm and displayed it at the screen and also will turn on the red led .

The same Atmega16 also used to control the HVAC system and the operation start with thermal sensor LM35 if the temperature is greater than reference point the fan must be turn on or if the temperature is less than the reference point then the heater must be turned on and display all this in the screen.

- **Mechanism of the modeling& simulation**

In The heart rate part ,when the signal generator generate a signal the ATMEGA16 received it as analog signal and then transfer it to a digital value and then send it to modulo tx which works as a transmitter and provides a wireless transferring of data for 100 meters . this data will be received by modulo rx and send it to the ATmega16 at the observation room the ATmega16 will check the heart beat after converting it to digital value and compare it with the set value (which is 72 beat per minute in normal condition) here we will make range for that (70-75).

If the heart beat is over than 75 or less than 70 the ATMEGA16 will output 5volt to turn on the buzzer and the red led.

And display the HR at the LCD.

The HVAC operate when the temperature is greater or less than 25◦c

When the LM35 measure the room temperature and converted it to mV according to its grading scaling and send it to the ATMEGA16 the ATMEGA16 will converted it in to thermal value by mathematical operations and then will compare it with the set point 25◦c so to turn on the fan if it greater than 25 ◦c and the red led or turn on the heater if it less than 25 ◦c and the red led too.

The fan ,heater and the buzzer will be connected to a relay and diode because all these devices can't operate with the 5v that the ATMEGA16 output so the relay will operate as a switch when it fed with 5v the coil will generate a magnetic field and close the circuit with net power to turn the device . and the diode will connected in parallel with the relay coil to protect the relay from reflected current

The figure (4.7) represent schematic of HR alarm simulation

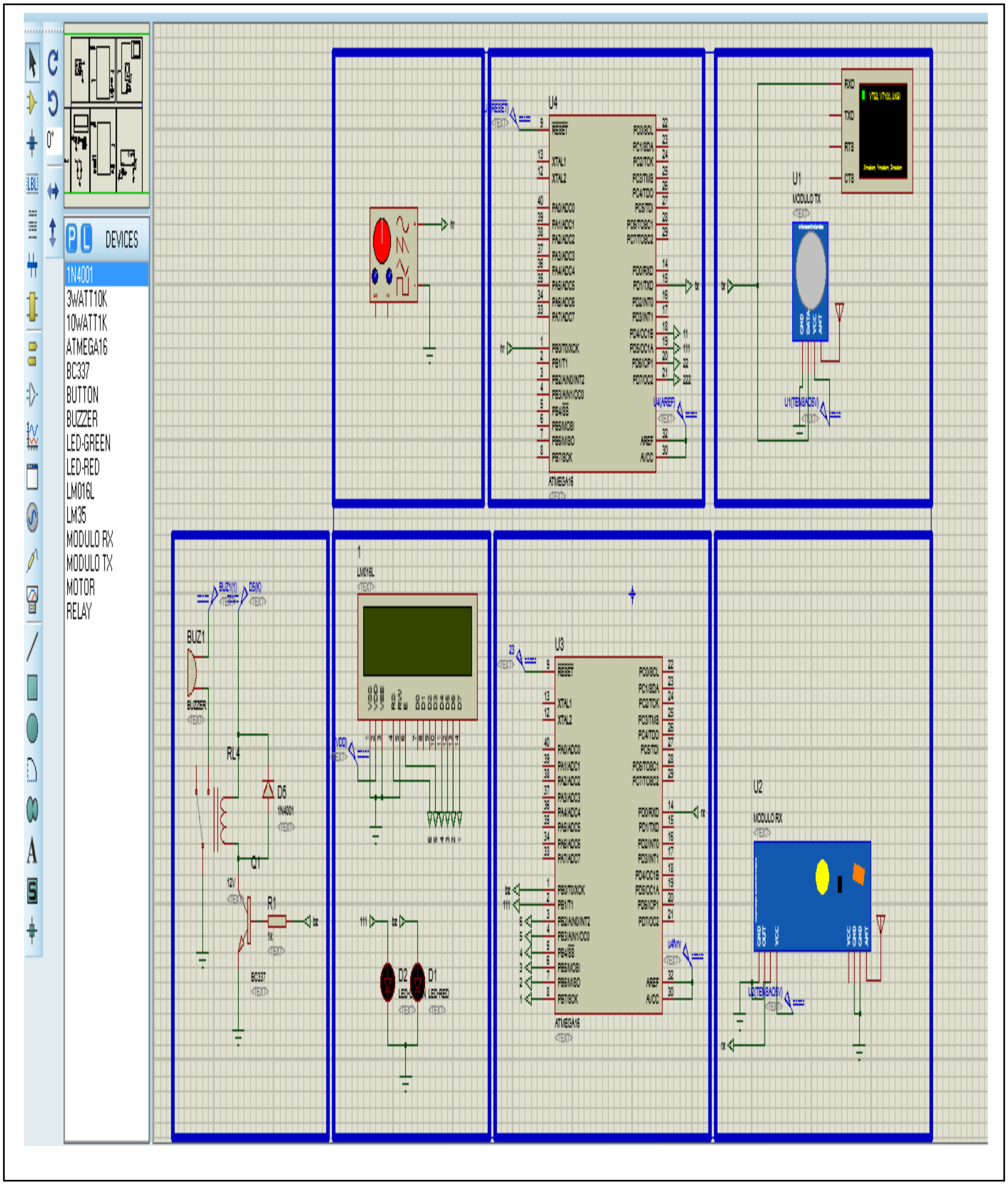

Figure 4.7 : HR alarm simulation

Figure (4.8) represent schematic of the HVAC simulation

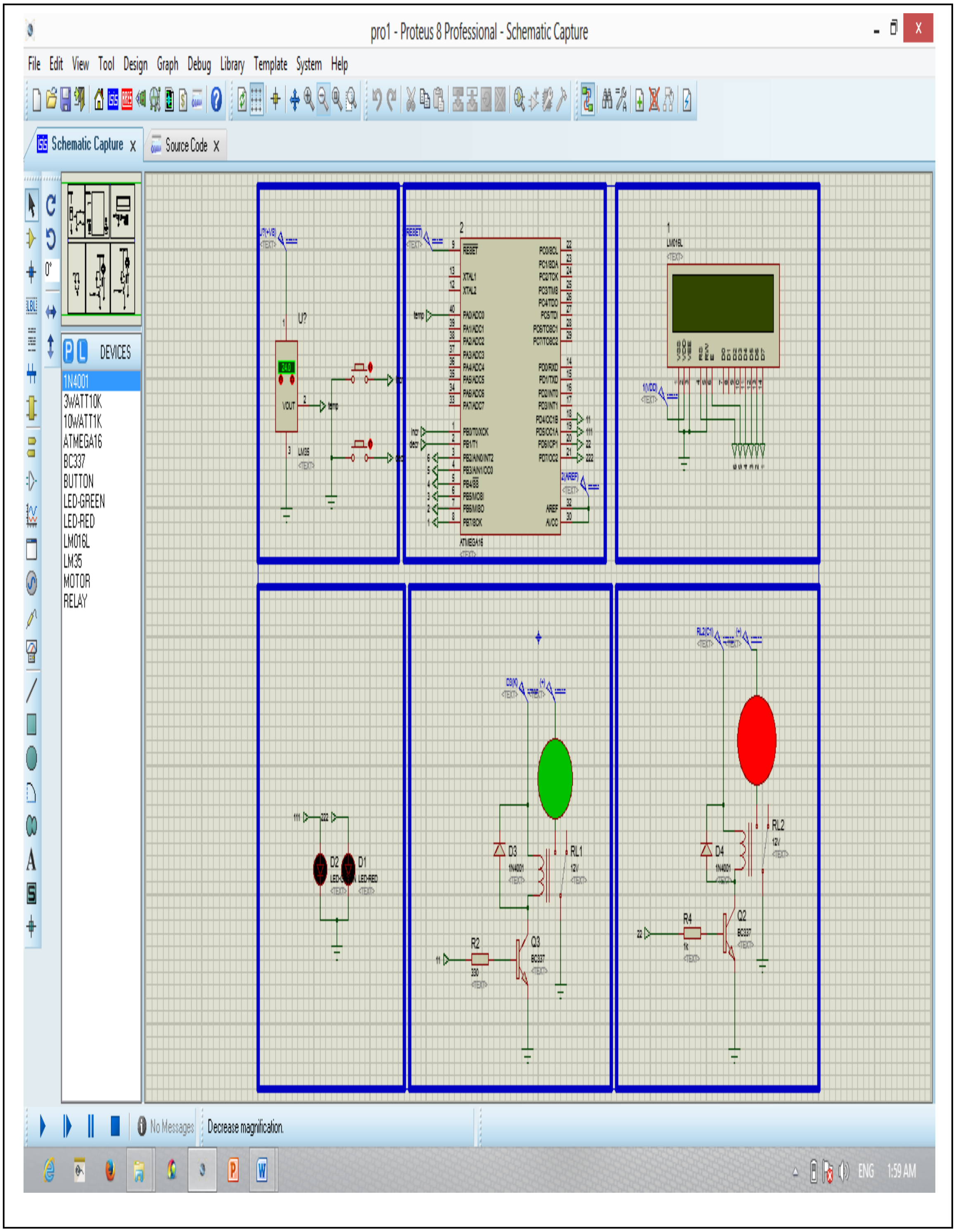

Figure 4.8 : HVAC simulation

4.3.2 Security

The security operation is to guaranty that only allowed people access to the ICU because the ICU need specific environment to save the life of the patients whom are in critical care .

The simulation consist of PIC16F887 as a controller ,keypad and stepper motor to open and close the door .

Also there is a fan work as an air layer isolation to prevent the out door air to inter to the ICU , also there is a entire switch to open the door from inside .

- **Circuit simulation**

The circuit operation start with password setting and store it on the microcontroller memory when you press the star the program will ask you to enter the password which consist of 4 digit the controller will compare each digit with the stored one if they are corresponding the microcontroller will output 5volt to the pin which connected to the ULN2003A to open the door by turn on the stepper motor which will turn for a few second that determined by the designer and inverse the rotate to close the door .

And if the passwords is not correspond the controller will ask you to try again and show all that on a display screen .

Also the door can be open from inside by a push button switch which connected to the ULN2003A when you press it the circuit will close and the stepper motor will be fed .

The figure (4.9) represent the door security

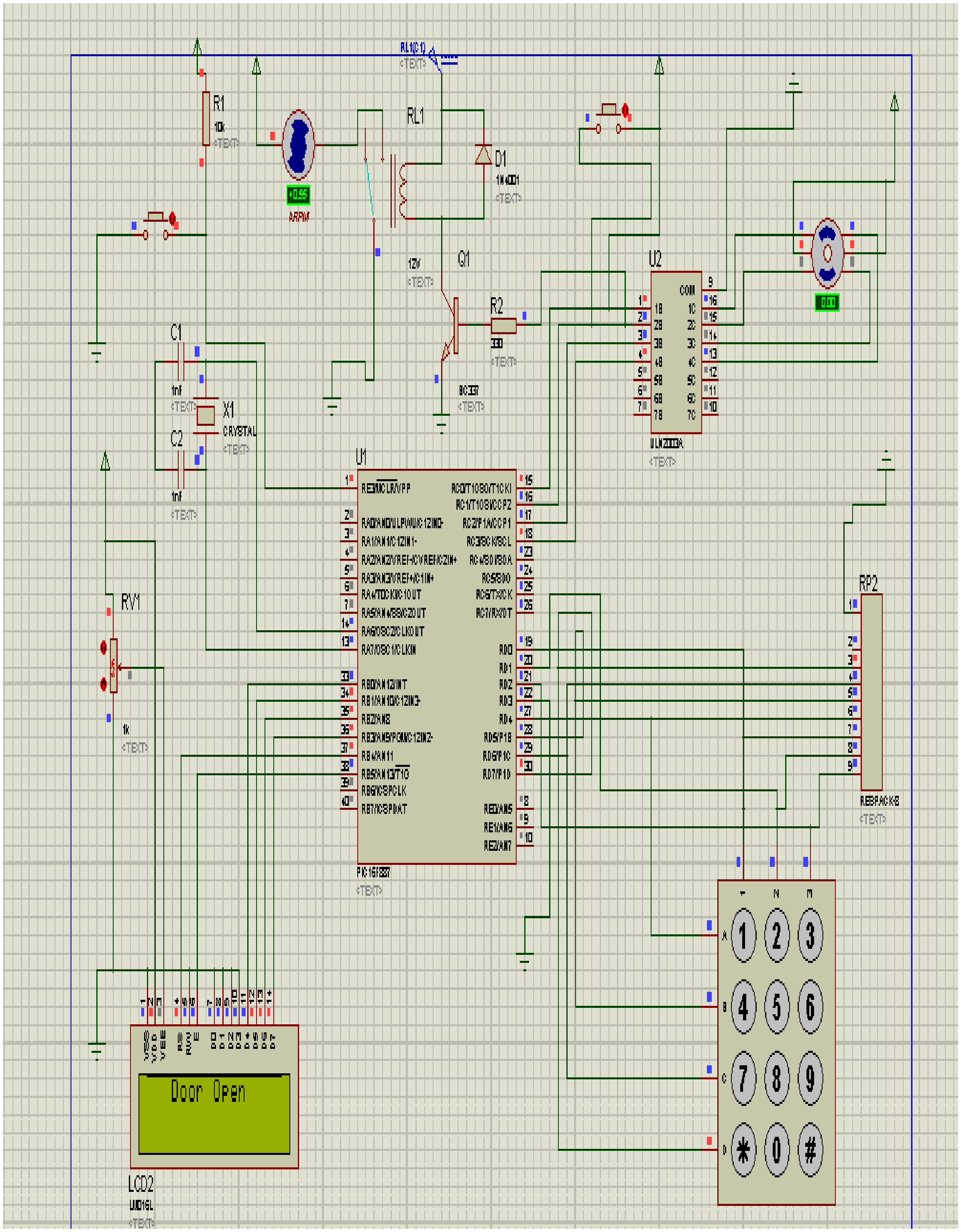

Figure 4.9 : Door security

4.4 lighting

ICU required a specific design of lighting there are a medical lights recommended for ICU room that provides comfort environment .

Light affects the body by receptor stimulation through the eyes (retina) and through the skin. The classical visual sensory system is comprised of photoreceptor cells of rods (low-level light) and cones (sharpness, detail, and color vision)

- **Tips for design**

- General lighting design should provide: indirect lighting, supplementary direct lighting for examinations and treatment and higher luminance for emergencies. This is done either by activating more luminaries or by switching on all the lamps in the luminaries.
- Patient controlled general lighting should be dimmable so that patients will not be subjected to unreasonable glare.
- High color temperature and color rendering index (5000K >85CRI) fluorescent lamps are recommended to allow medical staff to assess skin tone and pallor, eye tints, prominence of veins, etc.
- Lighting systems that use lamps with special properties for treatment of various medical conditions (e.g. germicidal, UV, and plaster heat curing lamps) may be incorporated and will need to be controlled independently from the general lighting.
- An adjustable and moveable task luminaries provides higher level illumination for: examinations and emergency surgical/trauma procedures.

- Glare free illumination of display screens and life support systems must permit reading of labels, operation of the controls and reading patient charts.
- Dedicated observation lighting enables patients and medical equipment to be monitored at night. In rooms where patients are monitored through windows, the level of lighting needs to be significantly lower in the room than in the observation area outside. The daylight entering the space needs to be controllable using appropriate window treatments.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Intensive care unit design is mean to control many parameters ,HVAC, Lighting , security and heart rate alarm.

The research was designed to provide control of previous parameters , control HVAC system ensures that the system will not become unstable and HVAC would overheat or overcool the spaces .

Control security system is necessary for the ICU to guarantee the safety of the patients and more over to secure ICU against potential dangers like fire .

Research light control system refers to more sophisticated system known as Robust lighting system to provide visual comfort , minimize the energy consumption and preserve the quality of the work environment (LED) also a heart rate alarm was developed to ensure immediate response to the patient critical condition .

5.2 Recommendations

Further investigations on this work may include a way to deal with false positive alarm rates, which are managed with nurses caring fewer patients , the other standpoint concerns the development of technical solutions such as improvement in the technology of some sensors to reduce artifacts and the use of multi parametric analysis to reduce the number of false positive alarm.

REFERENCES

[1] Marie Christine "Alarm in the intensive care unit " , university of lille ,france 2001.

[2] David M.schowerkand Glen , “standard HVAC control system” , "US-Engineering research laboratories" .

[3] Improving the energy efficiency of our buildings ,Department for Communities and Local Government , “Eland House,” London , December 2012

[4] Gaidelines for intensive care uniedesign , society of critical care medicine, 2008 .

[5] G.Boyle "Renewable energy , power for a sustainable future" , second edition , the open university 2004.

APPENDIX

HR CODE

Hrsend side

```
$regfile = "m16def.dat"

$crystal = 1000000

$baud = 2400

Config Timer0 = Counter , Edge = Rising

 Dim W As Word

Do

Stop Timer0

Timer0 = 0

Start Timer0

Wait 1

Stop Timer0

W = Timer0

Printbin Timer0

Loop
```

HR receiver side

```
$regfile = "m16def.dat"

$crystal = 1000000

ConfigLcdpin = Pin , Db4 = Portb.4 , Db5 = Portb.5 , Db6 = Portb.6 , Db7 = Portb.7 , E = Portb.3 , Rs = 
Portb.2

ConfigLcd = 16x2

Cursor OffNoblink

Config Portb.0 = Output :Bz Alias Portb.0
```

```
Config Portb.1 = Output : Normal Alias Portb.1

$baud = 2400

Dim HrAs Word


Do

If Ischarwaiting() = 1 Then

Hr = Inkey()

'Input Hr

End If

Locate 1 , 1

Lcd "HR="

LcdHr

Lcd "      "

Waitms 100


If Hr> 75 &&Hr< 70 Then

Bz = 1

Normal = 0

Else

Normal = 1

Bz = 0

End If

Loop
```

HVAC code

```
$regfile = "m16def.dat"

$crystal = 1000000

ConfigLcdpin = Pin , Db4 = Portb.4 , Db5 = Portb.5 , Db6 = Portb.6 , Db7 = Portb.7 , E = Portb.3 , Rs =
Portb.2

ConfigLcd = 16x2

Cursor OffNoblink

ConfigAdc = Single ,Prescaler = Auto

Dim W As Word

Dim V As Single

Dim Temp As Word

Dim Ref As Word

Ref = 25

Config Portd.4 = Output

Config Portd.5 = Output

Config Portd.6 = Output

Config Portd.7 = Output

Config Portb.0 = Input

Config Portb.1 = Input

Sw_1 Alias Pinb.0 : Portb.0 = 1

Sw_2 Alias Pinb.1 : Portb.1 = 1

Do

W = Getadc(0)

V = W * 5

V = V / 1024

Temp = V * 100
```

```
Locate 1 , 1
Lcd "REF="
Lcd Ref
Locate 2 , 1
Lcd "temp="
Lcd Temp
If Temp = Ref Then
Portd.4 = 0
Portd.5 = 0
Portd.6 = 0
Portd.7 = 0
End If
If Temp > Ref Then
Portd.4 = 1                              '"fan on"
Portd.5 = 1
Portd.6 = 0
Portd.7 = 0
End If
If Temp < Ref Then
Portd.4 = 0                              '"heater on"
Portd.5 = 0
Portd.6 = 1
Portd.7 = 1
End If
Debounce Sw_1 , 0 , Ref_increment , Sub
Debounce Sw_2 , 0 , Ref_decriment , Sub
Loop
```

```
Ref_increment:

Ref = Ref + 1

Return

Ref_decriment:

Ref = Ref - 1

Return
```

Security code

```
unsigned short kp;

char code1[15] ,user1[4];

int i = 0, j, cnt;

int w1;

//keypad module connections

charkeypadPort at PORTD;

//end keypad module connections

//lcd module connections

sbit LCD_RS at RB4_bit;

sbit LCD_EN at RB5_bit;

sbit LCD_D4 at RB0_bit;

sbit LCD_D5 at RB1_bit;

sbit LCD_D6 at RB2_bit;

sbit LCD_D7 at RB3_bit;

sbitLCD_RS_Direction at TRISB4_bit;

sbitLCD_EN_Direction at TRISB5_bit;

sbit LCD_D4_Direction at TRISB0_bit;

sbit LCD_D5_Direction at TRISB1_bit;

sbit LCD_D6_Direction at TRISB2_bit;

sbit LCD_D7_Direction at TRISB3_bit;
```

```
//void code_enter(){
kp = 0;       //Reset key code variable
    //wait for key to be pressed and released
do
    //kp = Keypad_Key_Press();     // store key code in kp variable
kp = Keypad_Key_Click();       // store key code in kp variable
while (!kp);
    //prepare value for output, transform key to it's ASCII value
switch (kp){
case  1: kp = 49; break; // 1
case  2: kp = 50; break; // 2
case  3: kp = 51; break; // 3
            //case  4: kp = 65; break; // A for 4x4 pad
case  5: kp = 52; break; // 4
case  6: kp = 53; break; // 5
case  7: kp = 54; break; // 6
            //case  8: kp = 66; break; // B for 4x4 pad
case  9: kp = 55; break; // 7
case 10: kp = 56; break; // 8
case 11: kp = 57; break; // 9
            //case 12: kp = 67; break; // C for 4x4 pad
case 13: kp = 42; break; // *
case 14: kp = 48; break; // 0
case 15: kp = 35; break; // #
            //case 16: kp = 67; break; // D for 4x4 pad
            }

code1[i] = kp;
```

```
Lcd_Chr(2, i+1, code1[i]);        //Print key ASCII value on Lcd
i++;

//20ms delay function no need of it

voidcode_read(){      //read data from eeprom
Delay_ms(20);
user1[0] = EEPROM_Read(0x00);           // Read data from address 0
Delay_ms(20);
user1[1] = EEPROM_Read(0x01);           // Read data from address 1
Delay_ms(20);
user1[2] = EEPROM_Read(0x02);           // Read data from address 2
Delay_ms(20);
user1[3] = EEPROM_Read(0x03);           // Read data from address 3
Delay_ms(20);
   }

voidcode_write(){       //write data to eeprom
Delay_ms(20);
EEPROM_Write(0x00,code1[0]);          // Write data to address 0
Delay_ms(20);
EEPROM_Write(0x01,code1[1]);          // Write data to address 1
Delay_ms(20);
EEPROM_Write(0x02,code1[2]);          // Write data to address 2
Delay_ms(20);
EEPROM_Write(0x03,code1[3]);          // Write data to address 3
   }
```

```
voidchange_code(){
Lcd_Cmd(_LCD_CLEAR);           // clear display
Lcd_Out(1,1, "Enter New Code:");

    i = 0;
code_enter();
code_enter();
code_enter();
code_enter();
code_write();
delay_ms(20);
code_read();
delay_ms(20);
Lcd_Cmd(_LCD_CLEAR);           // clear display
Lcd_Out(1,1, "New Code Set");
Delay_ms(5000);
    }

void main(){
ADCON1 != 0x07;
Keypad_Init();            // Initialize Keypad
ANSEL  = 0;                        // Configure AN pins as digital I/O
    ANSELH = 0;
    c1on_bit=0;                    // disable comparator
    c2on_bit=0;
    TRISC = 0x00;
    PORTC = 0x00;
Lcd_Init();                        // Initialize LCD
```

```
Lcd_Cmd(_LCD_CLEAR);                    // Clear display
Lcd_Cmd(_LCD_CURSOR_OFF);               // Cursor off
code_read();

Lcd_Cmd(_LCD_CLEAR);       //clear display
Lcd_Cmd(_LCD_CURSOR_OFF);    // cursor off
    //Lcd_Out(1, 1, msg1);
    //Delay_ms(500);
Lcd_Cmd(_LCD_CLEAR);                    // Clear display
Lcd_Out(1, 5, "SUST");                  // Write message text on LCD
Lcd_Out(2, 4, " ICU PROJECT");
delay_ms(2000);
Lcd_Cmd(_LCD_CLEAR);
Lcd_Out(1, 1,  "Digital Lock ");
delay_ms(2000);

cnt = 0;
L1:  do{
Lcd_Cmd(_LCD_CLEAR);
Lcd_Out(2, 3, "Press *");
       i = 0;
code_enter();
if(code1[0] == 42){      // *
Lcd_Cmd(_LCD_CLEAR);      // clear display
Lcd_Out(1, 1, "Enter Code");
                //delay_ms(500);
                i = 0;
code_enter();
```

```
code_enter();

code_enter();

code_enter();

code_enter();

                    if(code1[0] == '1' && code1[1] == '2'  && code1[2] == '3' && code1[3] == '4'
&& code1[4] == '5' ){      // master code

code_enter();

if(code1[5] == 35){      // #

change_code();


                                             }

                                 }

                           else if(cnt<3 && code1[0] == user1[0] && code1[1] == user1[1] &&
code1[2] == user1[2] && code1[3] == user1[3] && code1[4] == 35){     // save password
verification


Lcd_Cmd(_LCD_CLEAR);       //Lcd clear

Lcd_out(1,4,"Door Open");  //Door Open



EEPROM_Read(0x21);

                                                  w1 = 1;

Delay_ms(20);

EEPROM_Write(0X21, w1);

Delay_ms(20);

EEPROM_Read(0x21);


                                                  //move stepper motor to ON position

                                                  PORTC=0x03;

Delay_ms(500);
```

```
            PORTC=0x06;
Delay_ms(500);
            PORTC=0x0C;
Delay_ms(500);
            PORTC=0x09;
Delay_ms(500);

Delay_ms(5000);
            //goto L1;



LCD_Cmd(_LCD_CLEAR);
Lcd_out(1,4,"Door Close");



EEPROM_Read(0x21);
            w1 = 0;
Delay_ms(20);
EEPROM_Write(0x21, w1);
Delay_ms(20);
EEPROM_Read(0x21);



            //move stepper motor to OFF position
            PORTC=0x0C;
Delay_ms(500);
            PORTC=0x06;
Delay_ms(500);
```

```
                    PORTC=0x03;
Delay_ms(500);
                    PORTC=0x09;
Delay_ms(500);


Delay_ms(2000);
                    //goto L1;
                    }


else{
cnt++;
Lcd_Cmd(_LCD_CLEAR);     //clear display
Lcd_Out(1, 1, "Wrong Password");
Delay_ms(2000);
                 //goto L1;
                 }
if(cnt>=3)
goto L1
     }
}while(1);}
```