NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical & Electronic Engineering

BUILDING MANAGEMENT SYSTEMS
BMS

Graduation Project EE- 400

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Abstract

Flashback on centralization of operations Before the Second World War, the technical installations in commercial buildings were completely manually operated. Large control panels were built to centralize the flow of information from the technical installations and enabled remote operation.

These panels took up a lot of floor space and required extensive and expensive cabling as each data point (field input or output signal) was wired individually to the control panel. To enhance the transfer of information these control panels were sometimes equipped with mimic diagrams depicting the technical installations. The mimic diagrams contained indicators to reflect the actual state of various process parameters and control elements for remote control purposes.

At the beginning of the nineteen seventies, developments in electronics and communications led to the internal transformation of these so-called Building Automation systems.

Although the external structure remained the same, the matrix switching relay techniques in substations were replaced by digital switching techniques

Introduction

All Buildings have some form of mechanical and electrical services in order to provide the Facilities necessary for maintaining a comfortable working environment. These services have to be controlled by some means to ensure, for example, that there is adequate hot have to be controlled by some means to ensure, for example, Water for sinks, that the hot water in the radiators is sufficient to keep an occupied space Warm, that heating with ventilation and possibly cooling is provided to ensure comfort Conditions wherever, irrespective of the number of occupants or individual preferences. Basic controls take the form of manual switching, time clocks or temperature switches that Provide the on and off signals for enabling pumps, fans or valves etc.

Contents

Chapter 1

BMS benefits and its components

1.1. The benefits of BMS

Integrated building automation offers benefits in many areas including limiting environmental impact, saving on energy costs and improving building security and safety. The systems not only regulate building functions, they compile data to help building managers determine ways to further cut costs and increase the efficiency and comfort of their buildings.

1- Energy Savings

it is estimated that a BAS can save a business between 5% and 30% on utility costs by managing HVAC and lighting systems. HVAC and lighting are the two largest users of energy in modern buildings and are usually the first systems to be automated. Wireless BAS systems can monitor every zone of the building and make instant adjustments to maintain comfort while lowering energy usage. Lighting can be reduced remotely in areas of the building that are not occupied which also cuts energy costs.

2- Environmental Impact

By reducing the energy usage of a building, a BAS also reduces the amount of greenhouse gases released into the atmosphere. A BAS can be integrated into plumbing systems to monitor and reduce water usage. By eliminating waste, these systems help buildings use resources more efficiently and reduce their impact on the environment. The systems also allow third parties, like government agencies, to collect data and validate the amount of energy consumed by the building.

3- Improved Security

The need for security depends on the nature of the business conducted in the building. A BAS can be programmed to lock doors and turn off lights at a designated time. Should an employee wish to access the building after that time, a key card will allow access and the system will turn on the lights in the area where the employee is working, but nowhere else. The system can also be programmed to control exterior lights in parking lots and security cameras. Should a security breach occur, the system will notify appropriate personnel.

4- Building Maintenance

In addition to monitoring energy usage, an integrated BAS monitors and collects data from all the zones in the building and reports the results on the system's computer. By reviewing the information provided by the BAS, an operator can identify and diagnose operational problems early without having to send a technician to locate it. Finding operational problems early and correcting them saves on the cost of building maintenance and prevents breakdowns which can interrupt business operations.

5- Operator Convenience

Many BAS can be accessed from any location with an internet connection so building operators do not have to be on site to access building data. Facilities with more than one building can integrate the systems of all the buildings onto a single front end computer which allows an operator to monitor the entire facility from a single source. Since the system provides the data to diagnose problems, it saves money by reducing the number of employees required to provide building maintenance.

There are many benefits to businesses from the use of BAS in their facilities and each system can be tailored to meet the needs of the individual company. Smart buildings help any business operate more efficiently while providing high levels of comfort and convenience to building operators and tenants.

1.2. The components of BMS system

1.2.1. The DDC (direct digital controller):

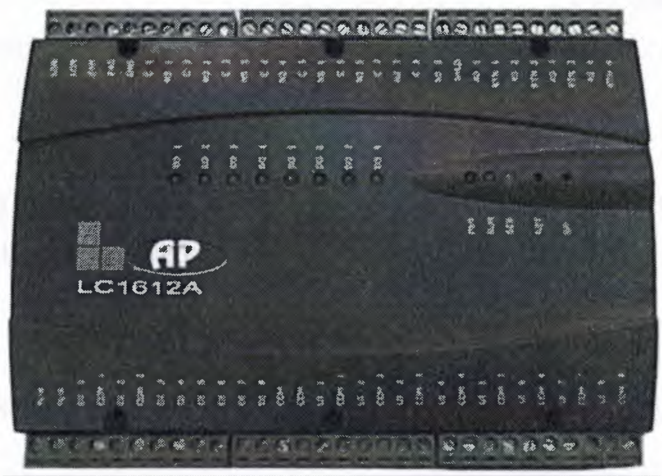


Figure 1.1: DDC controller

DDC is a control device based on microprocessors ,uses programmable memory to store and run up instructions .It can do different types of control functions like logic operation ,mathematical operations , timers , and counters ….etc.

The inputs and outputs design allows us to adjust the load to suit the control system. Therefore, it is mainly used in buildings systems such as:

- heating, ventilation, and air conditioning (HVAC)
- Illumination system
- Access system
- Observation system
- Access system
- Fire alarm system

1.2.1.2. The characteristics of DDC:

1- Flexibility: Editing the program of DDC, therefore authorizing tasks without changing the cables of the inputs and outputs.

2- Exploring faults and correcting errors: In the control panel which contain *relays*, if you want to edit or make change that requires too much time , while using programmable control needs rewrite some lines in the program , to save time and labor.

3- Expanding ability: DDC gives a lot of contacts (normally opened, normally closed). All what we need is an extension device and adding few lines to the main program.

4- Saving: Saving time by showing error messages, also saving in size of the equipment's.

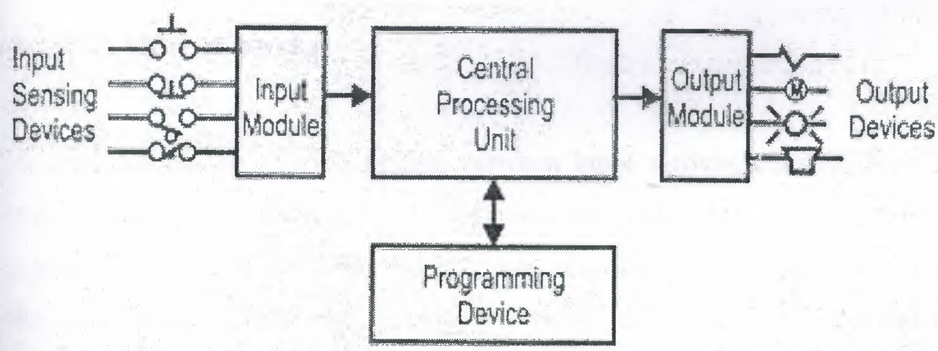


Figure 1.2: logic circuit of DDC

1- Input unit: connect sensors to the control device.
2- Output unit: connect controller to controlled devices.
3- Central processing unit: which include memory.
4- Programming device: often it is a PC.

1.2.2. Remote I/O:

1.2.2.1 Definition:

Input/output modules that are located far away from the CPU or the DDC, and communicate with it through protocols it considers as expand unit for the inputs ,and outputs.

Figure 1.3 : Remote I/O

1.2.2.2. How it works:

It provides communication system between input signals (coming from sensors) with computer or DDC , and between the computer or DDC and output signals(*relays*, *contactors*) through protocols like (*BACnet*, *Modbus*). The inputs and the outputs could be digital or analog or both depending on the devices that we connected to it. The control process starts first , import the input signals from the sensors to be translated through protocols , second it will be sent by cable to computer or DDC and stored in memory as bits to be able one of program language (C++ , visual basic) or software (SCADA , Citect) solve the control algorithm .

Finally, the orders will be transferred by cables to outputs unit then to devices have to control. The speed of this process depends on two variables:

- The speed of executing the instruction in the computer
- The type of communication cable between the computer and remote i/o ,and it's length .

1.2.2.3. Control features by Remote i/o:

1- execute complex control algorithms that couldn't be solved on DDC
2- Build control , monitoring ,and archived system through SCADA softwere without external controller
3- The speed of control process will be almost the speed of the computer itself
4- We can connect more than remote i/o together by using adapter (communication type RS 485) or switch (communication type Ethernet)

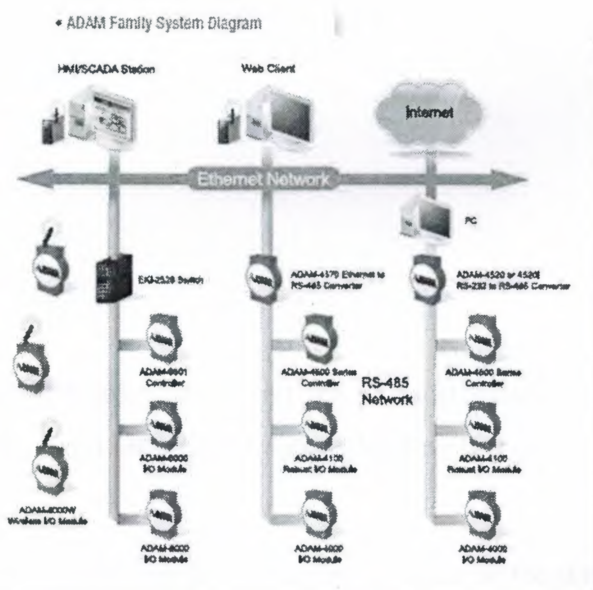


Figure 1.4: Remote I/O network

The figure show us how we can connect the remotes i/o using wireless or switches or serial port like (RS485 , RS285) to pc then to the SCADA system ,and the internet

1.2.3. Remote i/o applications :

- Remote data acquisition
- Process monitoring
- Industrial process control
- Energy management
- Building automation
- Supervisory control
- Security systems
- Product testing

1.2.3. Sensors

1.3.1.1. Definition:

It is electrical or electronic deviceS that convert the physical parameters (temperature, humidity, lighting, pressure ….etc) into electric signals because practically it isnot easy to deal with physic parameter.

The sensor is the eye of our system which can see the variation of the status for suitable react.

The figure below show us the method of run the sensor, since the sensor got signal that will be connected the to input of the DDC ,and according to sensor signal the DDC take the right decision in running or stopping devices which connect to output of the DDC

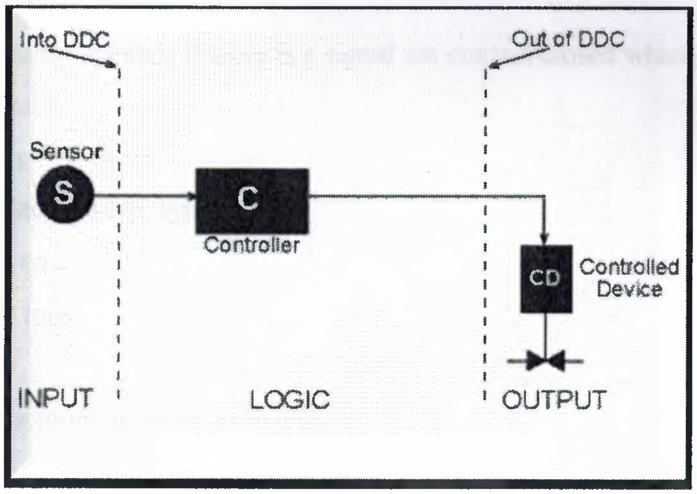


Figure 1.5 :sensor location

1.3.1.2. The types of sensors:

We can classified the sensors :

- According to the type of physic signals
  Like temperature sensor , pressure sensor , movement sensor ..

- According to particular application:
  - Digital sensors :

  On/Off contact if there is or not a physic signal.
  - Analog sensors: It is changes the value of the output which is ampere (rating of mille ampere) or volt (rating of mile volt) according to the amplitude of input signal.

- According to contact type

  It is divided into two types :

  - Normally closed: If there is a signal the contact opened which is closed in the normal status .
  - Normally opened: If there is a signal the contact closed which is opened normally
- According to electronic circuit

  It is divided into two types :

  - PNP type
  - NPN type.

- According to the numbers of wires .

1.3.1.3. The usage sensors in this project:

- Pressure sensor
- Humidity sensor
- Temperature sensor
- Air quality
- Light level
- Movement sensor
- Smoke detector

1.3.1.3.1. Temperature Sensor

The temperature has a great effect on the materials so, it is important to follow up the variant of it basically there are two types:

- The variation of temperature followed by variation in the resistance
- The variation of temperature followed by variation in the voltage

And they can be classified as:

Figure 1.6 : types of sensors

Room temperature sensor Conduct temperature sensor Water temperature sensor

1.3.1.3.2. Humidity sensor

The humidity has a great effect on the physical and chemical operations proportionally to the place so we should measure the humidity.

Figure 1.7: DHS-Duct Hum .Sensor

There is another type which measure the humidity and the temperature Combined Temp. & Humidity Sensor

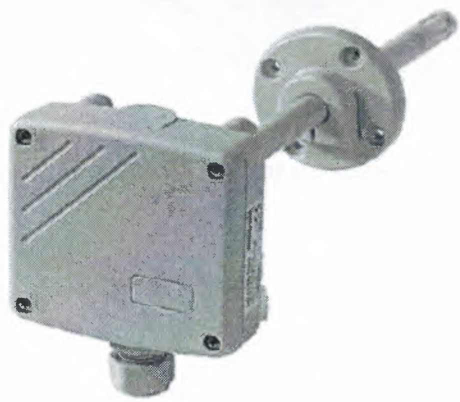


Figure 1.8 : temp & humidity sensor

1.3.1.3.3. Pressure sensor

One of the most important once that's related to its usage in monitoring applications, and knowing the liquids levels. In the HVAC system we used several kinds of pressure sensors:

- Air Pressure Sensor
- Air Diff Pressure. Transmitter
- Water Diff .Press Transmit

There is equation to determine the liquid level

$$P=g*h*i$$

g : gravity

h : liquid level

i : liquid intensity

Figure 1.9: Differ pressure sensor

1.3.1.3.4. Light sensors

It is so important because of it helps to determine the light flux ,and control it during the day by control the light flux of the lamps. It is better to be analog to decrease the threshold of the flux , nevertheless it is analog we should divided into levels , the number of levels depends on the importance of the room

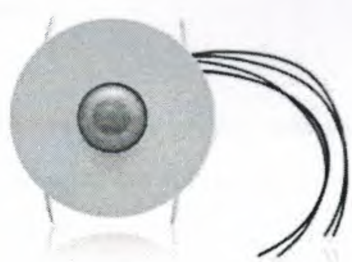


Figure 1.10 : light sensor

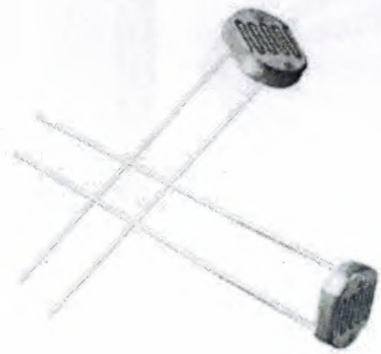


Figure 1.11 : LDR sensor

A photoresist or light-dependent resistor (LDR) or photocell is a light-controlled variable resistor. The resistance of a photoresist decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresist can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits.

1.3.1.3.5. Movement sensor

It is a very common sensor wherever you go you will see it, and its applications really important for example ; close and open the doors automatically , turn on the light after and off before in the halls ,and anti-stole system …… etc.

Usually motion detector is specifically intended for ceiling mounting with a Volumetric circular monitoring area. The maximum mounting height is 3.6 m

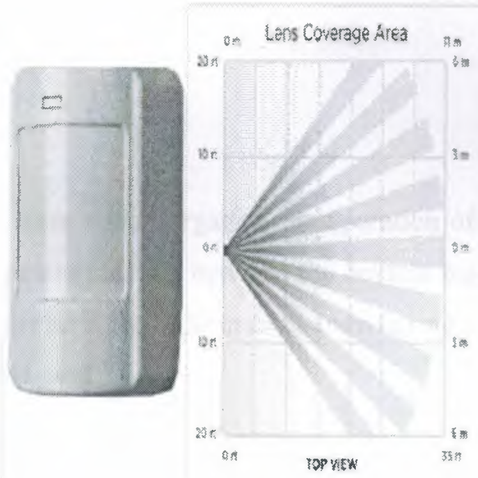


Figure 1.12: movement sensor

1.3.1.3.6. Smoke detector

Smoke detectors are used for early detection of smoke so that possible injury to people and damage to property can be avoided or limited in the event of a fire.
Smoke detector can be connected to the zone terminal. A potential free, normally open contact is used as an alarm output

Figure 1.13: smoke detector

1.2.4. The protocols

The protocol is a band of rules which organize the operation of transferring data through the network , the way of communicating between the devices that contain microprocessors ,and without it we can't ensure the information transferring . We will talk about the common protocols and most used.

1.4.1. Modbus protocol:

It is a serial communication protocol , the start of using was while using the logic programmer control , now it is the most common one . It can connect up to thirty device to each network then to central unit .

1.4.2. LON work:

This protocol used to connect between the DDCs ,and the remote i/o also the DDCs from differ companies .The important chractrastic of it reliability with long distance and good cost

1.4.3. BAC net protocol :

It can connect several DDCs for differ companies with the ability to connect it to SCADA most used in BMS systems because the flexibility to connect the systems of the building like HVAC system , loads management system ,fire alarm system ,and lighting system.

1.4.4. TCP\IP

This protocol used to connect information networks and the computer into structure of local networks. It is the basic structure of internet network

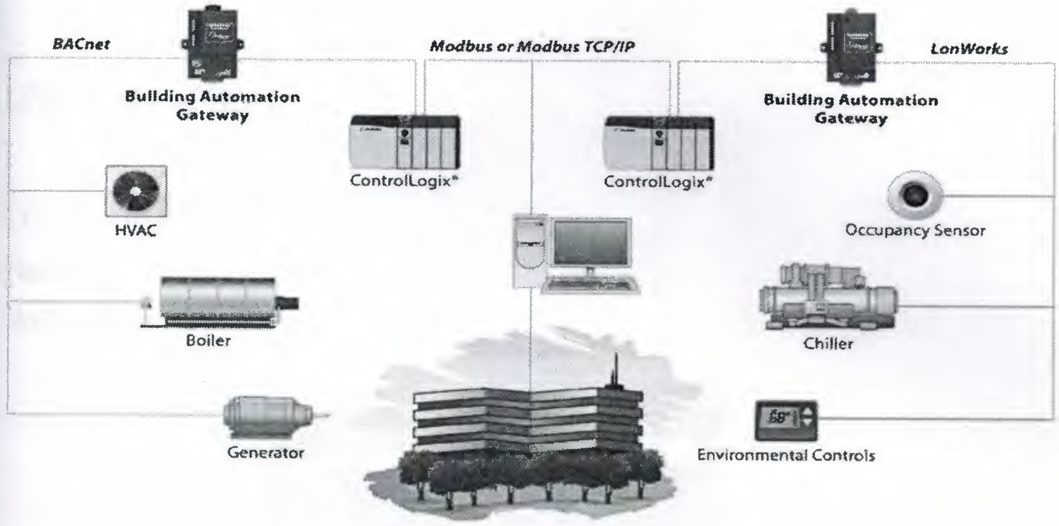


Figure 1.14 : network protocols

1.2.5. Human Machine Interfaces

There are screens that used with the PLCs ,and DDCs as a input/output machine , they show the status of the inputs /outputs , the value of timers ,and counters … etc. it can although show text in any language that user want.

Figure 1.15: HMI

1.5.1. The types of HMI

1- Touch screen
2- Industrial PC
3- Industrial monitors

Figure 1.16: types of HMI

1.5.2. The characteristics of HMI

1- Monitoring the status of the sensors and motors ,and the other input/output elements .
2- It can give a report ,and show the curves of product operations
3- It shows videos or flash that help the worker to run up the machines or what to do in emergency cases
4- Design a control interface of the systems in the BMS
5- Representing all switches by drawings on the screen, and dealing with it by touch

1.2.6. SCADA (Supervisory Control and Data acquisition)

The basis of any real-time control is the SCADA system, which Acquires data from different sources, preprocesses, and stores it in a database accessible to different users and Applications. Modern SCADA systems are configured around..

1.6.1 The following standard base functions:

- Data acquisition
- Monitoring and event processing
- Control
- Data storage archiving and analysis
- Application-specific decision support
- Reporting

1.6.2 Elements of SCADA Systems

- I/O Remote or RTU: Remote Terminal Unit to transfer informations.
- Communication system between central units the terminals once.
- Software in case using pc for example; Pcviwe – Wincc – Astudio .
- External controllers like DDC or PLC.

1.6.3. . SCADA APPLICATIONS

1- Supervising ,and monitoring every device on original project
2- Control the machines which connect to SCADA system

3- Showing the alarms directly in case fault happened to deal with it instantly

4- Display text or graphic report to follow up the situation of operations

5- Edit the control program when we use the computer as a controller

6- Execute the maintenance operations easily

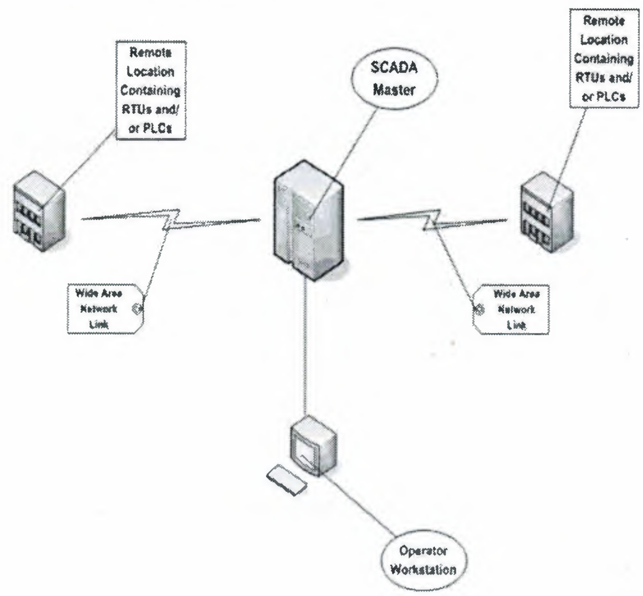


Figure 1.17 : SCADA structure

Chapter 2

The control systems of BMS

Building Management System shall monitor and manage:

1. Electrical Distribution Panels
2. Lighting Control
3. HAVC system
4. Fire Alarm system
5. CCTV System Monitoring
6. Elevators systems
7. Access Control, Parking Access, Intrusion Detection
8. UPS

Figure 2.1 BMS

2.1 HVAC system :

If clean air is the blood of a building then HVAC systems are the heart. HVAC systems, ensure we are comfortable in extreme weather conditions and maintain an acceptable level of carbon dioxide and other pollutants within the building. If designed and implemented correctly they will do all this and more while spending the least amount of energy.

The control system:

- Should minimize energy consumption while meeting process goals
- Must meet the budget
- Must be designed for maximum simplicity
- Must be easy to understand and maintain

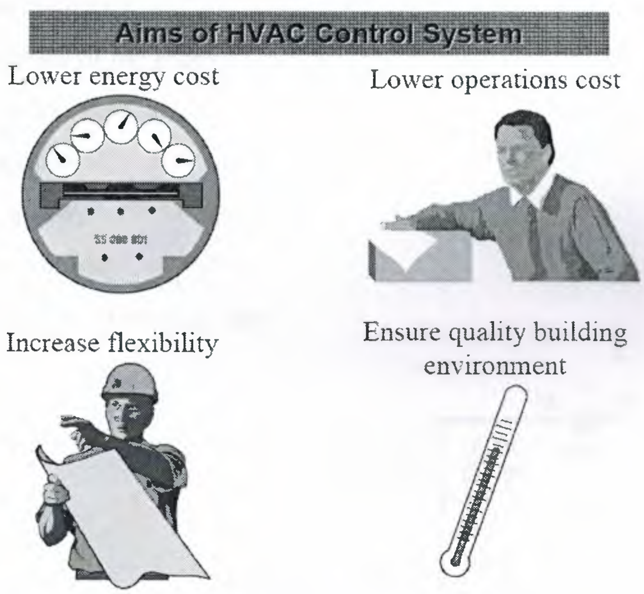


Figure 2.2 : aims of HVAC system

2.1.1 Heating system :

Heating is necessary requirement ,so develop this system in order to enhance the security of fire and decrease the coast without affecting the air quality ,and the humidity range .

Ventilation system depends on basically heat the water in the boilers witch pumped from the main tanks to specific temperature due to burners which work on fuel (we can use solar system in the daylight that highly decrease the coast) then to heat exchanger in its turn raise the temperature of air then the air sent to ducts then through fan coil to destination room .

First according to the volume of the destination ,and the walls materials , glass ,windows ,and considering the air leakage the mechanical engineers study to determine parameters like :

- Heating load for the building
- Distribute radiators .and choosing it
- Cross sections of the pipes
- Reduction pressure factor
- Boiler capacity
- Burner capacity
- Fuel tank volume

The component of heating unit

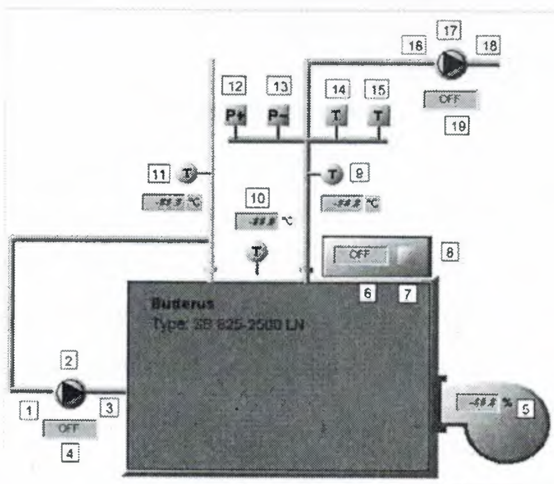


Figure 2.3:Heating unit

The signals of our system

1- Fault signal of water circulate pump
2- Overload current signal for the circulate pump
3- working circulate pump signal
4- run circulate pump signal
5- Run boiler signal
6- Working boiler signal
7- Fault boiler signal
8- Order run boiler
9- Going water temperature
10-Boiler water temperature
11-Return water temperature
12-Raising pressure signal
13-Reduction pressure signal
14-Raising water temperature
15-Reduction water temperature
16-Hot water pump fault signal
17-Over current hot water pump
18-Working Hot water pump signal
19-Run hot water pump

In general the sensors divided into temperature sensors , pressure sensors ,and monitor status sensors (running – fault) as we had in previous chapter Beside of the mechanical study electrical engineers do the electric one .To determine the power that should be feed the pumps ,burners ,exhausted fans depending on the heat capacity (should be calculated in mechanical section) Although drive this system , turning on ,and off , figure the faults , supervisor it ,and archived it due to the monitor system that we have

The digital inputs are:

1. Fault signal of water circulate pump
2. Overload current signal for the circulate pump
3. working circulate pump signal
5. Run boiler signal
6. Working boiler signal
7. Fault boiler signal
12. Raising pressure signal
13. Reduction pressure signal
14. Raising water temperature
15. Reduction water temperature
16. Hot water pump fault signal
17. Over current hot water pump
18. Working Hot water pump signal

Digital outputs :

4. Run circulate pump signal
19. Run hot water pump
8. Order run boiler

Analog inputs :

9. Going water temperature
10. Boiler water temperature
11. Return water temperature

2.1.2. Air conditioning System :

The basic unit in air conditioning system is chiller that use to cool the water in big buildings ,it consider a high economic solution comparing with air conditioning units .

The component of air conditioning system :

1- Compressor to cool water

2- Pumps to pump the cold water ,and return it .

3- Pipes

4- Heat exchanger

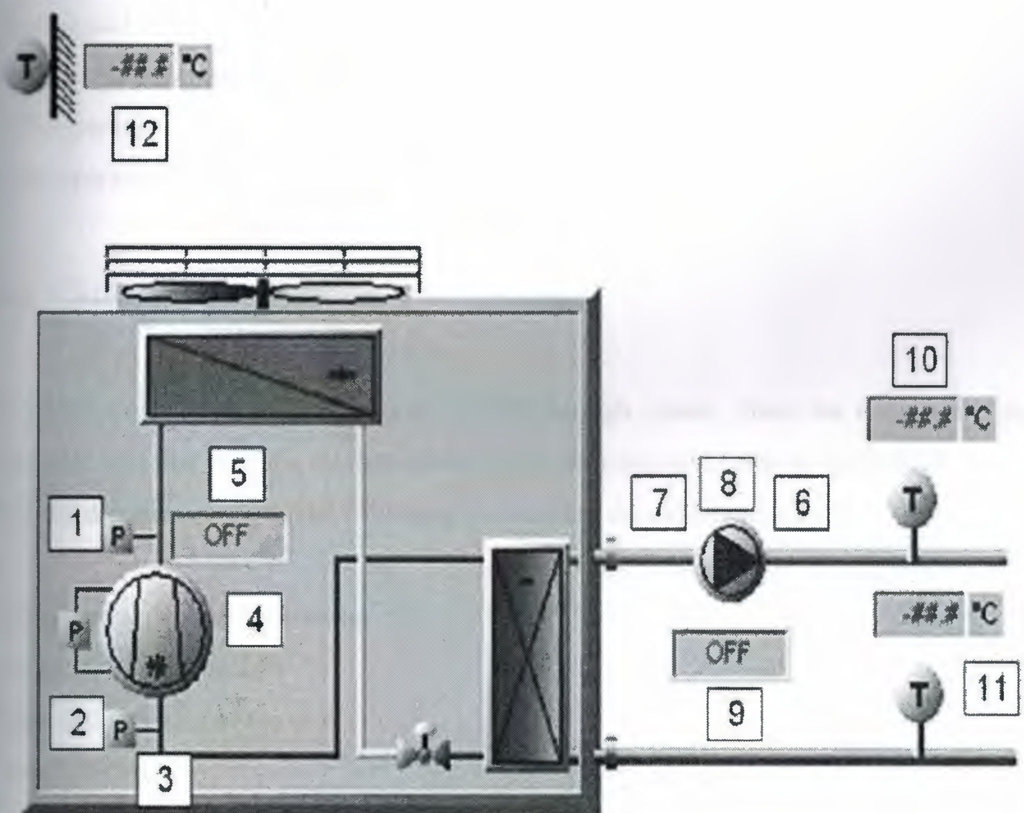


Figure 2.4: Chiller unit

3.2.2. The signals of chiller unit

1- pressure raise signal of the gas
2- pressure reduction signal of the gas
3- general fault signal of the chiller
4- working signal of the chiller
5- run signal of the chiller
6- working signal of the cold water pump
7- fault signal of the pump
8- Cold water pressure on the pump
9- Run signal of the pump
10- Temperature signal of pumped water
11- Temperature signal of return water
12- Temperature signal of the room

3.3.1 Chiller Method:

The water pumped from the tanks to chiller through pipes , then the cold water go to exchanger unit that cool the air that pushed through insulation ducts to destination.
After the mechanical study the following parameters should be calculated :

1- air quantity needed for cooling
2- capacity of cooling coil
3- converting factor of the coil
4- total air flux
5- capacity of renew air

After the mechanical study that depends on the volume of the building, the area, expect number of persons per room ,and the materials of walls and windows .... etc .

After the mechanical study and estimate the require parameters ,electric engineers do the electric study to supply power to each of pumps , compressors ,and air handling unit ,therefore running chiller ,and control it by the following classified signals

digital inputs

1- pressure raise signal of the gas
2- pressure reduction signal of the gas
3- general fault signal of the chiller
4- working signal of the chiller
6- working signal of the cold water pump
7- fault signal of the pump
8- cold water pressure on the pump

Analog inputs

10- temperature signal of pumped water
11- temperature signal of return water
12- temperature signal of the room

Digital outputs

5- run signal of the chiller
9- run signal of the pump

2.1.3. The ventilation system

The ventilation system bring together between heating, and cooling.

The components of air process unit that is basic part in the system representing as signals are:

1- air humidity signal

2- temperature signal of return air

3- changing pressure signal of the fan

4- working signal of the fan

5- Fault signal of the fan

6- run order signal of exhausted fan

7- close damper signal

8- open damper signal

9- filter clogging signal

10- manual run signal from panel

11- remote run signal

12- close open damper order signal

13- open hot water valve signal

14 fault humidity pump signal

15- working humidity pump signal

16- run humidity pump signal

17- open cold water pump signal

18- fault push fan signal

19- working push fan signal

20- changing pressure push fan signal

21- run push fan signal

22- pushed air temperature signal

23- room temperature signal

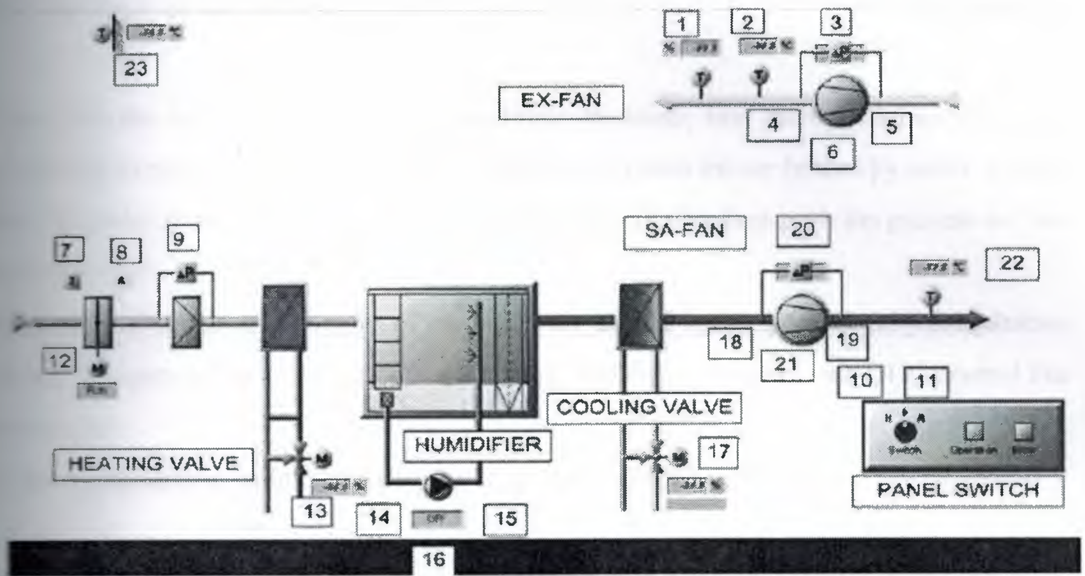


Figure 2.5: air process unit

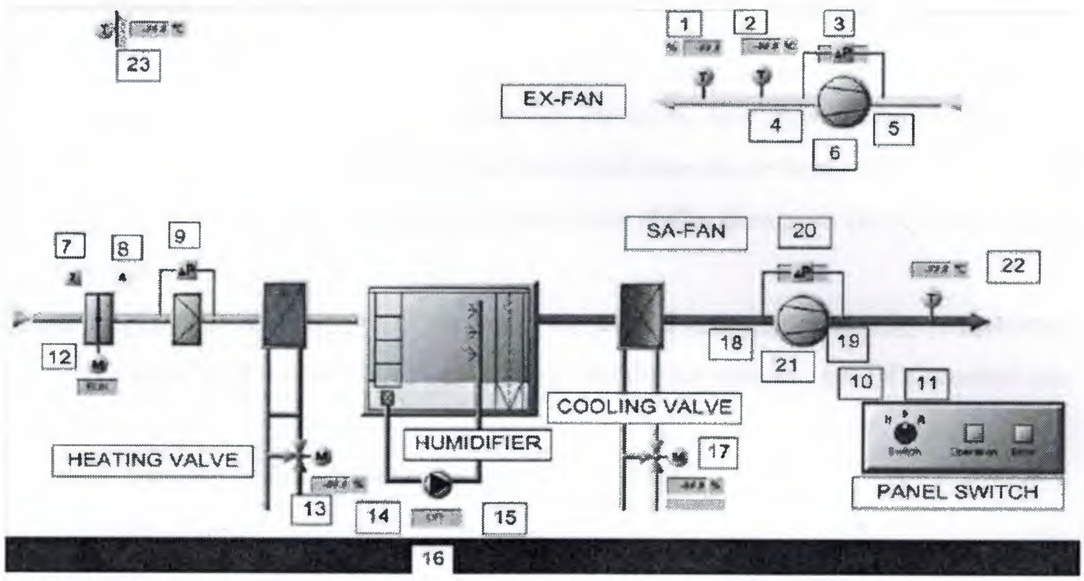
The ventilation include the operations that execute in the air process central unit AHIU that divided into :

1- heating : it is an operation that heat the air without changing of humidity percent by flowing it near a hot dry surfaces which called primary heaters

2- wetting : it is an operation change the humidity percent in the air by using vapor or water

In addition to water air washing ,therefor the humidity do by water through spray water soft drops with enough intensity in the air way so , the some water drops evaporate ,and mixed with the air

3- cooling : it is an operation that cool the air without changing of humidity percent by flowing it near a cold dry surfaces there temperature higher than dry air ,and less than clammy air



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The method of air process central unit :

In this unit the air will be prepared to condition the room, first the external air will flow through the exhaust fan to filter to get rid of Impurities then the air heated by water coming from the boiler then cool it by cold water coming from chiller then push the process air into ducts to rooms .

The control of partition operations of preparing the air due to dry ,and calamity temperature sensors .The process unit consist of many analog ,and digital sensors , the DDC control this process unit

By the digital analog inputs , and outputs signals which are :

Analog inputs :

1- air humidity signal

2- temperature signal of return air

22- pushed air temperature signal

23- room temperature signal

Digital inputs :

3- changing pressure signal of the fan

4- working signal of the fan

5- Fault signal of the fan

7- close damper signal

8- open damper signal

9- filter clogging signal

10- manual run signal from panel

11- remote run signal

13- open hot water valve signal

14 fault humidity pump signal

15- working humidity pump signal

17- open cold water pump signal

18- fault push fan signal

19- working push fan signal

20- changing pressure push fan signal

Digital Outputs:

6- run order signal of exhausted fan

12- close open damper order signal

16- run humidity pump signal

21- run push fan signal

2.2. Lighting System:

2.2.1. Introduction:

Lighting is fundamental system ,and critical ,because 30% of building power go to lighting specially hotels ,universities ,and malls ,so it become a necessary to save power in this section therefor , there are some methods to do this :

1- use fluorescent lamps instead of induction once
2- use compact lamps which reach the percent of saving 80%
3- switching off the light in empty rooms
4- Enter the automation in lighting system using movement sensors ,and timers in external lighting and ,stairs
5- Use Low current lamps
6- Trying to get maximum Benefit of the daylight
7- Paint the rooms of light colors specially white

For maximum saving, and prevent unnecessary use we should use automation control system

To be a basic part of building management system

The component of lighting system:

1. **External lighting :**

To control the external lighting there some points :

- Convert The intensity flux of the outside into analog signal
- Run orders for fence light ,and there are digital output signals
- Open close electronic shutters ,and there are digital output signals

2. **Internal lighting :**

There are some basic points:

- Flux intensity of the room ,and it is analog signal
- Switch on the light order ,and it is output digital signal
- Switch on the light order proportionally ,and it is output analog signal

There are some controllers in purpose of control the lighting for example;

- DDC controller
- Controlling by EIB/KNX

2.2.2. Lighting system control using DDC:

We have to connect all lighting digital or analog points to the inputs outputs unit Of each room for example ;

- Switches
- Shutters
- Light sensors

Then connect these unit to main controller through for example; RS-485 Then program this controller for best efficiency in lighting and best quality. The advantage of this type that you can control, and monitor each point of lighting system but the disadvantages high cost ,and the failure of main controller means stop the entire lighting system

Generally, there are some conditions should be respected like :

1- The light flux intensity should be in range of the standards
2- Preventing the light phenomenon
3- Shouldn't be a reason of electrical shocks or fires
4- The intensity of the emergency light should be enough to prevent the accident ,and In case of emergencies the normal light must switching off , and switching on the emergency light in addition the working duration must be specified

All previous conditions in purpose of safety for example ;

- Exists light to make the escape easily
- Alternative light in internal feeding unit in case of faults

2.3. Fire alarm system:

2.3.1. Definition

It becomes as first priority in modern buildings almost all buildings set it .At the beginning of fire the fire alarm system should run to prevent the fire of expanding to long distance ,so become hard to control ,and threat the people in first level ,and public Properties in second level .

The goal of the fire alarm system is to detect the fire ,and alarm about it in shortest period ,until who in charge take control on it , because of the high speed spreading Fire, the effective system is detect the fire quickly and locate it exactly .

Nevertheless, some develop systems pre –programmable do certain tasks to reduce the fire ,and smoke spreading for example ;

- Make a call of re-store numbers to fire station
- Open ,and close vents
- Open ,and close doors to delay the fire
- Stop the lefts

Applying fields of fire alarm system :

Because of fire alarm system save people lives ,and public property the international standards obligate to set fire alarm system in all building ,and the follow once :

- High towers
- Crowded buildings
- Public building
- Factories ,and store houses
- Petrol station
- Fuel rooms

2.3.2. Classification of fire alarm systems :

1- manual fire alarm system

2- automated fire alarm system

2.3.2.1. the manual alarm system :

The basic condition of this system is needing someone to push the bottom ,often glass bottoms distributed around the building then the signal sent to control panel ,the installation ,and equipment's should supply from secondary source to be able to use in primary outage . The drawings or maps which lead you to the places of alarm equipment's which distributed around the buildings must be near to main entrance ,security room , and main telephon room .

Figure 2.6:Fire alarm bottom

2.3.2.2. automated fire alarm system :

Its best use In high possibilities places to start fire .It works on the outputs of the fire temperature or smoke ,no need for someone to run the system as manual system ,and gain the time between starting fire and moment of notice it therefore , control the fire ,and prevent it to expand ,so decrease the loses ,and save people lives .

There are many sensors that their task early detecting of the fire

- Smoke detector :

  Since it senses the smoke it runs ,there are two types according to way of sense the smoke .

- Flame detector

  It runs if it sense to infrared

The BMS duty to do all the alarm operations about the fire ,and limit it due to sequence of orders sent by the controller (DDC) after sending the sensor signal of starting fire :

The executed orders by controller:

1-Run sound alarm or light alarm also

2- Stop the HVAC system because the air increased the strength of fire ,so we have to close all the vents

3- Open the escape doors in emergency case

4- Turn on the static extinguish fire which propaply a gas (CO_2)

5- Send text messages to pearson or more in case the building was empty

6- Turn on the exit light

7- Stop the lefts in nearest floor under the fire

8- Outage of fire area (the fire could be because of overload or electric shock)

All there orders should be addressable ,so locate the fire in which part of the building ,that depend on specify an address for each input ,and output therefore the controller know which sensors send the order , this characteristic we can find it in DDCs but not in PLCs that more condition with industrial work . Everything will be monitored ,archived ,and control through SCADA , and HMI

Finally the basic tasks should be executed by fire alarm system

- Early detected for the fire
- Run an alarm to fire stations
- Locate the fire in which part

Chapter 3

BUILDING MANAGEMENT SYSTEM

USING ARDUINO AND LABVIEW

3.1. The components of the project:

I do a small application which is explanation of BMS .and I used the follow component :

3.1.1. ARDUINO:

ARDUINO is a microcontroller which is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. The important part for us is that a micro-controller contains the processor (which all computers have) and memory, and some input/output pins that you can control. (often called GPIO - General Purpose Input Output Pins).

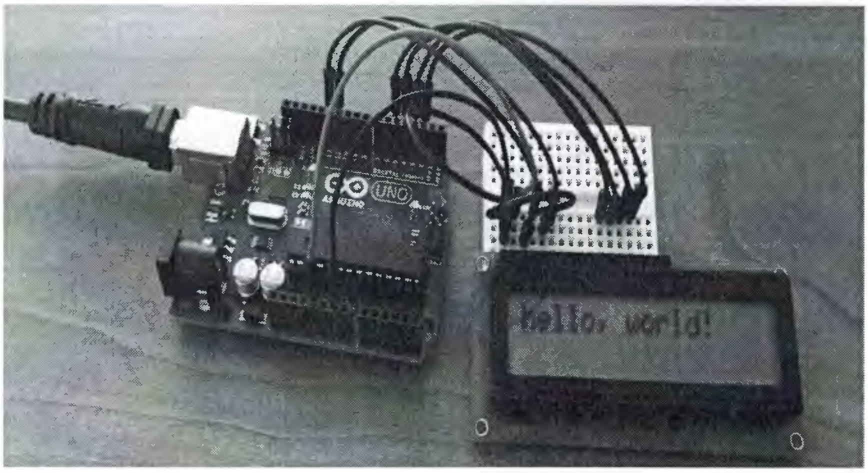


Figure 3.1: Arduino Board

For this book, we will be using the Arduino Uno board. This combines a micro-controller along with all of the extras to make it easy for you to build and debug your projects. Arduino is an open-source microcontroller board, with an associated development environment. The schematics and the software are released under the Creative Commons License.

Manufacturing and distributing an official Arduino product is subject to a few restrictions (basically the authors need to be contacted) to make sure that:

- Things work properly.
- The product represent the project.
- It is manufactured under reasonably fair labor conditions.

3.1.1.1. Specification (Arduino)

- ATmega328 microcontroller
- 16 MHz, 32 KB FLASH, 2KB SRAM, 1K EEPROM
- 19 DIO pins (6 can be 8-bits 500Hz PWM outputs)
- 6 analog inputs (10 bits over 0-5V range, 15kSPS)
- 5V operating voltage, 40 mA DC Current per IO Pin
- I2C (TWI) fully supported and SPI partially supported
- USB connection (FTDI chip converts USB to Serial)
- FTDI Drivers provide a virtual com port to the OS
- Power jack and optional 9V power supplier

3.1.1.2. Shields

- Shields are boards to be mounted on top of the Arduino
- They extend its functionality to control different devices, acquire data, and so on…
- Motor/Stepper/Servo Shields (Motor Control)

  For example the motor used in the project need 12v to supply
- Prototyping Shields
- Ethernet and Wireless communication Shields
- Wave Shields (Audio)
- GPS and Logging Accelerometer Shields
- Relay Control Shields

We will be using a test board in our project; this is a relatively easy way to make circuits quickly. Test boards are made for doing quick experiments. They are not known for keeping circuits together for a long time. When you are ready to make a project that you want to stay around for a while, you should consider an alternative method such as wire-wrapping or soldering or even making a printed circuit board (PCB).

The first thing you should notice about the test board is all of the holes. These are broken up into 2 sets of columns and a set of rows (the rows are divided in the middle). The columns are named a, b, c, d, e, f, g, h, i, and j (from left to right). The rows are numbered 1 - 30. (from top to bottom). The columns on the edges do not have letters or numbers. The columns on the edges are connected from top to bottom inside of the test board to make it easy to supply power and ground. (You can think of ground as the negative side of a battery and the power as the positive side.)

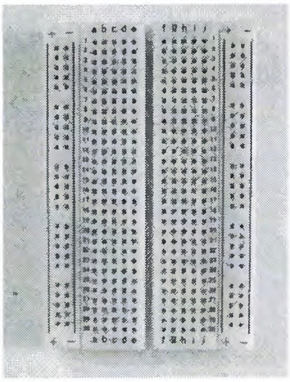


Figure 3.2: Test board

3.1.1.3. What is Arduino good for?

- Projects requiring Analog and Digital IO
- Mechatronics Projects using Servo, DC or Stepper Motors
- Projects with volume/size and/or budget constraints
- Projects requiring some amount of flexibility and adaptability (i.e. changing code and functions on the fly)
- Basically any Mechatronics project requiring sensing and acting, provided that computational requirements are not too high (e.g. can't do image processing with it)
- Ideal for undergraduate/graduate Mechatronics Labs and Projects
- Ideal for undergraduate/graduate Mechatronics Labs and Projects

3.1.14. Install the software

If you have access to the internet, there are step-by-step directions and the software Available at: here. Otherwise, the USB stick in your kit has the software under the Software Directory .

There are two directories under that. One is “Windows” and the Other is “Mac OS X”. If you are installing onto Linux, you will need to follow the directions at: here

3.1.2. THE LABVIEW

3.1.2.1. Overview of LabVIEW Programing environment

LabVIEW is a highly productive graphical development environment with the performance and flexibility of a programming language, as well as high-level functionality and configuration utilities designed specifically for measurement and automation applications.

In general-purpose programming languages, the code is as much of a concern as the application. We must pay close attention to the syntax (commas, periods, semicolons, square brackets, curly brackets, round brackets, etc.). In contrast, with LabVIEW we use icons to represent functions, and we wire them together to determine the flow of data through our program, similar to creating flowcharts. It has all the breadth and depth of a general-purpose programming language, but it is easy to use, increasing our productivity by decreasing the time required to develop our applications.

We can easily divide measurement and automation application into three main parts: acquisition, analysis, and presentation of data. LabVIEW provides a seamless way to acquire our data, perform necessary analysis on that data, and present the information in a chosen format.

Each program in LabVIEW is called a virtual instrument, or VI. The VI serves as the primary building block of a LabVIEW application, and we can use it to modularize our code for efficient design, clear and concise documentation, and simplified maintenance

LabVIEW programs are called virtual instruments (VIs).

Each VI contains three main parts:

- Front panel – How the user interacts with the VI
- Block diagram – The code that controls the program
- Icon/connector – The means of connecting a VI to other Vis and the graphical representation of the VI

In LabVIEW, we build a user interface by using a set of tools and objects. The user interface is known as the front panel. We then add code using graphical representations of functions to control the front panel objects. The block diagram contains this code. In some ways, the block diagram resembles a flowchart.

We interact with the front panel when the program is running. We can control the program, change inputs, and see data updated in real time. Controls are used for inputs such as adjusting a slide control to set an alarm value, turning a switch on or off, or stopping a program. Indicators are used as outputs. Thermometers, lights, and other indicators display output values from the program. These may include data, program states, and other information.

Every front panel control or indicator has a corresponding terminal on the block diagram. When we run a VI, values from controls flow through the block diagram, where they are used in the functions on the diagram, and the results are passed into other functions or indicators through wires.

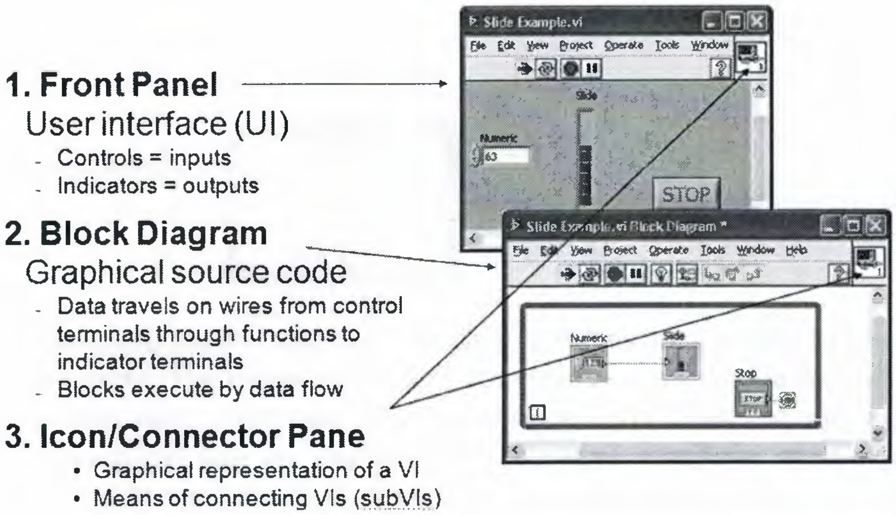
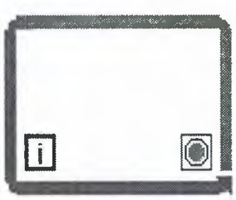


Figure 3.3: Parts of LabVIEW environment

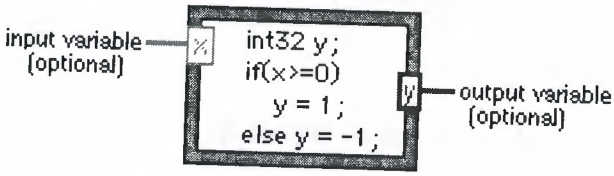
Here we will present an Overview of some Functions that used in the project.

While Loop



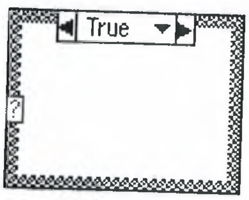
Repeats the subdiagram inside it until the conditional terminal, an input terminal, receives a particular Boolean value. The Boolean value depends on the continuation behavior of the While Loop. Right-click the conditional terminal and select **Stop if True** or **Continue if True** from the shortcut menu. You also can wire an error cluster to the conditional terminal, right-click the terminal, and select **Stop on Error** or **Continue while Error** from the shortcut menu. The While Loop always executes at least once.

Formula Node



Evaluates mathematical formulas and expressions similar to C on the block diagram. The following built-in functions are allowed in formulas: abs, acos, acosh, asin, asinh, atan, atan2, atanh, ceil, cos, cosh, cot, csc, exp, expm1, floor, getexp, getman, int, intrz, ln, lnp1, log, log2, max, min, mod, pow, rand, rem, sec, sign, sin, sinc, sinh, sizeOfDim, sqrt, tan, tanh. There are some differences between the parser in the Mathematics VIs and the Formula Node.

Case Structure



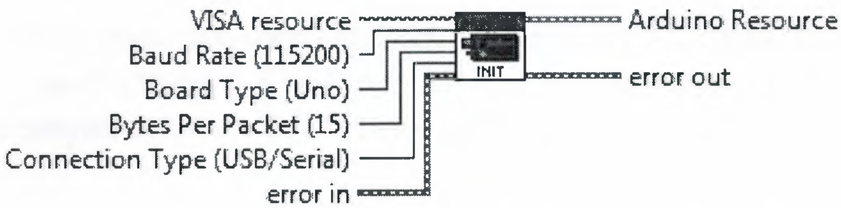
Has one or more subdiagrams, or cases, exactly one of which executes when the structure executes. The value wired to the selector terminal determines which case to execute and can be Boolean, string, integer, or enumerated type. Right-click the structure border to add or delete cases. Use the Labeling tool to enter value(s) in the case selector label and configure the value(s) handled by each case.

3.1.2.2. Lab view functions:

1- Lab VIEW interface for arduino

2-

[LabVIEW Interface for Arduino.lvlib:Init.vi]

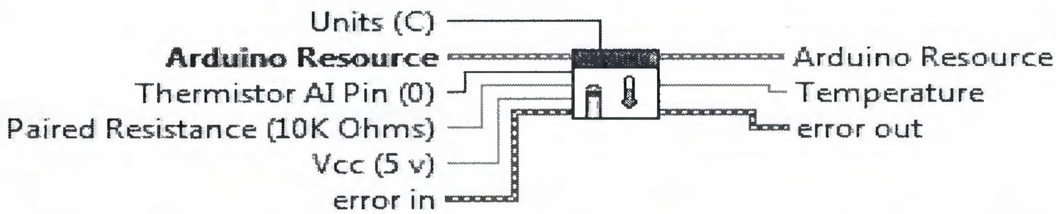


Initializes a connection to an Arduino running the LabVIEW Interface for Arduino sketch.

Note: The baud rate specified must match the baud rate defined by DEFAULTBAUDRATE in the Arduino firmware.

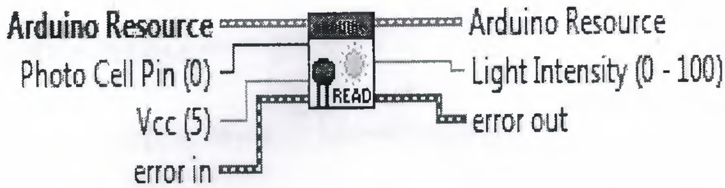
Note: The Bytes Per Packet input must match the COMMANDLENGTH specified in the Arduino firmware.

3- Thermostat read



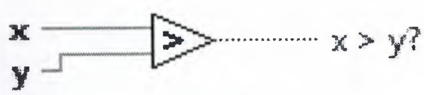
Read the temperature from a thermistor. Thermistor must be used in a voltage divider with a paired resistance. The paired resistance is user selectable however a value of 10K Ohms is recommended.

4- Photo cell read :



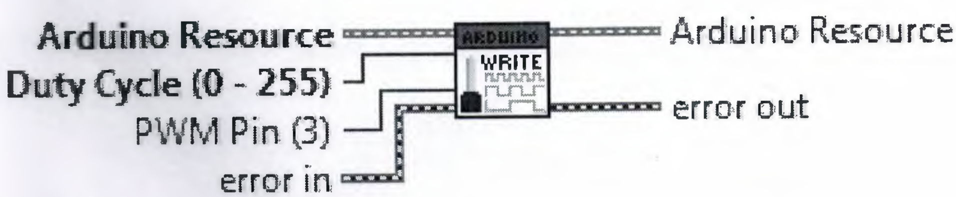
Measure light intensity using a Photocell. The user must specify the supply voltage (Vcc) in volts and the paired resistance in (R1) in Ohms. Light intensity is returned in arbitrary units and ranges from 0 in complete darkness to 100 in full direct light.

5- Greater



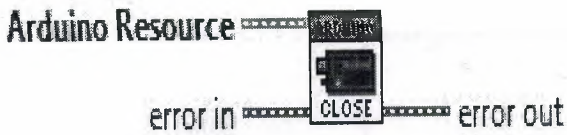
Returns TRUE if **x** is greater than **y**. Otherwise, this function returns FALSE. You can change the comparison mode of this function.

6- PMW WRITE PIN



Writes the specified PWM value to a single PWM pin on the Arduino.

6- CLOSE



Closes the active connection to an Arduino.

3.2. The block diagram :

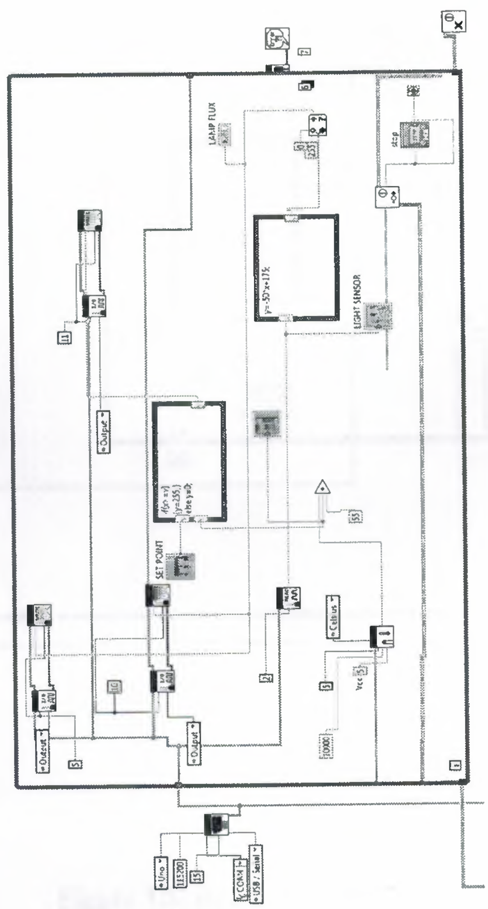


Figure 3.4: Block diagram part 1

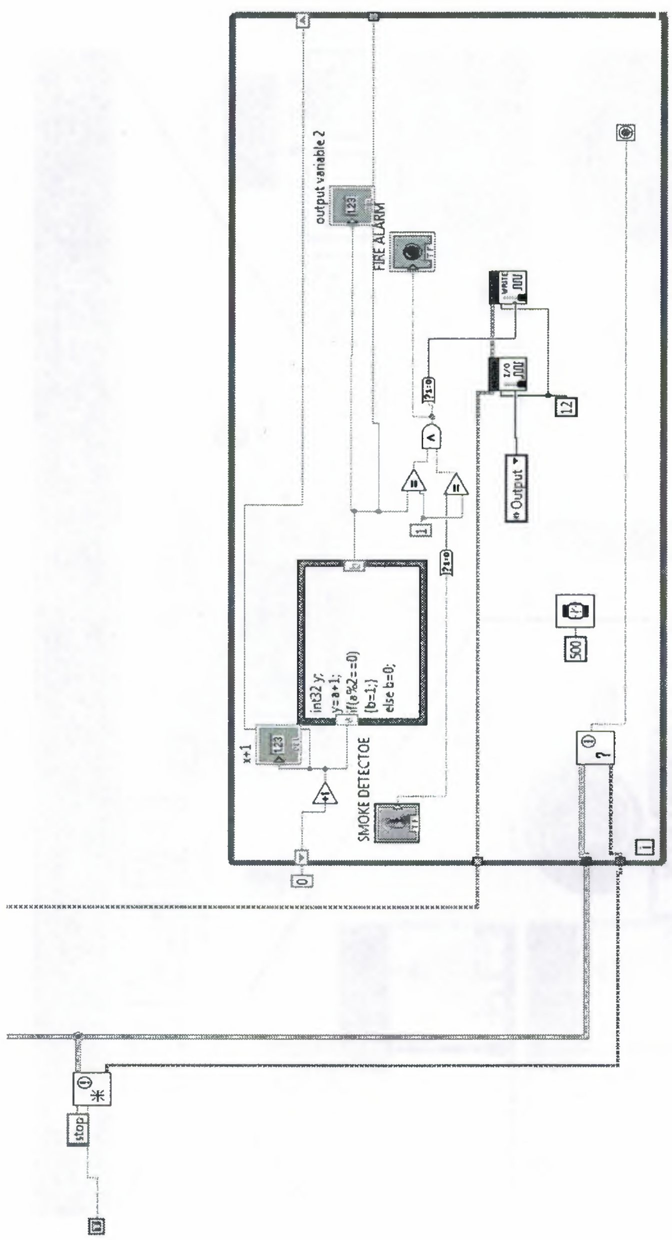


Figure 3.5: Block diagram part 2

3.3. The user interface

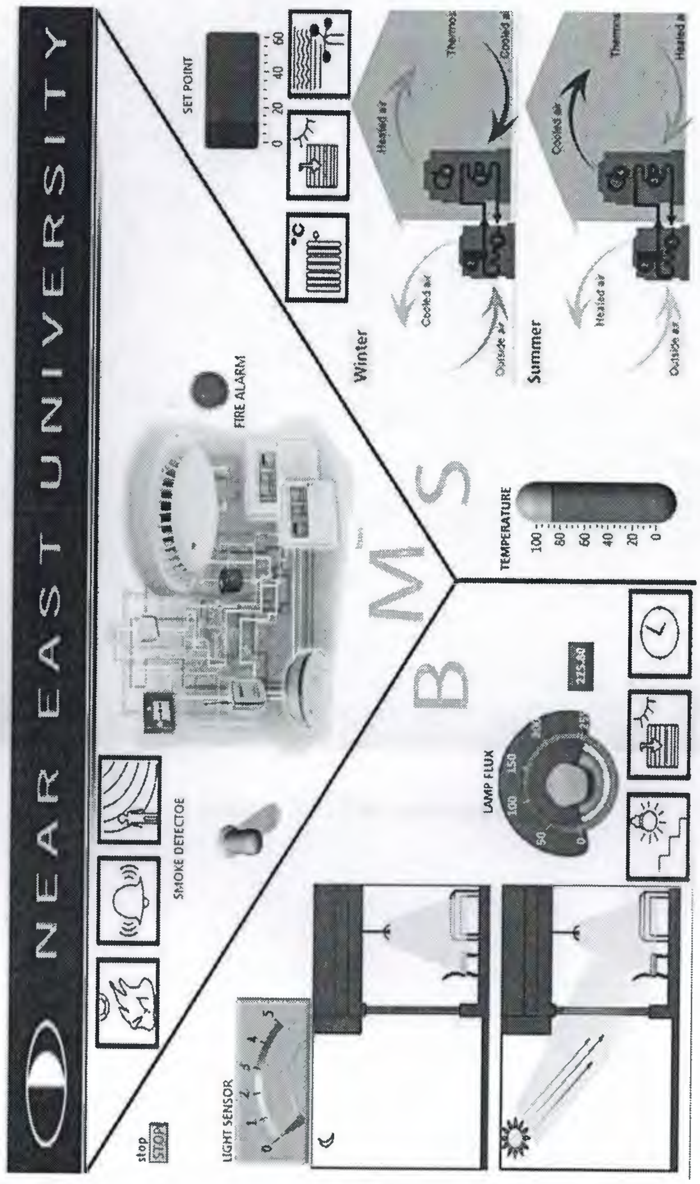


Figure 3.6 :user interface

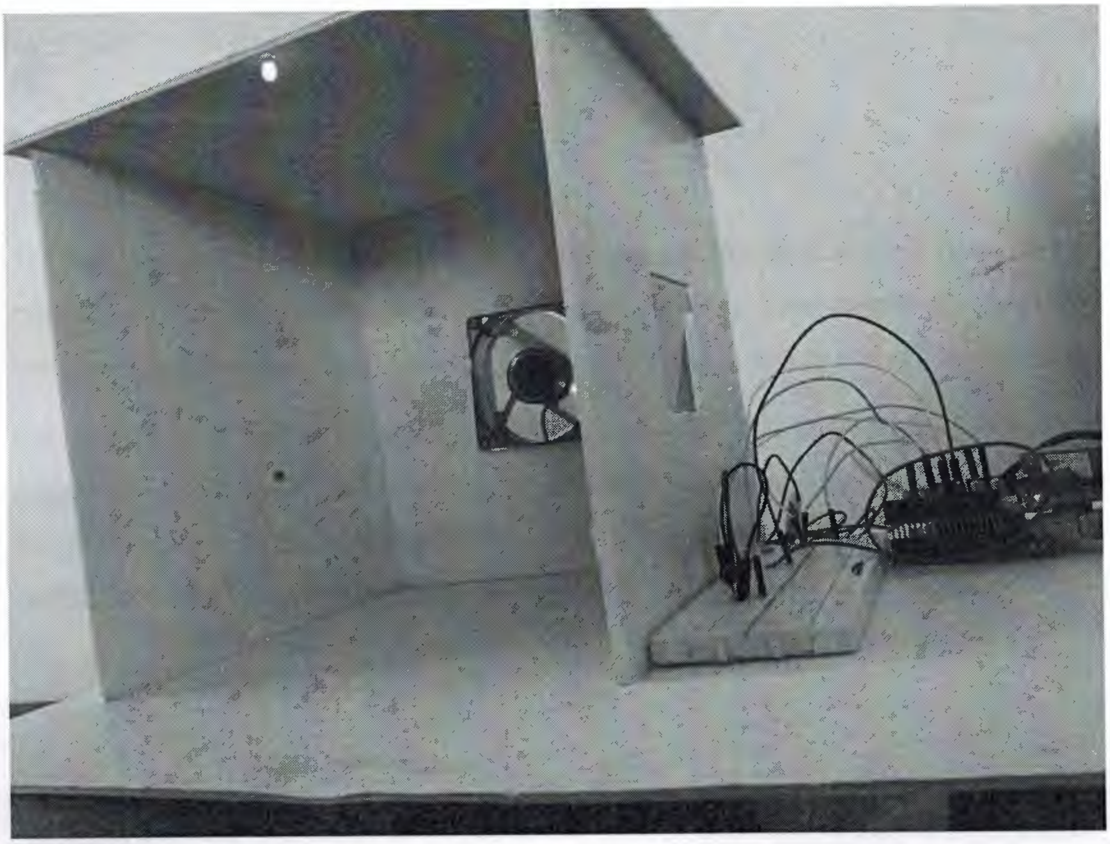


Figure 3.7: The prototype

CONCLUSION

The importance of building management systems has evolved from last few years with the evaluation of green building concept. In many countries governments are making it mandatory to follow the LEED (leadership in environment & energy design) requirements

For which energy ,and efficiency monitoring is essential . In addition to conservation of energy ,re-use of water ,and recycling of wastes is now taking the priority of building design companies. In that scenario th role of BMS systems becomes central while choosing ,and selecting the equipment's for a project or a building at the beginning stages .

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