ANALYSIS OF THE PERFORMANCE OF A NEWLY DEVELOPED HEAT CONTROL SYSTEM TO PROTECT MACHINE FROM OVERHEAT

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A thesis submitted to the Department of Mechanical Engineering, Sonargaon University, Dhaka, in January, 2023 in partial fulfilment of the requirements for the degree of Bachelor of Science in Mechanical Engineering.

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The Authors

Dedicated

To

Our Parents & Teachers

Abstract

In industrial machines different alarms are embedded in machines controllers. They make use of sensors and machine states to indicate to end-users various information (e.g. diagnostics or need of maintenance) or to put machines in a specific mode (e.g. shut-down when thermal protection is activated). More specifically, the alarms are often triggered based on comparing sensors data to a threshold defined in the controller's software. In batch production machines, triggering an alarm (e.g. thermal protection) in the middle of a batch production is crucial for the quality of the produced batch and results into a high production loss. This situation can be avoided if the settings of the production machine (e.g. production speed) is adjusted accordingly based on the temperature monitoring. Therefore, predicting a temperature alarm and adjusting the production speed to avoid triggering the alarm seems logical. In this paper we show the effectiveness of Least Squares Support Vector Machines (LS-SVMs) in predicting the evolution of the temperature in a steel production machine and, as a consequence, possible alarms due to overheating. Firstly, in an offline fashion, we develop a micro controller based heat detector model, where a systematic model selection procedure allows to carefully tune the model parameters. Afterwards, the Micro controller model is used online to forecast the future temperature trend. Finally, in this project we are detecting machine overheat by micro controller.

An embedded system is a combination of computer hardware and software designed to perform a dedicated function. The major part of embedded system hardware is a microcontroller which it acts as a computer-on-a-chip. Microcontroller consists of memory, CPU, input output unit and analog to digital convertor devices. An embedded system uses sensors to receive analog data from external environment, the microcontroller converts the received analog data to digital form. In addition, it compare digital data with the program data that stored in its memory and take the action.

The proposed system is simulated by Proteus simulator and the code is written by micro c language. The hardware components that used are microcontroller, sensor for collecting the information, LCD for displaying the collected information, LED and fan, then linking microcontroller by a program that stored in a computer. The sensor take temperature from external environment then a microcontroller convert this temperature from analog to digital by a convertor and compare it with a stored data and take the suitable action.

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CHAPTER 1

Introduction

1.1 Background Study

In recent years, server overheating has become one of the most important concerns in large-scale data centers. Due to the considerations such as real estate and integrated management, data centres continue to increase their computing capabilities by deploying high-density servers (e.g., blade servers). As a result, the increasingly high server and thus power densities can lead to some serious problems. First, the reduced server space may result in a greater probability of thermal failures for various components within the servers, such as processors, hard disks, and memories. Such failures may cause undesired server shutdowns and service disruption. Second, even though some components may not fail immediately, their lifetimes may be significantly reduced due to overheating. It is reported in that the lifetime of an electronic device decreases exponentially with the increase of the operating temperature. Finally, the generated heat dissipation can also lead to negative environmental implications. Therefore, it is important for each server component to run at a temperature below its overheating threshold. However, in today's data centres, how to precisely detect whether any component in a server is overheating remains an open question. The current practice of detecting and monitoring an over- heating server can be divided into two categories. The first category is a coarse-grained approach that only uses the temperature at a proxy component, e.g., CPU or at a fixed location, e.g., the server inlet, for server overheating monitoring. This is in contrast to the fact that different components in a server may have different overheating thresholds, which are closely related to their respective thermal failure rates and expected lifetimes. Relying on a single.

Through machine learning, operational data analytics and predictive asset health monitoring, engineers can optimize maintenance and reduce reliability risks to plant or business operations. Software designed to support preventive maintenance (which is sometimes called preventative maintenance) helps produce stable operations, ensure compliance with warranties and resolve issues impacting production — before they happen.

1.2 Non-Destructive Testing

1.2.1 Objective

To gain experience with and understanding of the types, advantages and applications ofvarious NDT methods. To be able to choose the best NDT method for a given part.

1.2.2 Introduction

Up to this point we have learnt various testing methods that somehow destruct the test specimens. These were, tensile testing, hardness testing, etc. In certain applications, the evaluation of engineering materials or structures without impairing their properties is very important, such as the quality control of the products, failure analysis or prevention of the engineered systems in service.

This kind of evaluations can be carried out with Non destructive test (NDT) methods. It is possible to inspect and/or measure the materials or structures without destroying their surface texture, product integrity and future usefulness.

The field of NDT is a very broad, interdisciplinary field that plays a critical role in inspecting that structural component and systems perform their function in a reliable fashion. Certain standards has been also implemented to assure the reliability of the NDT tests and prevent certain errors due to either the fault in the equipment used, the miss-application of the methods or the skill and the knowledge of the inspectors.

Successful NDT tests allow locating and characterizing material conditions and flaws that might otherwise cause planes to crash, reactors to fail, trains to derail, pipelines to burst, and variety of less visible, but equally troubling events. However, these techniques generally require considerable operator skill and interpreting test results accurately may be difficult because the results can be subjective.

These methods can be performed on metals, plastics, ceramics, composites, cermets, and coatings in order to detect cracks, internal voids, surface cavities, delamination, incomplete c defective welds and any type of flaw that could lead to premature failure. Commonly used NDT test methods can be seen in table 1. These are universal NDT methods; however, very special tests have been developed for specific applications.

Table 1.2.2: Commonly used NDT techniques:

Technique	Capabilities	Limitations
Visual Inspection	Macroscopic surface flaws	Small flaws are difficult to detect, no subsurface flaws.
Microscopy	Small surface flaws	Not applicable to larger structures; no subsurface flaws.
Radiography	Subsurface flaws	Smallest defect detectable is 2% of the thickness; radiation protection. No subsurface flaws not for porous materials
Dye penetrate	Surface flaws	No subsurface flaws not for porous materials
Ultrasonic	Subsurface flaws	Material must be good conductor of sound.
Magnetic Particle	Surface / near surface and layer flaws	Limited subsurface capability, only for ferromagnetic materials.
Eddy Current	Surface and near surface flaws	Difficult to interpret in some applications; only for metals.
Acoustic emission	Can analyze entire structure	Difficult to interpret, expensive equipments.

1.2.3 Visual Inspection:

VI is particularly effective detecting macroscopic flaws, such as poor welds. Many welding flaws are macroscopic: crater cracking, undercutting, slag inclusion, incomplete penetration welds, and the like. Like wise, VI is also suitable for detecting flaws in composite structures and piping of all types. Essentially, visual inspection should be performed the way that one would inspect a new car prior to delivery, etc. Bad welds or joints, missing fasteners or components, poor fits, wrong dimensions, improper surface finish, delaminations in coatings, large cracks, cavities, dents, inadequate size, wrong parts, lack of code approval stamps and similar proofs of testing.

Figure: 1.2.3: Visual Inspection

1.2.4 Radiography:

Radiography has an advantage over some of the other processes in that the radiographyprovides a permanent reference for the internal soundness of the object that is radiographed.

The x-ray emitted from a source has an ability to penetrate metals as a function of the accelerating voltage in the x-ray emitting tube. If a void present in the object being radiographed, more x-rays will pass in that area and the film under the part in turn will have more exposure than in the non-void areas. The sensitivity of x-rays is nominally 2% of thematerials thickness. Thus for a piece of steel with a 25mm thickness, the smallest void that could be detected would be 0.5mm in dimension. For this reason, parts are often radiographedin different planes. A thin crack does not show up unless the x-rays ran parallel to the plane 0the crack. Gamma radiography is identical to x-ray radiography in function. The difference isthe source of the penetrating electromagnetic radiation which is a radioactive material such mCo 60. However this method is less popular because of the hazards of handling radioactivematerials.

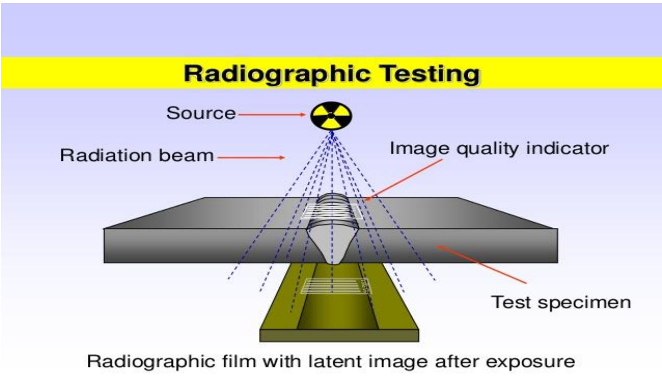


Figure: 1.2.4: Radiography

1.2.5 Liquid (Dye) Penetrant Method:

Liquid penetrant inspection (LPI) is one of the most widely used nondestructive evaluation (NDE) methods. Its popularity can be attributed to two main factors, which are its relative ease of use and its flexibility. The technique is based on the ability of a liquid to be drawn into a "clean" surface breaking flaw by capillary action.

This method is an inexpensive and convenient technique for surface defect inspection. The limitations of the liquid penetrant technique include the inability to inspect subsurface flaws and a loss of resolution on porous materials. Liquid penetrant testing is largely used on nonmagnetic materials for which magnetic particle inspection is not possible.

Materials that are commonly inspected using LPI include the following; metals (aluminum, copper, steel, titanium, etc.), glass, many ceramic materials, rubber, plastics.

Liquid penetrant inspection is used to inspect of flaws that break the surface of the sample. Some of these flaws are listed below; fatigue cracks, quench cracks grinding cracks, overload and impact fractures, porosity, laps seams, pin holes in welds, lack of fusion or braising along the edge of the bond line.

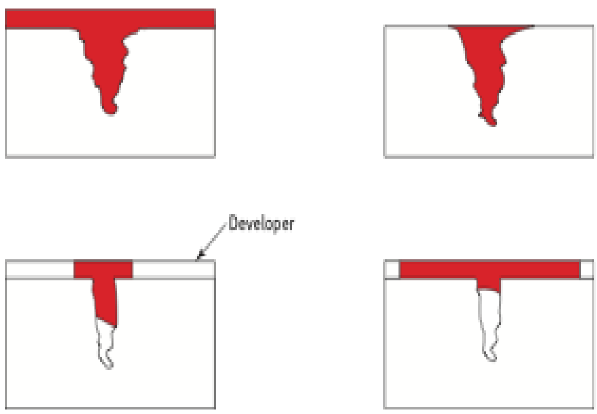


Figure:1.2.5 Liquid (Dye) Penetrant Method

1.2.6 Magnetic Particles

Magnetic particle inspection is one of the simple, fast and traditional nondestructive testing methods widely used because of its convenience and low cost. This method uses magnetic fields and small magnetic particles, such as iron filings to detect flaws in components. The only requirement from an inspect ability standpoint is that the component being inspected must be made of a ferromagnetic material such iron, nickel, cobalt, or some of their alloys, since these materials are materials that can be magnetized to a level that will allow the inspection to be effective. On the other hand, an enormous volume of structural steels used in engineering is magnetic. In its simplest application, an electromagnet yoke is placed on the surface of the part to be examined, a kerosene-iron filling suspension is poured on the surface and the electromagnet is energized. If there is a discontinuity such as a crack or a flaw on the

surface of the part, magnetic flux will be broken and a new south and north pole will form at each edge of the discontinuity. Then just like if iron particles are scattered on a cracked magnet, the particles will be attracted to and cluster at the pole ends of the magnet, the iron particles will also be attracted at the edges of the crack behaving poles of the magnet. This cluster of particles is much easier to see than the actual crack and this is the basis for magnetic particle inspection. For the best sensitivity, the lines of magnetic force should be perpendicular to the defect.

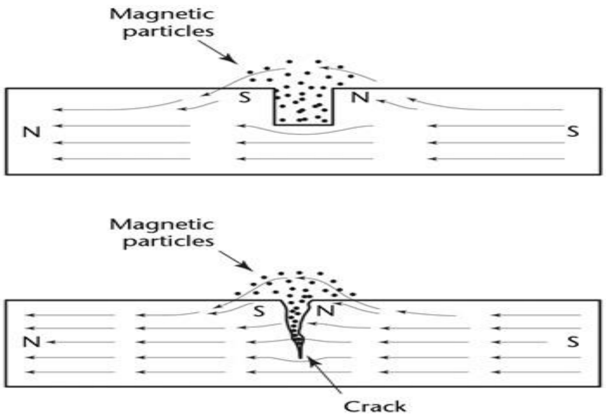


Figure: 1.2.6 Magnetic Particles

1.2.7 Eddy Current Testing:

Eddy currents are created through a process called electromagnetic induction. When alternating current is applied to the conductor, such as copper wire, a magnetic field develops in and around the conductor. This magnetic field expands as the alternating current rises to maximum and collapses as the current is reduced to zero. If another electrical conductor is brought into the close proximity to this changing magnetic field, current will be induced in this second conductor. These currents are influenced by the nature of the material such as voids, cracks, changes in grain size, as well as physical distance between coil and material. These currents form an impedance on a second coil which is used to as a sensor. In practice a probe is placed on the surface of the part to be inspected, and electronic equipment monitors the eddy current in the work piece through the same probe. The sensing circuit is a part of the sending coil.

Eddy currents can be used for crack detection, material thickness measurements, coating thickness measurements, conductivity measurements for material identification, heat damage detection, case depth determination, heat treatment monitoring.

Some of the advantages of eddy current inspection include; sensitivity to small cracks and other defects, ability to detect surface and near surface defects, immediate results, portable equipment, suitability for many different applications, minimum part preparation, no necessity to contact the part under inspection, ability to inspect complex shapes and sizes of conductive materials.

Some limitation of eddy current inspection; applicability just on conductive materials, necessity for an accessible surface to the probe, skillful and trained personal, possible interference of surface finish and roughness, necessity for reference standards for setup, limited depth of penetration, inability to detect of the flaws lying parallel to the probe coil winding and probe scan direction.

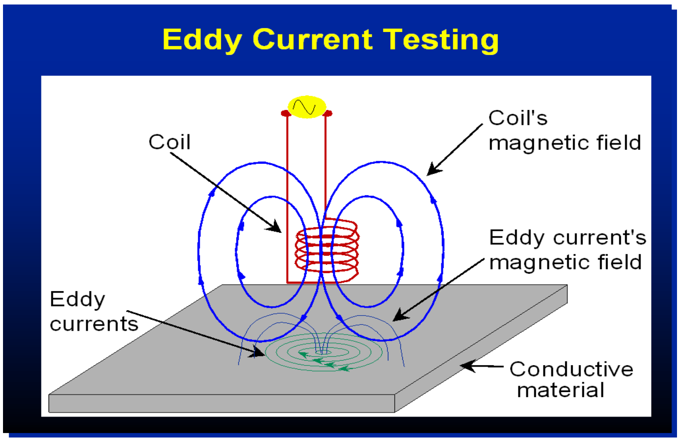


Figure: 1.2.7 Eddy Current Testing

1.2.8 Ultrasonic Inspection:

Ultrasonic Testing (UT) uses a high frequency sound energy to conduct examinations and make measurements. Ultrasonic inspection can be used for flaw detection I evaluation, dimensional measurements, material characterization, and more. A typical UT inspection system consists of several functional units, such as the pulser/receiver, transducer, and display devices. A pulser/receiver is an electronic device that can produce high voltage electrical pulse. Driven by the pulser, the transducer of various types and shapes generates high frequency ultrasonic energy operating based on the piezoelectricity technology with using quartz, lithium sulfate, or various ceramics. Most inspections are carried out in the frequency rang of 1 to 25MHz. Couplants are used to transmit the ultrasonic waves from the transducer to the test piece; typical couplants are water, oil, glycerin and grease.

The sound energy is introduced and propagates through the materials in the form of wavesand reflected from the opposing surface. An internal defect such as crack or void interrupts the waves' propagation and reflects back a portion of the ultrasonic wave. The amplitude of the energy and the time required for return indicate the presence and location of any flaws in the work-piece.

The ultrasonic inspection method has high penetrating power and sensitivity. It can be used from various directions to inspect flaws in large parts, such as rail road wheels pressure vessels and die blocks. This method requires experienced personnel to properly conduct the inspection and to correctly interpret the results.

As a very useful and versatile NDT method, ultrasonic inspection method has the following advantages; sensitivity to both surface and subsurface discontinuities, superior depth of penetration for flaw detection or measurement, ability to single-sided access for pulse-echo technique, high accuracy in determining reflector position and estimating size and shape, minimal part preparation, instantaneous results with electronic equipment, detailed imaging with automated systems, possibility for other uses such as thickness measurements.

Its limitations; necessity for an accessible surface to transmit ultrasound, extensive skill and training, requirement for a coupling medium to promote transfer of sound energy into test specimen, limits for roughness, shape irregularity, smallness, thickness or not homogeneity, difficulty to inspect of coarse grained materials due to low sound transmission and high signal noise, necessity for the linear defects to be oriented parallel to the sound beam, necessity for reference standards for both equipment calibration, and characterization of flaws.

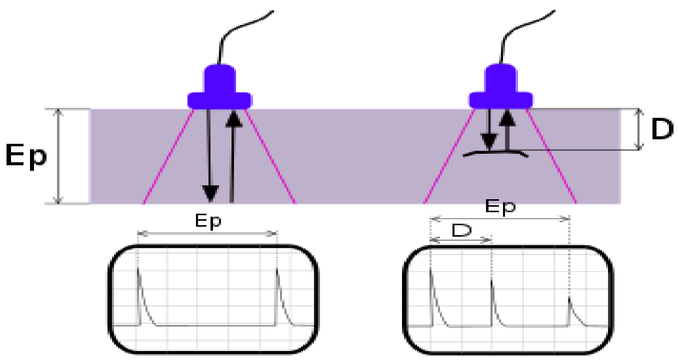


Figure: 1.3: Ultrasonic Inspection

1.2.9 Acoustic Method:

There are two different kind of acoustic methods: (a) acoustic emission; (b) acoustic impact technique.

1.2.10 Acoustic Emission:

This technique is typically performed by elastically stressing the part or structure, for example, bending a beam, applying torque to a shaft, or pressurizing a vessel and monitoring the acoustic responses emitted from the material. During the structural changes the material such as plastic deformation, crack initiation, and propagation, phase transformation, abrupt reorientation of grain boundaries, bubble formation during boiling in cavitation, friction and wear of sliding interfaces, are the source of acoustic signals. Acoustic emissions are detected with sensors consisting of piezoelectric ceramic elements. This method is particularly effective for continuous surveillance of load-bearing structures.

1.2.11 Acoustic Impact Technique

This technique consists of tapping the surface of an object and listening to and analyzing the signals to detect discontinuities and flaws. The principle is basically the same as when onetaps walls, desktops or countertops in various locations with a finger or a hammer and listens to the sound emitted. Vitrified grinding wheels are tested in a similar manner to detect cracks in the wheel that may not be visible to the naked eye. This technique is easy to perform and can be instrumented and automated. However, the results depend on the geometry and massof the part so a reference standard is necessary for identifying flaws.

1.2.12 Liquid Penetrant Method

In this method the surfaces to be inspected should be free from any coatings, paint, grease. dirt, dust, etc., therefore, should be cleaned with an appropriate way. Special care should be taken not to give additional damage to the surface to be inspected during the cleaning process. Otherwise, the original nature of surface could be disturbed and the results could be erroneous with the additional interferences of the surface features formed during the cleaning process.

Surface cleaning can be performed with alcohol. Special chemicals like cleaner-remover can also be applied if needed. In the experiment, only cleaner-remover will be sufficient. Subsequent to surface cleaning, the surface is let to dry for 2 minutes.

Commercially available cans of liquid penetrant dyes with different colors are used to reveal the surface defects.

Steps used in the experiment:

1. Clean the surface with alcohol and let surface dry for 5 min.
2. Apply the liquid penetrant spray (red can) to the surface and brush for furtherpenetration. Then, wait for 20 min.
3. Wipe the surface with a clean textile and subsequently apply remover spray(blue can) to remove excess residues on the surface and wait for a few min.
4. Apply the developer spray (yellow can) at a distance of about 30cm from the surface. The developer will absorb the penetrant that infiltrated to the surface features such as cracks,splits, etc., and then reacted with it to form a geometric shape which is the negative of the geometry of the surface features from which the penetrant is sucked.
5. The polymerized material may be collected on a sticky paper for futureevaluation and related documentation, if needed.

1.2.13 Magnetic Particle:

In this experiment, commercially available magnetic powder manufactured for NDT inspection will be used. A strong U shape magnet will be used to provide the necessary magnetic field at the inspected area.

The following steps are applied during the experiment:

1. The surface of the specimen will be roughly cleaned wiping with a piece of textile.
2. The fluorescent magnetic spray will be applied on the surface being inspected.
3. Magnetic field will be applied with a strong magnet to the location of interest.
4. The spots where the fluorescent magnetic particles accumulated will beinspected under UV light.

1.2.14 Ultrasonic Inspection:

For this experiment,USM-2 type ultrasonic unit will be used. The props used supports to workat frequency of 5 MHz. Echo techniques will be employed to find the cracks. Instrument will be tuned to a frequency of 5 MHz. An appropriate couplant used should not cause corrosion or other damage. During the inspection the calibration will be done on the reference standard, if needed. Two different test blocks will be employed in this test, sufficient amount of couplant will be applied to the transducer scan areas on the forward and after sides of the support fitting. The display will be monitored for crack indications. A crack signal will be similar to the following:

The following steps should be applied during the experiment:

1. The couplant should be applied on the inspected area.
2. For the circular test specimen, the prop will be placed in the corresponding space in the supporting fitting tool. Enough couplant should be used between the probe and tool.
3. For the flat specimen, no tool is needed, couplant only applied between the inspected surface and the probe.
4. Special attention should be paid on the location where possible cracks exist.
5. A discontinuity like a crack produces a peak on the screen.
6. Attention should also be given to the movement of the possible peak caused by the cracks on the specimen.

1.3 Literature Review:

Prof. Mukesh Tiwari, Mr. Manish Shrivastava (2013) [2]was published to develop this project is from an machine overheat detection with alert blog known as "heat detector". The article talks about the need of such a project to be and how it would ease the existing industries area that is in place today. In the traditional system, several people are required to monitor a machine lot so as to assess the number of free slots and match it with the capacity of a working machine. If this system is replaced with an automated indicator the number of People employed would reduce. The article talks about this scenario. The need for each component is also elucidated. The heat detector is the heart of this project. The board is controlled using a program that is written on it. The program assessed the number of switches presses where each switch corresponds to a slot and subtracts it from the capacity or the total number of slots present. The literature also describes the common anode display used to display the number of free slots calculated using the program.

LED is used to display the number of free slots that are empty. The article also talks about the use of a detection system . Kushagra Kumar Choubey, Mousam Sharma (2015) [3] was published that described a design of temperature controller that drives the relays for switching the system ON/OFF for controlling the temperature. In 1959, Some improvements were proposed to a simple temperature controller using a Pt resistance thermometer as one arm of an ac resistance bridge that was published by Wilson and has been operating in many laboratories. Here a transistor preamplifier is used to activate a relay that turns ON/OFF the system. In March 2010 in an IEEE publication, another intelligent temperature control system based on Microcontroller AT89S51 was proposed where the temperature measurement device used consists of the 1- Wire bus digital temperature sensor DS18B20 and the temperature monitoring over a certain range could be achieved. Here in this paper a I2C based Digital Temperature sensor IC is used to measure the temperature that measures with a much higher resolution and accuracy. For the control of temperature with better precision a PWM signal is used to drive a MOSFET that in turn controls the current that drives the heating element.

Prof.P. V. Gawande. (2013) [4] explains the reliability data of fire detection and alarm systems was made resulting to rough estimates of some failure frequencies. No theoretical or technical articles on the structure of reliability models of these installations were found. Inspection records of fire detection and alarm system installations by SPEK were studied, and transferred in electronic data base classifying observed failures in failure modes (59) and severity categories guided by freely written records in the original data. The results of that work are presented without many comments in tabular form in this paper. A small sample of installations was collected, and number of components in them was counted to derive some distributions for determination of national populations of various components based on know total amount of installations. From NPPs (Loviisa, Olkiluoto and Barseb‰ck) failure reports were analysed, and observed failures of fire detection and alarm systems were classified by severity and detection mode. They are presented here in tabular form for the original and new addressable systems. Populations were counted individually, but for all installations needed documents were not available. Therefore, presented failure frequencies are just first estimates, which will be refined later.

Syed Sayeed Ahmed, et.al (2016) [5] was a period of tremendous growth in the popularity of smoke detectors. A growth in research and the general knowledge base regarding the operation of smoke detectors accompanied this. Most of the practical means of estimating the response of smoke detectors were derived from this era and have remained largely unchanged. By itself, this fact is not significant. However, there have been significant advances in detector technology since that time, including more uniform smoke entry characteristics among detector technologies, reduced sensitivity to nuisance (i.e., non-fire) sources, algorithm-based detection and multi-sensor, multi-criteria detection.

Research into the current trend toward the development of fire detection algorithms and multi-sensor, multi-criteria fire detectors is prevalent in the literature in the last decade [e.g. 1996; Milke and McAvoy, 1997; Rose-Pehrsson, et al., 2000; Wong, et al., 2000].

However, advancement in the research behind predicting the response of common spot-type ionization and photoelectric detectors has been minimal. More fundamental approaches exist to model the detectors, though these methods have not been advanced sufficiently to prove practically useful for modelling smoke detectors.

1.4 Scope of Work

Several scopes and guidelines are listed to ensure the project is conducted within its intended boundary. The first scope of this project is to understand theoretical aspect of temperature sensor including working principles, characteristic of the sensor, and quality. From the analyses, a humidity & temperature sensor is chosen to make the system work properly Meanwhile, the second scope of this project is the development of an humidity & temperature based control system. Base on the investigation that previously done, some application of a certain part.

1.5 Motivation

In traditional system, when the machine working in the industry due to over voltage and some mishap, machine become overheat it cause to damage in industry therefore we need a device that can control this type of happenstance, there we will use the heat detector that reduce the human effort, if some error and any type of any disturbance come in the circuit like over voltage therefore we use heat detector device that give the signal if any paranormal disturbance occurs in the circuit.

1.6 Objective

The main objective of the project is to design a programmable sequential switching of any load using embedded system based micro controller concept. It uses micro controller from the 8051 family, which is of 8-bit. The development of this application requires the configuration of micro controller architecture - that is, the selection of the machines, and writing debugging of the application program. In this project, the clock plays an important role, wherein it is used in these modes: the set mode, auto mode and manual mode for controlling different machines.

1.7 Heat Detector Circuit

Let us consider thermistor having 110 Ohms, and after heating its resistance value becomes 90 Ohms. Then, as per potential divider circuit which is pervasive concept namely voltage divider: the voltage across one resistor and the ratio of that resistor's value and the sum of resistances times the voltage across the series combination are equal. The input/output relationship for this heat detector circuit system, takes the form of a ratio of the output voltage to the input voltage which is given by the voltage divider concept in this particular concept. Finally, the output voltage is applied to NPN transistor shown in the circuit through a resistor. A Zennor diode is used to maintain emitter voltage at 4.7 volts, which can be used comparatively. If the base voltage is greater than the emitter voltage, then the transistor starts conduction. This is because as the transistor gets more than 4.7V base Voltage and a buzzer are connected to complete the heat detector circuit which is used for producing sound.

CHAPTER 2

Literature Review

2.1 Introduction

In this application the thermistor is used to protect a circuit by limiting the amount of current that can flow into it. If too much current starts to flow into a circuit through the thermistor this causes the thermistor to warm up. This in turn increases the resistance of the thermistor reducing the current that can flow into the circuit.

2.2 What is Thermistor and How it Works?

A thermistor is an inexpensive and easily obtainable temperature sensitive resistor, thermistor working principle is, it's resistance is depends upon temperature. When temperature changes, the resistance of the thermistor changes in a predictable way. The benefits of using a thermistor is accuracy and stability.

2.3 Requirements

The Model Guidance document defines minimum standards for temperature and humidity monitoring and alarm systems and components, and for the operational management of these systems.

2.4. Temperature monitoring systems

Air temperature monitoring systems and devices should be installed in all temperature controlled Rooms used to store TTSPPs. Sensors should be located in areas where the greatest variability in temperature is expected to occur within the qualified storage volume and they should be positioned so as to be minimally affected by transient events such as door opening.

2.5 Alarm systems

Temperature, and where necessary, humidity alarm systems should be linked to the monitoring system. When temperature & humidity going to changed sensor will give a signal to alarm.

2.6 Temperature

Thermistor 10k analog temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology ,to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and an NTC temperature measurement devices ,and connected with a high-performance 8-bit microcontroller.

2.7 How A Thermistor Works

Introduction:

A thermistor is a component that has a resistance that changes with temperature. There are two types of thermistor, those with a resistance that increase with temperature (Positive Temperature Coefficient – PTC) and those with a resistance that falls with temperature (Negative Temperature Coefficient – NTC).

2.7.1 Temperature co-efficient:

The most common type of thermistors are those in which resistance decreases as the temperature increases (NTC).

The amount by which the resistance decreases as the temperature increases is not constant, it varies in a non-linear way. A formula can be used to calculate the resistance of the thermistor at any given temperature. Normally these are calculated for you and the information can be found in the devices datasheet.

Thermistor Applications:

There are many applications for a thermistor, three of the most popular are listed below.

Temperature sensing:

The most obvious application for a thermistor is to measure temperature, they are used to do this in a wide range of products such as thermostats.

In rush current limiting:

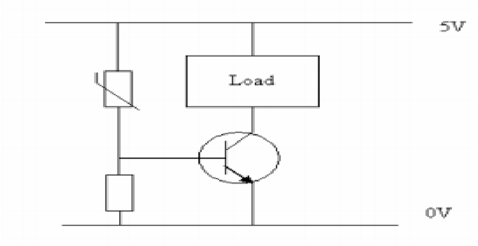
In this application the thermistor is used to initially oppose the flow of current (by having a high resistance) into a circuit. Then as the thermistor warms up (due to the flow of electricity through the device) its resistance drops letting current flow more easily.

Circuit protection:

In this application the thermistor is used to protect a circuit by limiting the amount of current that can flow into it. If too much current starts to flow into a circuit through the thermistor this causes the thermistor to warm up. This in turn increases the resistance of the thermistor reducing the current that can flow into the circuit.

Example:

The circuit shown below shows a simple way of constructing a circuit that turns on when it goes hot. The decrease in resistance of the thermistor in relation to the other resistor which is fixed as the temperature rises will cause the transistor to turn on. The value of the fixed resistor will depend on the thermistor used, the transistor used and the supply voltage.



2.7.2. Applications

HVAC, dehumidifier, testing and inspection equipment, consumer goods, automotive, automatic control, data loggers, weather stations, home appliances, humidity regulator, medical and other humidity measurement and control.

2.7.3. Features

Low cost, long-term stability, relative humidity and temperature measurement, excellent quality, fast response, strong anti-interference ability, long distance signal transmission, digital signal output, and precise calibration.

2.8 Microcontroller

A microcontroller is an integrated chip that is often part of an embedded system. The microcontroller includes a CPU, RAM, ROM, I/O ports, and timers like a standard computer, but because they are designed to execute only a single specific task to control a single system, they are much smaller and simplified so that they can include all the functions required on a single chip.

A microcontroller differs from a microprocessor, which is a general-purpose chip that is used to create a multi-function computer or device and requires multiple chips to handle various tasks. A microcontroller is meant to be more self-contained and independent, and functions as a tiny, dedicated computer.

The great advantage of microcontrollers, as opposed to using larger microprocessors, is that the parts-count and design costs of the item being controlled can be kept to a minimum. They are typically designed using CMOS (complementary metal oxide semiconductor) technology, an efficient fabrication technique that uses less power and is more immune to power spikes than other techniques.

There are also multiple architectures used, but the predominant architecture is CISC (Complex Instruction Set Computer), which allows the microcontroller to contain multiple control instructions that can be executed with a single macro instruction. Some use a RISC (Reduced Instruction Set Computer) architecture, which implements fewer instructions, but delivers greater simplicity and lower power consumption.

Early controllers were typically built from logic components and were usually quite large. Later, microprocessors were used, and controllers were able to fit onto a circuit board. Microcontrollers now place all of the needed components onto a single chip. Because they control a single function, some complex devices contain multiple microprocessors.

Microcontrollers have become common in many areas, and can be found in home appliances, computer equipment, and instrumentation. They are often used in automobiles, and have many industrial uses as well, and have become a central part of industrial robotics. Because they are usually used to control a single process and execute simple instructions, microcontrollers do not require significant processing power.

Embedded design

A microcontroller can be considered a self-contained system with a processor, memory and peripherals and can be used as an embedded system. The majority of microcontrollers in use today are embedded in other machinery, such as automobiles, telephones, appliances, and peripherals for computer systems. These are called embedded systems. While some embedded systems are very sophisticated, many have minimal requirements for memory and program length, with no operating system, and low software complexity. Typical input and output devices include switches, relays, solenoids, LEDs, small or custom LCD displays, radio frequency devices, and sensors for data such as temperature, humidity, light level etc. Embedded systems usually have no keyboard, screen, disks, printers, or other recognizable I/O devices of a personal computer, and may lack human interaction devices of any kind.

Interrupts

Microcontrollers must provide real time (predictable, though not necessarily fast) response to events in the embedded system they are controlling. When certain events occur, an interrupt system can signal the processor to suspend processing the current instruction sequence and to begin an interrupt service routine (ISR, or "interrupt handler"). The ISR will perform any processing required based on the source of the interrupt before returning to the original instruction sequence. Possible interrupt sources are device dependent, and often include events such as an internal timer overflow, completing an analog to digital conversion, a logic level change on an input such as from a button being pressed, and data received on a communication link. Since power consumption is important as in battery operated devices, interrupts May also 20 wake a microcontroller from a low power sleep state where the processor is halted until required to do something by a peripheral event.

2.8.1 Programs

Microcontroller programs must fit in the available on-chip program memory, since it would be costly to provide a system with external, expandable, memory. Compilers and assemblers are used to turn high-level language and assembler language codes into a compact machine code for storage in the microcontroller's memory. Depending on the device, the program memory may be permanent, read-only memory that can only be programmed at the factory, or program memory may be field-alterable flash or erasable read-only memory.

2.9 Liquid Crystal Display (LCD)

A liquid crystal display (LCD) is an electro-optical amplitude modulator realized as a thin, flat display device made up of any number of colour or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

LCDs have become very popular over recent years for information display in many „smart" appliances. They are usually controlled by micro controllers. They make complicated equipment easier to operate.

LCDs come in many shapes and sizes but the most common is the 16character x 2 lines display. It requires only 11 connections –eight bits for data (which can be reduced to four if necessary) and three control lines. It runs with a supply voltage of 5v DC and only needs 1mA of current .the display contrast can be varied by changing the voltage into pin of the display, usually with a trim pot.

In recent years the LCD is finding widespread use replacing LEDs. This is due to following reasons:

1.The declining prices of LCDs

2.The ability to display numbers, characters, and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.

CHAPTER 3

Methodology

3.1 Introduction

This chapter gives an explanation on the method and step used in designing the humidity and temperature control system. It includes the description of the design flow, design architecture and detail explanations for the software development as well as hardware development.

3.1.1 Microcontroller chip

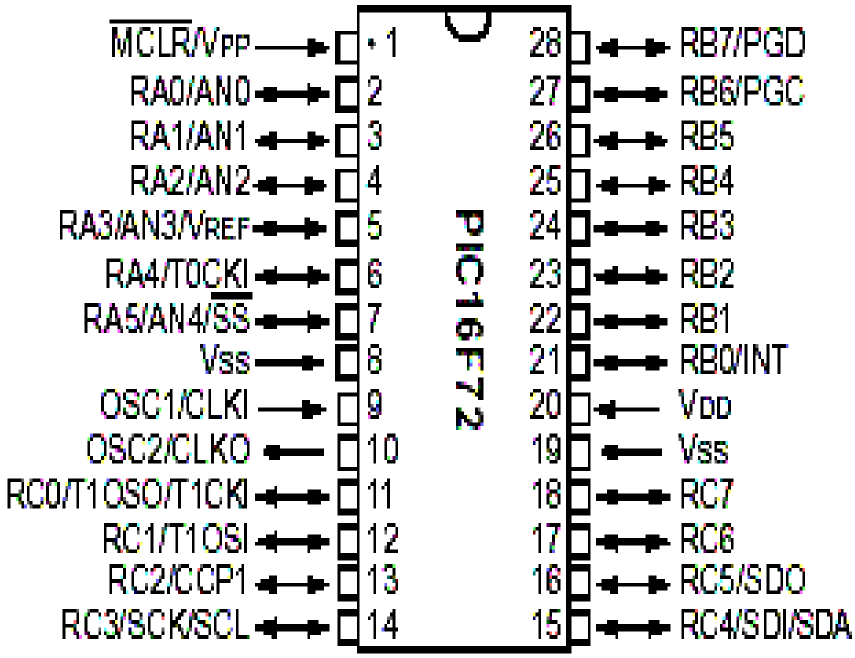


Figure 3.1 : Pic16F72

PIC microcontrollers are a family of specialized microcontroller chips produced by Microchip Technology in Chandler, Arizona. The acronym PIC stands for "peripheral interface controller," although that term is rarely used nowadays. A microcontroller is a compact microcomputer designed to govern the operation of embedded systems in motor vehicles, robots, office machines, medical devices, mobile radios, vending machines, home appliances, and various other devices. A typical microcontroller includes a processor, memory, and peripherals.

The PIC microcontrollers appeal to hobbyists and experimenters, especially in the fields of electronics and robotics. Key features include wide availability, low cost, ease of reprogramming with built-in EEPROM (electrically erasable programmable read-only memory), an extensive collection of free application notes, abundant development tools, and a great deal of information available on the Internet. The PIC microcontrollers often appear under the brand name PIC micro.

Every PIC microcontroller has a set of registers that also function as RAM (random access memory). Special purpose control registers for on-chip hardware resources are also mapped into the data space. Every PIC has a stack that 12 saves return addresses. The stack was not software-accessible on the earlier versions of the PIC, but this limitation was removed in later devices. To make wearable obstacle detection system for visually impaired people respond faster, it should be equipped with advanced microcontroller to decrease computational complexity. PIC 16F877A was chosen to detect any switch triggered and generate the audio sounds and vibrations.

The PIC does not have an operating system and simply runs the program in its memory when it is turned on. PIC microcontroller is a small computer on a single integrated circuit which stores a set of instructions. It consists of a processor core, memory, and programmable input/output peripherals. PIC is an important component in the proposed system which deals with a Micro C programming code which was installed in it.

The system is featured by its small size and low cost when it is compared with other systems that use separate microprocessor, input/output devices, and memory. Mixed signal microcontrollers are common, integrating analog components needed to control non digital electronic systems.

PIC microcontroller operates at +5 V which can be regulated using the voltage regulator (L7805) which conserves voltage at +5 V if the input voltage for it exceeds +5 V.

Also PIC cannot run without using its crystal oscillator which is used to execute the programming code. The PIC is used as a real-time processing element; therefore, a high frequency oscillator is used.

3.1.2 Overview

The PIC16F72 belongs to the Mid-Range family of the PIC devices. A block diagram of the device is shown in Figure 1-1. The program memory contains 2K words, which translate to 2048 instructions, since each 14-bit program memory word is the same width as each device instruction. The data memory (RAM) contains 128 bytes. There are 22 I/O pins that are user configurable on a pin-to-pin basis. Some pins are multiplexed with other device functions. These functions include:

- External interrupt
- Change on PORTB interrupts
- Timer0 clock input
- Timer1 clock/oscillator
- Capture/Compare/PWM
- A/D converter
- SPI/I2C Table 1-1 details the pin out of the device with descriptions and details for each pin.

3.2 PIC16F72 Block Diagram

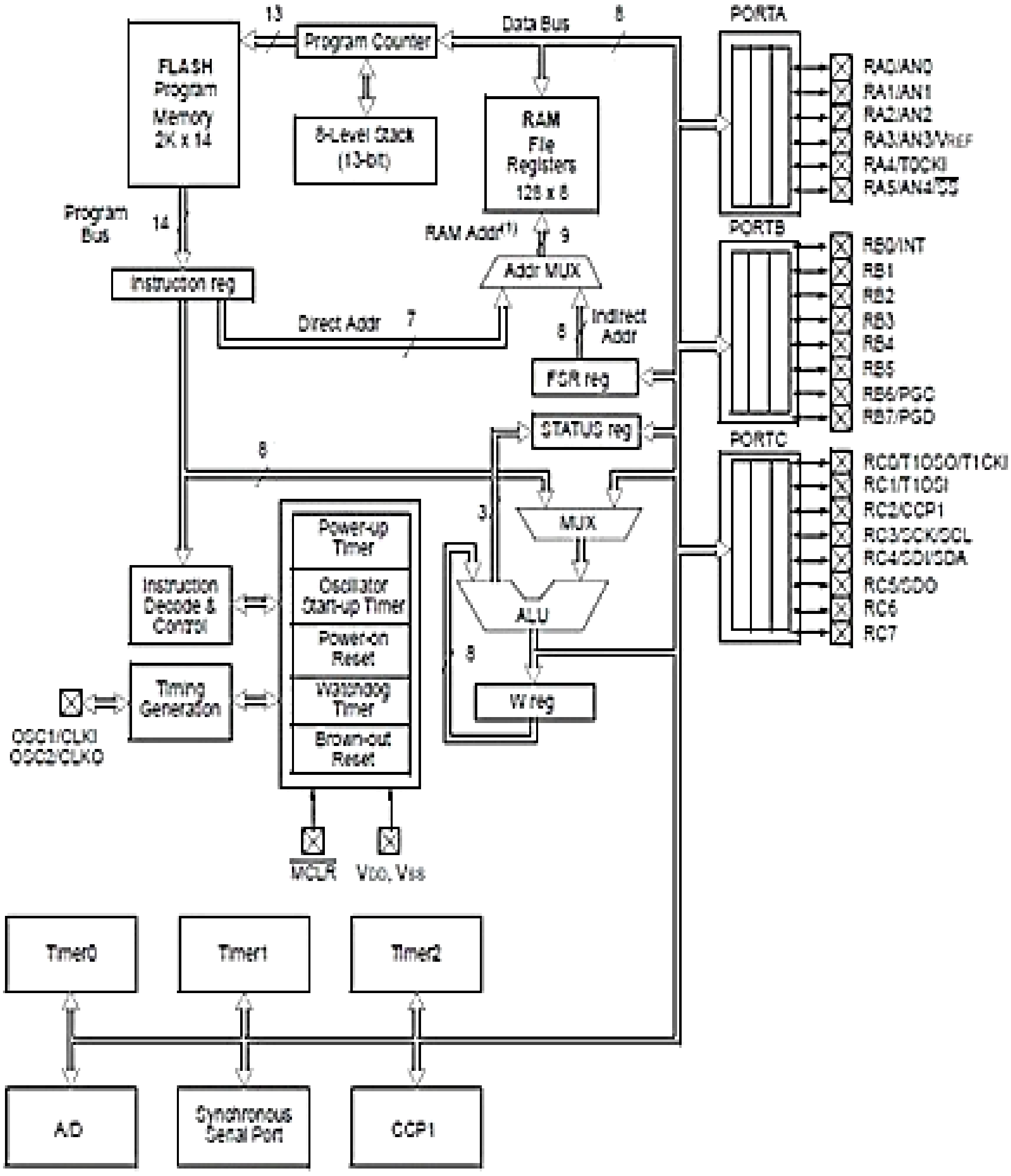


Figure3.2 Pin Descriptions

Pin Name	PDIP, SOIC, SSOP Pin#	MLF Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKI	9	6	I	ST/CMOS(3)	Oscillator crystal input/external clock source input.
OSC2/CLKO	10	7	O	—	Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode. In RC mode, the OSC2 pin outputs CLKO, which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
$\overline{MCLR}$/VPP	1	26	I/P	ST	Master Clear (Reset) input or programming voltage input. This pin is an active low RESET to the device.
					PORTA is a bi-directional I/O port.
RA0/AN0	2	27	I/O	TTL	RA0 can also be analog input0.
RA1/AN1	3	28	I/O	TTL	RA1 can also be analog input1.
RA2/AN2	4	1	I/O	TTL	RA2 can also be analog input2.
RA3/AN3/VREF	5	2	I/O	TTL	RA3 can also be analog input3 or analog reference voltage.
RA4/T0CKI	6	3	I/O	ST	RA4 can also be the clock input to the Timer0 module. Output is open drain type.
RA5/AN4/$\overline{SS}$	7	4	I/O	TTL	RA5 can also be analog input4 or the slave select for the synchronous serial port.
					PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	21	18	I/O	TTL/ST(1)	RB0 can also be the external interrupt pin.
RB1	22	19	I/O	TTL	
RB2	23	20	I/O	TTL	
RB3	24	21	I/O	TTL	
RB4	25	22	I/O	TTL	Interrupt-on-change pin.
RB5	26	23	I/O	TTL	Interrupt-on-change pin.
RB6/PGC	27	24	I/O	TTL/ST(2)	Interrupt-on-change pin. Serial programming clock.
RB7/PGD	28	25	I/O	TTL/ST(2)	Interrupt-on-change pin. Serial programming data.
					PORTC is a bi-directional I/O port.
RC0/T1OSO/ T1CKI	11	8	I/O	ST	RC0 can also be the Timer1 oscillator output or Timer1 clock input.
RC1/T1OSI	12	9	I/O	ST	RC1 can also be the Timer1 oscillator input.
RC2/CCP1	13	10	I/O	ST	RC2 can also be the Capture1 input/Compare1 output/ PWM1 output.
RC3/SCK/SCL	14	11	I/O	ST	RC3 can also be the synchronous serial clock input/output for both SPI and I^2C modes.
RC4/SDI/SDA	15	12	I/O	ST	RC4 can also be the SPI Data In (SPI mode) or Data I/O (I^2C mode).
RC5/SDO	16	13	I/O	ST	RC5 can also be the SPI Data Out (SPI mode).
RC6	17	14	I/O	ST	
RC7	18	15	I/O	ST	
Vss	8, 19	5, 16	P	—	Ground reference for logic and I/O pins.
VDD	20	17	P	—	Positive supply for logic and I/O pins.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

3.3 Memory Organization

There are two memory blocks in the PIC16F72 device. These are the program memory and the data memory. Each block has separate buses so that concurrent access can occur. Program memory and data memory are explained in this section. Program memory can be read internally by the user code (see Section 7.0). The data memory can further be broken down into the general purpose RAM and the Special Function Registers (SFRs). The operation of the SFRs that control the "core" are described here. The SFRs used to control the peripheral modules are described in the section discussing each individual peripheral module.

3.3.1 Program Memory Organization

PIC16F72 devices have a 13-bit program counter capable of addressing a 8K x 14 program memory space. The address range for this program memory is 0000h - 07FFh. Accessing a location above the physically implemented address will cause a wraparound. The RESET Vector is at 0000h and the Interrupt Vector is at 0004h.

3.4 Liquid Crystal Display (LCD)

A liquid crystal display (LCD) is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs). LCs does not emit light directly. LCDs therefore need a light source and are classified as "passive" displays. Some types can use ambient light such as sunlight or room lighting. There are many types of LCDs that are designed for both special and general uses.

They can be optimized for static text, detailed still images, or dynamic, fast-changing, video content. They are used in a wide range of applications including: computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have displaced cathode ray tube (CRT) displays in most applications. They are usually more compact, lightweight, portable, and lower cost.

They are available in a wider range of screen sizes than CRT and other flat panel displays. There are two types of data bus a user can choose which are 8 bit and 4 bit data bus. For an 8-bit data bus, the display requires a +5V supply plus 11 I/O lines. For a 4-bit data bus it only requires the supply lines plus seven extra lines. The LCD also requires 3 control lines from the microcontroller. In this system, 8 bit data bus is used as this mode is much simpler to set up than 4 bit data bus.

3.4.1 LCD Control Pins

LCDs are more energy efficient, and offer safer disposal, than CRTs. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically-modulated optical device made up of any number of pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome.

Enable (E)	This line allows access to the display through R/W and RS lines. When this line is low, the LCD is disabled and ignores signals from R/W and RS. When (E) line is high, the LCD checks the state of the two control lines and responds accordingly.
Read/Write (R/W)	This line determines the direction of data between the LCD and microcontroller. When it is low, data is written to the LCD. When it is high, data is read from the LCD
Register select (RS)	With the help of this line, the LCD interprets the type of data on data lines. When it is low, an instruction is being written to the LCD. When it is high, a character is being written to the LCD.

3.5 L7805CV Linear Voltage Regulator

L7805CV is a three terminal linear voltage regulator IC with a fixed output voltage of 5V which is useful in a wide range of applications. They are available in several IC Packages like TO-220, SOT-223, TO-263 and TO-3. Out of these, the TO-220 Package is the most commonly used one.

3.5.1 L7805CV Operation

L78 Series of fixed output voltage regulators are useful in a wide range of applications within the electronics Industry. The three terminal positive linear voltage regulators can remove problems that are related with single point regulation by providing local on-card regulation.

The ST Regulator IC can deliver up to 1.5A at the fixed output voltage, which can range from 5 V to 24 V. The voltage regulator offers safe area protection with the addition of internal thermal shutdown and current limiting.

3.6 Transformer

Every electrical and electronic device that we use in our day-to-day life will require a power supply. In general, we use an AC supply of 220V 50Hz, but this power has to be changed into the required form with required values or voltage range for providing power supply to different types of devices.

There are various types of power electronic converters such as step-down converter, step-up converter, voltage stabilizer, AC to DC converter, DC to DC converter, DC to AC converter, and so on. For example, consider the microcontrollers that are used frequently for developing many embedded system based project and kits used in real-time applications.

These microcontrollers require a 5V DC supply, so the AC 220V needs to be converted into 5V DC using the step-down converter in their power supply circuit.

3.7 Voltage regulator:

A voltage regulator generates a fixed output voltage of changes to its input voltage or load conditions. The voltage regulator must be stable with its condition. Here we use IC 7805 voltage Regulator. IC 7805 is a 5V Voltage Regulator that restricts the voltage output to 5V and draws 5V regulated power supply. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value.

IC 7805 is a 5V Voltage Regulator that restricts the voltage output to 5V and draws 5V regulated power supply. It comes with provision to add heat sink. The maximum value for input to the voltage regulator is 35V. It can provide a fixed steady voltage flow of 5V for higher voltage input till the threshold limit of 35V. If the voltage is near to 7.5V then it does not produce any heat and hence no need for heat sink. If the voltage input is more, then excess electricity is liberated as heat from 7805.It regulates a steady output of 5V if the input voltage is in rage of 7.2V to 35V. Hence to avoid power loss try to maintain the input to 7.2V. In some circuitry voltage fluctuation is fatal (for e.g. Microcontroller), for such situation to ensure constant voltage IC 7805 Voltage Regulator is used. IC 7805 is a series of 78XX voltage regulators. The name the last two digits 05 denotes the amount of voltage that it regulates. Hence a 7805 would regulate 5v and 7806 would regulate 6V and so on. The schematic given below shows how to use a 7805 IC, there are 3 pins in IC 7805, pin 1 takes the input voltage, GND of both input and out are given to pin 2, pin 3 produces the output voltage.

3.7.1 Pin Description:

Pin no.	Function	Name
1	Input voltage (5V-18V)	Input
2	Ground (0V)	Ground
3	Regulated output; 5V (4.8V-5.2V)	Output

3.8 Resistor (1Kohm)

1k ohm Resistors are used for regulating current and they resist the current flow and 1k ohm the extent to which they do this is measured in ohms (Ω).

3.9 Resistor (560kohm)

560k ohm resistor work at display backlight**,** always control the backlight.

3.10 Resistor (3K3 ohm)

3k3 ohm resistor work the contrast control, 3k3 ohm are control the contrast.

3.11 Diode 1N4007

DIODE 1N4007- Convert to ac to dc and control of the ac to dc system.

3.12 7Amps 250V AC or 10Amps 28V DC Relay

This is a Single pole double throw (SPDT) type relay with 5 pins in a cube type package and rated to work at 12VDC.

Load Current Max.: 7Amps 250V AC or 10Amps 28V DC.

Coil Resistance: 360-440 Ohms.

3.13 1000 uF/25V Electrolytic Decoupling Capacitor:

Capacitor is an essential component of our project. We can use the capacitor in different many applications. Using capacitor in a microcontroller its must because of the microcontroller is a digital device with fast switching edges which uses a large amount of current for a very short period of time at each transition. The capacitors supply the large amount of current needed so that the power supply doesn't sag during that time creating noise. The main function of a capacitor is storing electric charge. A charged capacitor could be used as a voltage source. It is always best to use a variety of capacitors on the power supply pins of the microcontroller to provide a low impedance wideband supply. In our work we used Electrolytic decoupling capacitors 1000uF/25V. These capacitors are great transient/surge suppressors and work well in high-voltage and audio applications. High quality radial electrolytic capacitors. Capacitors are used for several purposes like timing, smoothing power supply, coupling, filtering, tuning for radio system, storing energy etc.

3.14 What is a maintenance system?

A maintenance system can be viewed as a simple input/output system. The inputs to the system are manpower, failed equipment, material and spare parts, tools, information, police’s and procedures, and spares. The output is equipment that is up, reliable and well configured to achieve the planned operation of the plant.

3.15 The Three Types of Maintenance

1. Preventive maintenance
2. Reactive maintenance
3. Proactive maintenance

3.16 What is preventive maintenance?

Preventive maintenance refers to maintenance work done at regular time frames to fix signs of wear before they lead to breakdowns. (You will also see it called “preventative maintenance” or just “PM.”)

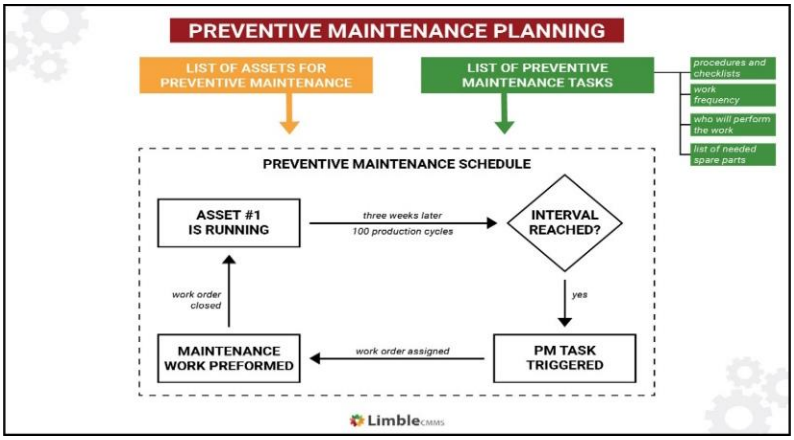


Figure:3.16 Preventive maintenance planing

Innovative organizations choose this approach because it:

- **Saves time and money** with fewer equipment breakdowns and replacements.
- **Reduces delays, safety risks**, and the damage to your company’s good name that comes with breakdowns.
- **Improves employee satisfaction**.
- Is great for any size organization and can be adjusted to your needs.

Over the years, preventative maintenance has proven to be an effective remedy that can be applied in virtually any industry. While it sees more use in asset-heavy fields like manufacturing, aviation, and construction, it is regularly applied in both industrial maintenance and facility management.

Examples of preventive maintenance

Industrial situations depend heavily on regularly scheduled maintenance to remain fully productive and free from costly, time-wasting mechanical breakdowns.

The term "preventive maintenance" covers a wide range of proscribed activities and general tasks. Each production component within a system will require some level of regular servicing, and that equipment typically will need to at least be cleaned and lubricated. In other situations, more extensive servicing may be required — involving the heavy reconditioning, repair or even replacement of certain parts.

At a higher level, preventive maintenance also involves providing upkeep for the physical plant that houses the various production systems. General tasks associated with this type of preventive maintenance include ensuring the HVAC system is in good working condition, all electrical systems are functioning and compliant with code standards, and all necessary lighting is operating correctly.

3.16.1 Types of preventive maintenance

There are 4 major types of preventive maintenance. Each is built around the concept of planned maintenance, although they are all organized and scheduled differently, to suit different business operation purposes.

Usage-based preventive maintenance

Usage-based preventive maintenance is triggered by the actual utilization of an asset. This type of maintenance takes into account the average daily usage or exposure to environmental conditions of an asset and uses it to forecast a3.16.1 due date for a future inspection or maintenance task.

Calendar/time-based preventive maintenance

Calendar/time-based preventive maintenance occurs at a scheduled time, based on a calendar interval. The maintenance action is triggered when the due date approaches and necessary work orders have been created.

Predictive maintenance

Predictive maintenance is designed to schedule corrective maintenance actions before a failure occurs. The team needs to first determine the condition of the equipment in order to estimate when maintenance should be performed. Then maintenance tasks are scheduled to prevent unexpected equipment failures.

Prescriptive maintenance

Prescriptive maintenance doesn't just show that failure is going to happen and when, but also why it's happening. This type of maintenance helps analyze and determine different options and potential outcomes, in order to mitigate any risk to the operation.

Advantages of preventive maintenance

There are two main advantages of using preventive maintenance as your main maintenance strategy: Being able to plan maintenance tasks and not requiring condition-based monitoring.

A preventive maintenance program allows you to plan maintenance tasks that reduce your costs and increase your productivity in the long term. Facility managers are able to prevent incipient failures (equipment imperfections that can cause degradation or catastrophic failure if corrective action is not taken).

Unplanned and reactive maintenance has many overhead costs that can be avoided during the planning process. The cost of unplanned maintenance includes lost production, higher costs for parts and shipping, and time lost responding to emergencies and diagnosing faults while equipment is not working. Unplanned maintenance typically costs three to nine times more than planned maintenance.

When you have a maintenance plan, it's easy to reduce the maintenance cost of your program. Equipment can be shut down to coincide with production downtime. Before the shutdown, any required spare parts, supplies, and personnel can be gathered to minimize the time taken for a repair. These proactive maintenance measures decrease the total cost of maintenance activities. Safety is also improved because equipment breaks down less often than in less complex strategies.

Additionally, a preventive maintenance program does not require condition-based monitoring. This eliminates the need (and cost) to conduct and interpret condition monitoring data and act on the results of that interpretation. It also eliminates the need to own and use condition monitoring equipment.

Disadvantages of preventive maintenance

The disadvantages of preventive maintenance are that, unlike reactive maintenance, preventive maintenance requires maintenance planning, and you run the risk of conducting preventive maintenance too frequently.

Preventive maintenance planning requires an investment in time and resources that aren't required with less complex maintenance strategies. Maintenance may occur too often with a preventive maintenance program. Unless, and until the maintenance frequencies are optimized for minimum maintenance, too much or too little preventive maintenance will occur.

Additionally, the frequency of preventive maintenance might be too high. Fortunately, the frequency can be lowered without sacrificing reliability when condition monitoring and data analysis are used. The decrease in maintenance frequency is offset by the additional costs associated with conducting condition monitoring.

Why Choosing Preventive Maintenance is so Important?

We believe that operations should center around planned/preventive maintenance. That's why we go the extra mile to team with companies, just like yours, to service their equipment. Consider the following benefits of preventive maintenance:

Eliminates downtime

Improves employee morale

Increases the longevity of equipment

Increases your credibility

Protects your reputation

Saves money

We're proud be part of a business' success story. We have helped many companies thrive after implementing our preventive maintenance approach. If you're interested in partnering with us, contact our team. We look forward to hearing from you!

3.17 What is reactive maintenance?

Reactive maintenance (also known as breakdown maintenance) refers to repairs that are done when equipment has already broken down, in order to restore the equipment to its normal operating condition.

While reactive maintenance can have a place in a well-rounded maintenance strategy, it shouldn't be your go-to for all repairs.

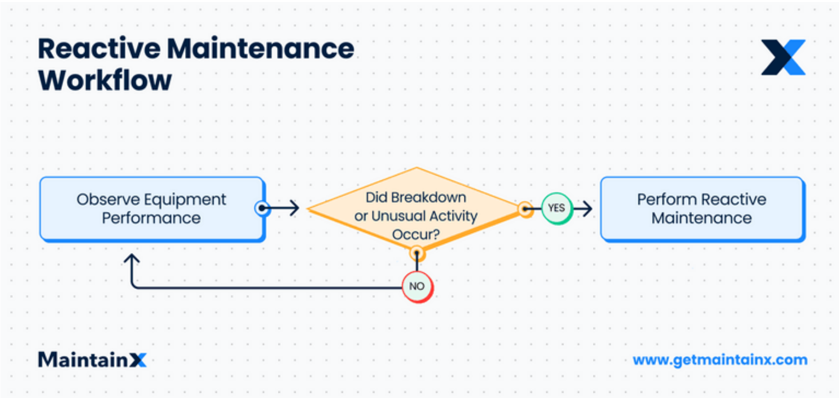


Figure:3.17 Reactive maintenance workflow

Examples of Reactive Maintenance

Let look at a few examples of what this looks like in common situations.

1. Car Maintenance

How many times have you seen a car not starting because the battery died and the owner had to jumpstart it and later replace it? Here the driver performed a reactive maintenance task. Another example would be when you take your car for an oil change. The technician may realize that other parts, the headlights, for example, also need servicing. You can decide to have the repairs done at that particular moment or schedule them for another day. However, should your headlines stop working on a dark road at night, you would need to perform emergency maintenance.

2. Road Repair

Roads are installed to last for a long time. However, wear and tear is a common occurrence, especially for roads that experience high traffic. One of the most common problems on our roads is potholes. Fixing potholes on a road can only be done after they occur.

Other examples include fixing broken doors, replacing leaking water pipes, and buying a new HVAC after the current one breaks down. We could go on and on!

Interesting Statistics

Most organizations downplay the importance of maintenance. However, it’s a massive industry worth billions of dollars. Here are a few maintenance statistics:

- Maintenance activities can take up to 40 percent of the total production costs, according to A Comprehensive Approach for Maintenance Performance Measurement.
- The U.S. maintenance industry employs more than 1.3 million people.
- A run-to-failure maintenance approach can cost up to 10 times more than a proactive maintenance plan. Nonetheless, about 80 percent of industrial plant maintenance managers still heavily rely on reactive maintenance.
- According to Plant Engineering, 44 percent of reactive maintenance is usually the result of aging equipment.

3.17.1 Types of Reactive Maintenance

1.Breakdown Maintenance

2.Run-to-failure Maintenance

3.Corrective Maintenance

4.Emergency Maintenance

Advantages of reactive maintenance

Generally speaking, it takes less time and money to do nothing than it does to do something, and this holds true when it comes to reactive maintenance. There is no initial cost associated with reactive maintenance, and it requires far less planning than preventive maintenance, for instance. But this is a very shortsighted approach, and relying exclusively on reactive maintenance in your facility is not sustainable for the long term.

Disadvantages of reactive maintenance

More expensive

Unexpected downtime during production runs can result in late orders, damaged reputations and impacted revenue. On top of that, the unpredictable nature of reactive maintenance means that labour and spare parts may not be readily available so organizations can end up paying a premium for emergency parts shipping, travel time, and after-hours support.

Shorter asset life expectancy

Reactive maintenance does not keep systems running in optimal “as new” condition. In a lot of cases, you’re doing just enough to get a machine up and running again, and over time, systems that have been patched again and again deteriorate faster and don’t maximize their initial capital cost investment.

Safety issues

When work is scheduled, technicians have time to review the standard procedures and safety requirements to complete the job correctly. Technicians tend to take more risks when maintenance work is reactive because they're under pressure to get systems running without delay.

Inefficient use of time

While planned maintenance can be included in a production schedule, reactive maintenance tends to catch you unawares, and technicians spend time running around looking for the correct manuals and schematics, ordering the right parts and trying to diagnose and fix the issue.

Bad for backlog

Emergency repairs are usually prioritized at the expense of planned work, which may be pushed or cancelled completely. This can lead to maintenance backlog which is really hard to get on top of once it starts to pile up.

Higher energy costs

When equipment is not properly maintained, it uses more energy. Doing simple things like greasing moving parts or changing filters can reduce energy consumption by 15%.

Why is reactive maintenance important?

Reactive maintenance is the process of repairing assets to standard operating conditions after poor performance or breakdown is observed. The primary benefits of reactive maintenance are; lowers costs and it requires less staff to implement.

The Different Between Reactive vs Preventive Maintenance

Reactive maintenance takes place after a problem has occurred, costing companies hundreds or thousands of dollars in repair. Planned/preventive maintenance occurs before a problem presents itself, which increases the longevity of equipment and a company's bottom line.

In the past, reactive maintenance was how companies across the world conducted their operations. But, a new way of thinking has woven itself into the current era. Businesses seek companies that have extensive experience with planned/preventive maintenance.

Hays Service has many predictive maintenance services that are used to spot a potential problem using vibration analysis, thermal imaging and analytics. Our talented and highly trained technicians and mechanics, coupled with our advanced testing equipment, is the reason why our predictive maintenance service is so successful.

3.18 What is proactive maintenance?

Proactive maintenance is a maintenance strategy that corrects the source of underlying equipment conditions. The goal of proactive maintenance is to reduce unplanned downtime, equipment failure, and risks associated with operating faulty equipment.

Proactive maintenance workflow

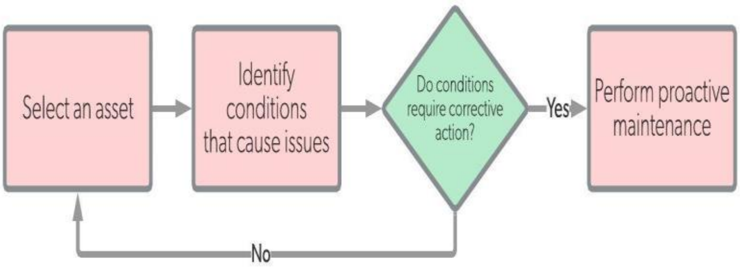


Figure:3.18 Proactive maintenance workflow

Example of proactive maintenance

Performing oil changes on a car is a relatable example of proactive maintenance. Engine deterioration from running on poor lubrication is a nightmare to fix, if even possible to fixed in the first place. What looks like a minimal investment of changing out the oil after a certain number of miles actually gives you more years on a car's life.

To illustrate an example of proactive maintenance on a larger scale, take the case of the National Ignition Facility (NIF), the largest and most energetic facility ever built. Since 2011, a combination of maintenance activities including condition-based maintenance has enabled NIF to see projected savings of nearly $3.5 million as of 2017. Savings were attributed mostly to avoided downtime and unnecessary emergency maintenance activities.

3.18.1 Types of proactive maintenance

Proactive maintenance is any form of maintenance that is done before any significant breakdowns or failures occur. The criteria that would trigger proactive maintenance activities bring about several types of proactive maintenance.

Preventive maintenance (PM)

Preventive maintenance (PM) is one of the most common forms of proactive maintenance. In a PM program, maintenance activities are performed to keep assets in good working condition. The frequency of performing PM activities can be 1) calendar-based, 2) usage-based, 3) predictive or based on analysis of historical data, or 4) prescriptive or as determined by logical software.

Condition-based maintenance (CBM)

Other types of proactive maintenance consistently keep track of how assets perform. The frequency of tracking assets can be real-time such as in condition-based maintenance (CBM) where sensors keep close track of equipment performance to address potential issues before they happen.

Scheduled and routine maintenance

The frequency of tracking equipment performance can alternatively be manually specified. In scheduled maintenance or routine maintenance, the maintenance planner can specify schedules or routines by which equipment performance should be checked. Proactive maintenance can take many forms, and plants would usually operate using a combination of these approaches. The most appropriate type of maintenance will depend on the type of equipment and should be carefully identified to ensure the most efficient strategy is used.

The Advantages of proactive maintenance

As demonstrated by the earlier examples, proactive maintenance enables a company to reduce costs in the long run. Savings are achieved by avoiding downtime and increasing equipment reliability and availability. Equipment can also be expected to be operational for longer periods if deterioration is minimized by proactive maintenance.

An additional benefit of performing proactive maintenance is a reduced risk of safety-related incidents. Equipment, particularly that which has the possibility of catastrophic failure, would be more safely operated if a proactive maintenance approach was practiced. This is very evident in the way oil and gas companies perform stringent maintenance activities to ensure that dangerous products are contained.

The disadvantage of proactive maintenance

The benefits of proactive maintenance come with investments in time and resources. The drawback that discourages plants from shifting to proactive maintenance strategies is usually the initial costs required. Proper planning should be performed to ensure that proactive maintenance procedures are cost-effective and beneficial to the plant.

Why is proactive maintenance important?

The goal of proactive maintenance is to increase asset reliability and reduce the risk of downtime. Wear and tear is a normal part of equipment lifecycles. However, a solid proactive maintenance strategy can extend the lifespan of assets and improve performance.

The Difference Between Preventive and Proactive Maintenance?

Preventive repairs work well on equipment and parts with a low chance of causing downtime — smaller components and consumables with finite life, usually available at a low cost. Proactive repairs work well for major components where decision-making data is available.

CHAPPTER 4

Results and Discussions

4.1 Block Diagram

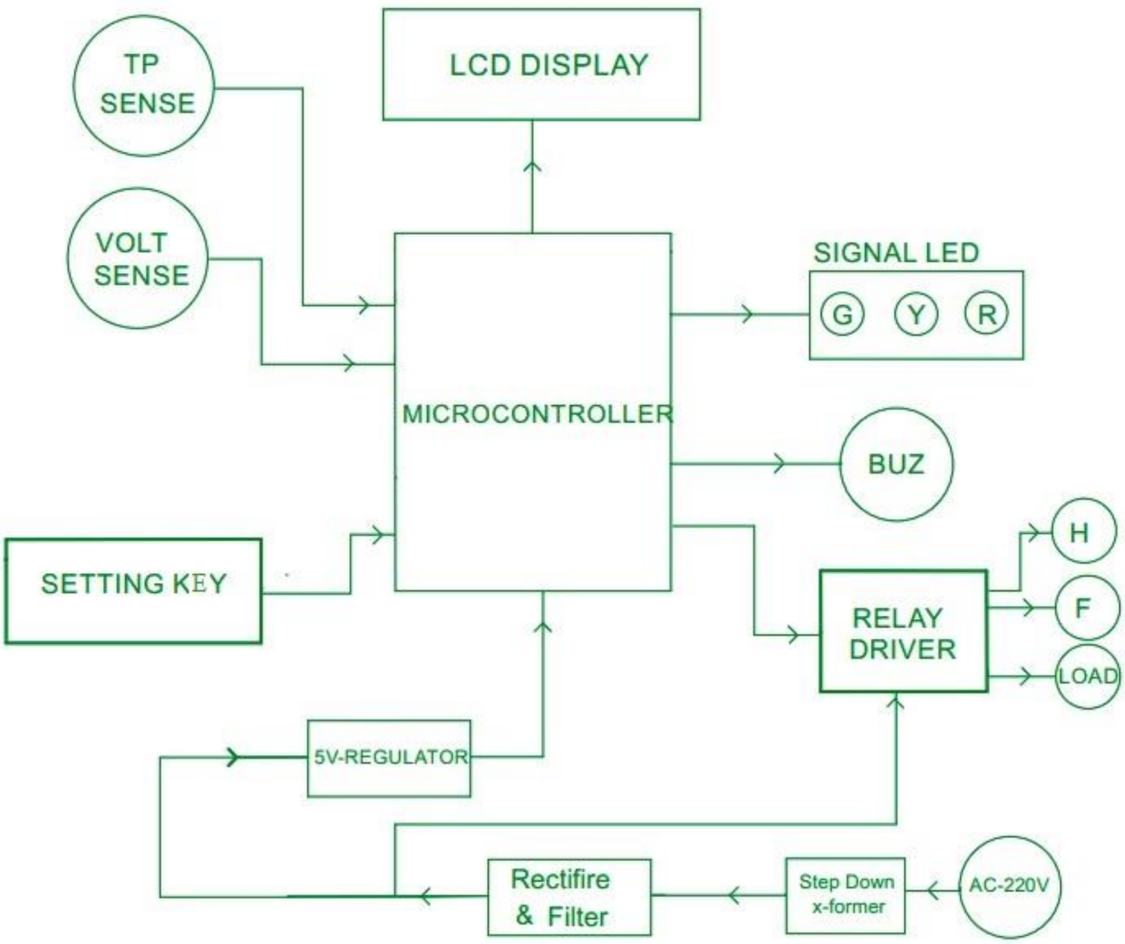


Figure4.1: Block Diagram

4.2 Circuit Diagram:

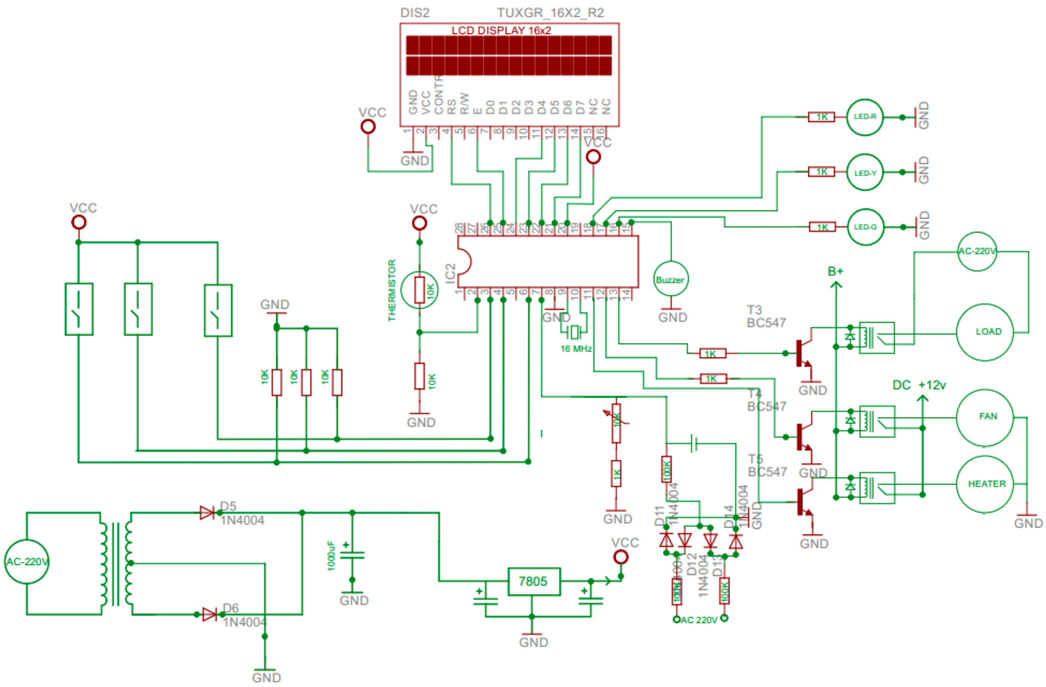
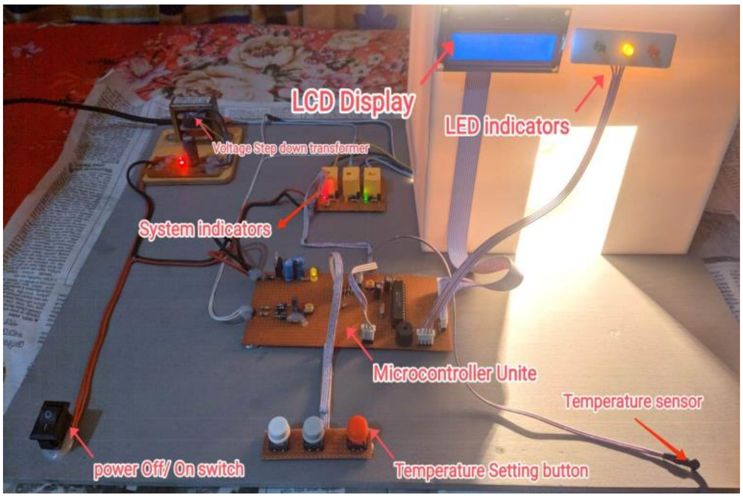


Figure4.2: Circuit Diagram

4.3 Results

Fan On Temp		Fan Off Temp		Heater On Temp		Heater Off Temp		High Temp		Line Volt	
Set Val	F On Val	Set Val	F Off Val	Set Val	H On Val	Set Val	H Off Val	Set Val	L Off Val	High Volt	Low Volt
34	35	27	26	23	22	31	32	45	46	250v	150v
35	36	32	31	26	25	30	31	40	41	250v	150v
30	31	28	27	24	23	25	26	48	49	250v	150v
37	38	33	32	25	24	32	33	43	44	250v	150v

4.4 project outlook



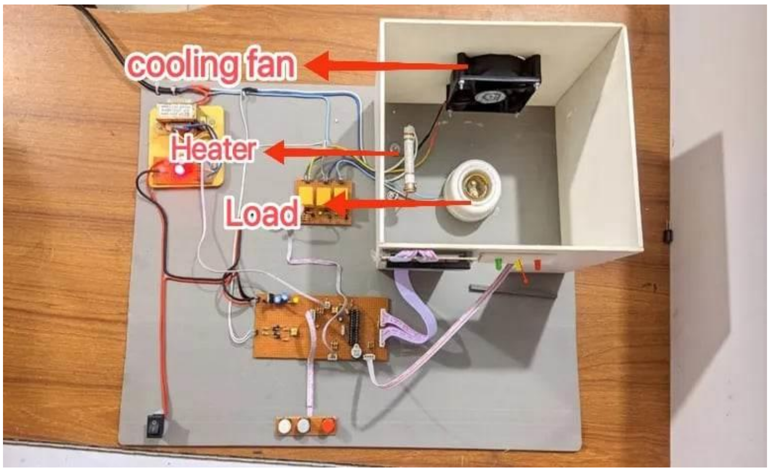


Figure4.3: Project Circuit Working Principle

When the Temperature & Humidity were growing up the relay will be operate one by one according to the assigned MC program .In normal case all LED's will be operate . When temperature will more than 34 °c relay 2(H1) will be operate and LED will getting off .As like this at temperature 35 °c & 36 °c relay 3(H2) & relay 4 (H3) will operate & LED's will getting off respectively.

In the case of Humidity: When the humidity will under 85 the relay 1 (Rh) will getting operate as the rate of humidity are being assigned on program.

Preventive maintenance keeps equipment and assets running efficiently, maintains a high safety level for your employees, and helps you avoid large and costly repairs down the road. Overall, a properly functioning preventive maintenance program ensures operational disruptions are kept to a minimum.

CHAPTER 5

Conclusions and Recommendations

5.1 Conclusions

This chapter contains the results obtained and discussion about the project. We have also covered discussions about advantages, disadvantages and limitation of current version of the protection system.

The project “modelling and simulation of machine overheating detection with alert” has been successfully designed and tested. It has been developed by integrating features of all the hardware components used and software also in which we have used C language. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced microcontroller and with the help of growing technology the project has been successfully implemented. We conclude that by implementing these systems we can access the live data and control the device interfaced with our system.

Preventive maintenance (PM) is the regular and routine maintenance of equipment and assets in order to keep them running and prevent any costly unplanned downtime from unexpected equipment failure. A successful maintenance strategy requires planning and scheduling maintenance of equipment before a problem occurs.

5.2 Project Circuit Applications

- Used to observe the temperature and humidity
- This system we can used as a Incubator
- Used to save the industry due to increase the temperature

5.3 Communication Process: Serial Interface

The interesting thing in this module is the protocol that uses to transfer data. All the sensor readings are sent using a single wire bus which reduces the cost and extends the distance. In order to send data over a bus you have to describe the way the data will be transferred, so that transmitter and receiver can understand what says each other. This is what a protocol does. It describes the way the data are transmitted. On DHT-11 the 1-wire data bus is pulled up with a resistor to VCC. So if nothing is occurred the voltage on the bus is equal to VCC.

5.4 Implementation:

What we have to do to read a DHT-11 sensor is:

1) Send request
2) Read response
3) Read each data segment and save it to a buffer
4) Sum the segments and check if the result is the same as Check Sum

If the Check Sum is correct, the values are correct so we can use them. If Check Sum is wrong we discard the packet.

To read the data bits can use a counter and start count Seconds of High level. For counts > 24uS

we replace with bit '1'. For counts <=24 we replace with bit'0'

5.5 Advantages:

1. Very easy to implement
2. High reliability
3. Digital output
4. Speed operation

5.6 Disadvantages:

1. It has limited long term stability
2. It is sensitive to dewing and certain aggressive substance
3. It is difficult to use bellow 0 temperature
4. Long-term measurement is limited due to required water reserve and wick maintenance.

CHAPTER 6

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APPENDIX A

```
#include <16F73.h>
#define LOAD PIN_C0
#define FAN1 PIN_C1
#define HEATER PIN_C2
#define BUZ PIN_C4
#define RLED PIN_C7
#define YLED PIN_C6
#define GLED PIN_C5

void setup(void);
void SETTINGS(void);
void LOD_CTRL(void);
void adc_read(void);
void lcd_show(void);

unsigned int COUNT,COUNT1,SETCNT=0,HTP=39,FONTP=29,FOFTP=28,HONTP=29,HOFTP=28;
unsigned int1 UP=0,DN=0,SET=0,TOG;
unsigned int16 acs=0;
float tp=0,TF=0;

//////////////////////////////////////////////////////////////////////////////

void main()
{
 setup();

 while(1)
 {
  LOD_CTRL();
  SET = input(PIN_A1);
  IF(SET)
  SETTINGS();
  ////////////////////////////////
  COUNT++;
  if(COUNT > 200)
  {
    COUNT =0;TOG ^=1;
    adc_read();
    lcd_show();
   }

 }
}

///////////////////////////////////////////////////////////////////////////////

void setup()
{
   setup_ADC(ADC_clock_internal);
   lcd_init();

   output_high(LOAD);
   output_HIGH(BUZ);delay_ms(70);output_LOW(BUZ);delay_ms(70);
   output_HIGH(BUZ);delay_ms(70);output_LOW(BUZ);delay_ms(70);
   output_HIGH(BUZ);delay_ms(70);output_LOW(BUZ);delay_ms(70);

   output_low(LOAD);

   lcd_gotoxy(1,1);
   printf(lcd_putc, "   WELCOME TO   ");
   lcd_gotoxy(1,2);
   printf(lcd_putc, "      SU       ");
   delay_ms(1500);

   lcd_gotoxy(1,1);
```

```
   printf(lcd_putc, " SUBMITTED BY:   ");
   lcd_gotoxy(1,2);
   printf(lcd_putc, "                 ");
   delay_ms(1500);

   lcd_gotoxy(1,1);
   printf(lcd_putc, "      NIRMAL     ");
   lcd_gotoxy(1,2);
   printf(lcd_putc, "      JERALD     ");
   delay_ms(1500);

   lcd_gotoxy(1,1);
   printf(lcd_putc, "     SAMPOD      ");
   lcd_gotoxy(1,2);
   printf(lcd_putc, "   BAJRADIPON     ");
   delay_ms(1500);

}

////////////////////////////////////////////////////////////////////////////////
void adc_read(void)
{
   set_ADC_channel(0);
   delay_ms(1);
   tp = read_adc();

   set_ADC_channel(4);
   delay_ms(1);
   acs = read_adc();
}
////////////////////////////////////////////////////////////////////////////////
void LOD_CTRL(void)
{

  if( TP > FONTP )
  {
   output_high(FAN1);
   output_high(YLED);
   output_LOW(GLED);
   output_LOW(RLED);
  }
  if(TP < FOFTP)
  {
   output_LOW(FAN1);
   output_high(GLED);
   output_LOW(YLED);
   output_LOW(RLED);
  }
  if( TP > HONTP )
  {
   output_high(HEATER);
  }
  if(TP < HOFTP)
  {
   output_LOW(HEATER);
  }
  if( (TP > HTP) | (acs < 150)| (acs > 250) )
  {
    unsigned int i=0;
    for(i=0;i<20;i++)
    {
       output_low(LOAD);
       output_LOW(GLED);
       output_low(YLED);

       adc_read();
       lcd_show();
```

```
        output_LOW(RLED); output_HIGH(BUZ);
        delay_ms(100);
        output_HIGH(RLED);output_LOW(BUZ);
        delay_ms(100);
     }
     output_high(GLED);
   }
   ELSE
   {
    output_high(LOAD);
    output_LOW(BUZ);
   }

 }
 ///////////////////////////////////////////////////////////////////////////////
 void lcd_show(void)
 {
   lcd_gotoxy(1,1);
   printf(lcd_putc, "T:%2.1f%cC ",TP,223);
   lcd_gotoxy(10,1);
   printf(lcd_putc, "V:%3lu",acs);

   lcd_gotoxy(1,2);
   printf(lcd_putc, "T:%2.1f%cF  ",TF,223);

   lcd_gotoxy(11,2);
   printf(lcd_putc,"H:%02u%cC ",HTP,223);

 }
 ////////////////////////////////////////////////////////////////////////////////

 void SETTINGS(void)
 {
   SETCNT=0;HTP=39;ACONTP=28;ACOFTP=27,FONTP=30;FOFTP=29;
   lcd_gotoxy(1,1);
   printf(lcd_putc, " SETTINGS       ");

   lcd_gotoxy(1,2);
   printf(lcd_putc, " PLEASE WAIT... ");
   delay_ms(1500);
   output_LOW(LOAD);

   WHILE( SETCNT < 5 )
   {
      IF(FONTP > 62) FONTP=62;IF(FONTP < 11) FONTP=11;
      IF(ACOFTP > 62) ACOFTP=62;IF(ACOFTP < 11) ACOFTP=11;
      IF(HTP > 99) HTP=99;IF(HTP < 11) HTP=11;

      UP = input(PIN_A2);
      DN = input(PIN_A3);
      SET = input(PIN_A1);

        IF(UP)
        {
          IF(SETCNT==0)
          FONTP++;
          IF(SETCNT==1)
          FOFTP++;
          IF(SETCNT==2)
          HTP++;
          IF(SETCNT==3)
          HONTP++;
          IF(SETCNT==4)
          HOFTP++;
          delay_ms(200);
        }
        IF(DN)
        {
```

```
          IF(SETCNT==0)
          FONTP--;
          IF(SETCNT==1)
          FOFTP--;
          IF(SETCNT==2)
          HTP--;
          IF(SETCNT==3)
          HONTP--;
          IF(SETCNT==4)
          HOFTP--;
          delay_ms(200);
        }
        IF(SET)
        {
          lcd_gotoxy(1,2);
          printf(lcd_putc, " PLEASE WAIT...  ");
          delay_ms(900);
          SETCNT++;
        }

        IF(SETCNT==0)
        {
          lcd_gotoxy(1,1);
          printf(lcd_putc, "SET FAN ON TEMP: ");
          lcd_gotoxy(1,2);
          printf(lcd_putc, " ON TEMP:%3u%cC  ",FONTP,223);
        }
        IF(SETCNT==1)
        {
          lcd_gotoxy(1,1);
          printf(lcd_putc, "SET FAN OFF TEMP:");
          lcd_gotoxy(1,2);
          printf(lcd_putc, "OFF TEMP:%3u%cC  ",FOFTP,223);
        }
        IF(SETCNT==2)
        {
          lcd_gotoxy(1,1);
          printf(lcd_putc, " SET HI TEMP:  ");
          lcd_gotoxy(1,2);
          printf(lcd_putc, " HI TEMP:%3u%cC  ",HTP,223);
        }
        IF(SETCNT==3)
        {
          lcd_gotoxy(1,1);
          printf(lcd_putc, "SET H ON TEMP:  ");
          lcd_gotoxy(1,2);
          printf(lcd_putc, "ON TEMP:%3u%cC  ",ACONTP,223);
        }
        IF(SETCNT==4)
        {
          lcd_gotoxy(1,1);
          printf(lcd_putc, "SET H OFF TEMP:");
          lcd_gotoxy(1,2);
          printf(lcd_putc, "OFF TEMP:%3u%cC  ",ACOFTP,223);
        }

   } //  WHILE( SETCNT < 2 )

   lcd_gotoxy(1,1);
   printf(lcd_putc, " SETTINGS      ");

   lcd_gotoxy(1,2);
   printf(lcd_putc, " COMPLETE...  ");
   delay_ms(1500);

}
```