TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
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"AUTOMATION OF ARTIFICIAL GREENHOUSE"

By:

Raju Shrestha (74712)
Manoj Aryal (74705)
Reshma Maharjan (74704)
Nirmal Roka (74703)

KATHMANDU, NEPAL

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A PROJECT WAS SUBMITTED TO THE DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING IN PARTIAL FULLFILLMENT OF THE REQUIREMENT FOR THE BACHELOR'S DEGREE IN ELECTRONICS & COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING
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The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a project report entitled "**Automation of Artificial Greenhouse**" submitted by Raju Shrestha, Manoj Aryal, Reshma Maharjan and Nirmal Roka in partial fulfillment of the requirements for the Bachelor's degree in Electronics & Communication Engineering.

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ABSTRACT

Environmental conditions are very dynamic. It changes continuously. The climate plays the vital role in the life cycle of plants and crops. Appropriate environmental conditions are necessary for optimum plant growth, improved crop yields, and efficient use of water and other resources. In order to ensure the proper growth and development of plants proper climatic condition should be maintained. Proper climatic condition can be maintained in an "Artificial Greenhouse".

The project "**Automation of Artificial Greenhouse**" is mainly concerned with automating the data acquisition process of intensity of light, humidity layer, moisture of the soil and temperature of the surrounding that govern plant growth, allows information to be collected at high frequency with less labor requirements. The temperature sensor gives the information about current temperature of greenhouse and is used as a reference to increase or decrease the temperature by switching the heater and cooler respectively. Soil moisture sensor detects the moisture level of soil and control by using drip line system. Humidity sensors measures relative humidity of air and control by using sprayers, sprinkle etc. Light sensors sense the intensity of light and control by using artificial lamp such as halogen lamp etc.

This project is based on microcontroller so it is cheap and components are easily available. The use of electronic components to interface the system makes the system cost effective, flexible and portable.

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LIST OF SYMBOLS AND ABBREVIATIONS

ADC	Analog to Digital Converter
UV	Ultra Violet
HID	High Intensity Discharge
LCD	Liquid Crystal Display
LDR	Light Dependent Register
IC	Integrated Chip
Vref	Reference Voltage
Vo	Output Voltage
Vcc	Source voltage
GND	Ground Terminal
EOC	End of Conversion
ALE	Address Latch Enable
MC	Microcontroller
OE	Output Enabled
PSEN	Program Store Enable
R/W	Read/Write
CLK	Clock
CMOS	Complementary Metal Oxide Semiconductor
CPU	Central Processing Unit
RAM	Random Access Memory
ROM	Read Only Memory
I/O	Input/ Output
RXD	Receive
TXD	Transmit
WR	Write
RD	Read
SFR	Special Function Register
PSW	Program Status Word
TTL	Transistor Transistor Logic
PROG	Program

A	Accumulator
PC	Program Counter
SP	Stack pointer
DPTR	Data Pointer Register
INT	Interrupt
LCD	Liquid Crystal Display
LED	Light Emitting Diode

1 INTRODUCTION

1.1. Background

Agriculture has been one of the primary occupations of man since early civilizations and even today manual interventions in farming are inevitable. In the context of Nepal more than 71 per cent of total population is engaged and dependent in agricultural sector. In these modern days of technology our country's agriculture system is still based on traditional ways, so it is not being productive. Traditional methods are time consuming, requires more manpower and high labor cost.

Greenhouses form an important part of the agriculture and horticulture sectors in our country as they can be used to grow plants under controlled climatic conditions for optimum production. Automating a greenhouse envisages monitoring and controlling of the climatic parameters which directly or indirectly govern the plant growth and hence their production. Automation is process control of industrial machinery and processes, thereby replacing human operators.

Through this project we are trying to replace manual methods prevailing in farming by microcontroller based automatic system which will help to modernize the agriculture system. The proposed system is an embedded system which will closely monitor and control the microclimatic parameters of a greenhouse on a regular basis round the clock for cultivation of crops or specific plant species which could maximize their production over the whole crop growth season and to eliminate the difficulties involved in the system by reducing human intervention to the best possible extent. The system comprises of sensors, Analog to Digital Converter, microcontroller and actuators. When any of the above mentioned climatic parameters cross a threshold which has to be maintained to protect the crops, the sensors sense the change and the microcontroller reads this from the data at its input ports after being converted to a digital form by the ADC. The microcontroller then performs the needed actions by employing relays until the strayed-out parameter has been brought back to its optimum level.

By the implementation of this project, the manpower needed in this farming can be minimizes which will decrease the expenditure. Also the system uses the cheap electronic devices which are portable and highly reliable.

1.2. Objectives

i. To understand the basic concept of microcontroller interfacing with different sensors, ADC, etc.
ii. To broaden the sector of electronics and automation technology in agricultural sector effectively.
iii. To be familiar with the implementation of microcontroller based automation system.
iv. To study the effect of climate on a plants and crops.
v. To maintain the required atmosphere and climate for a specific plant.
vi. To preserve the extinct and endangered flora.

2 LITERATURE REVIEW

2.1. Introduction of Greenhouse

A greenhouse is a structure with a different types of covering materials, like glass or plastic roof and frequently glass or plastic walls; it heats up because incoming visible solar radiation (for which the glass is transparent) from the sun is absorbed by plants, soil, and other things inside the building. Air warmed by the heat from hot interior surfaces is retained in the building by the roof and wall. In addition, the warmed structures and plants inside the greenhouse re-radiate some of their thermal energy in the infra-red, to which glass is partly opaque, so some of this energy is also trapped inside the glasshouse.

In Nepal mostly in Himalayan region greenhouse is made out of local stones for the walls all around, thus creating a significant thermal mass. Further locally available and prepared wood beams are used to build the greenhouse roof. Only the doubled layered UV stabilized plastic (to create a layer of insulating air and thus minimizing the energy losses during the cold nights) was shipped in from Kathmandu and the additional thick winter night covering.

2.2. Working System of Greenhouse

2.2.1. Drip Irrigation System

Drip irrigation is an irrigation method which saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone. It is also known as trickle irrigation or micro irrigation. Drip irrigation technology uses a network of plastic pipes, valves, tubing and emitter to carry water under low pressure to the plant. Basic components of drip irrigation system are pump (or pressurized water source), filtration system (like sand filter), backwash controller (prevent backflow), main line (larger diameter pipe), electronic valves, small diameter polyethylene pipe, emitting device (dripper or emitter, inline dripper, trickle rings).

The polyethylene tubing is run from the source water to the plant, where the emitter is attached for dripping water. Emitter line is used where continuous band of water is needed. The fittings are available to make sharp turns, branch lines and to make the transition between different sizes of tubing.

The high efficiency of drip irrigation system results from two primary factors. The first is that the water soaks into the soil before it can evaporate or run off. The second is that the water is only applied where it is needed, at plant root rather than everywhere. Besides this fertilization can be easily included with minima wastage of fertilizer. Regular water prevents plant dehydration.

2.2.2. Controlled Light Illumination by Growing Lights

The growing light enables cultivators to extend daylight hours which are useful for photosynthesis of plants. These artificial growing lights overcome the deficiency of natural light during winter and spring seasons where the amount of light required may be low. The light is the major component for photosynthesis which acts as a catalyst. The basic lamps used in greenhouse lightening are:

a) Gas Discharge Lamps

These are a family of artificial light sources that generate lights by sending an electrical discharge through and ionized gas. HID lamps offer long life and high efficiency, but are more complicated to manufacture, and they require electronics to provide the correct current flow through the gas.

b) High Intensity Discharge (HID) Lamps

This is a type of lamp which produces light by means of electric arc between tungsten electrodes hosed inside a translucent or transparent fused quartz or fused alumina arc tube. Compared to fluorescent and incandescent lamps, HID lamps have higher luminous efficiency since a greater proportion of their radiation is in visible light as opposed to heat. They have life 5000 hours or more.

c) Incandescent Lamp

The incandescent lamp makes light by heating a metal filament wire to a high temperature until it glows. Incandescent lamp is produced in a wide range of sizes, light output, and voltage ratings, form 1.5 volts to about 300 volts. They are very sensitive to change in supply voltage. These lamps are gradually being replaced by fluorescent lamps, HID lamps, etc.

2.3. Temperature Maintaining System

The temperature plays the vital role in the life cycle of the plants and crops. The change in temperature causes the shift in cultivation of crops. Appropriate temperature should be maintained for the optimum growth and development of crops. The temperature of the greenhouse can be maintained by using the heating and cooling equipments.

2.3.1. Cooling Equipments

Although plants are capable of controlling their leaf temperatures by evaporating water, this process can at times consume energy that should otherwise be used for active growth. Therefore, greenhouse crops can often benefit from any help that reduces water stress, poor growth, and injury to tissues. These equipments are used to low down the temperature of the greenhouse to the required level. The different cooling equipments are:

a) Ventilation

Ventilation is required for greenhouse cooling to remove heated greenhouse air and to introduce drier air for evaporative cooling. For a moderately shaded greenhouse, the ventilation system should be designed to be capable of exhausting at least 8-10 cubic feet of air per minute for every square foot of greenhouse area. Solar heat gain is dependent upon greenhouse area, not volume, since no matter how tall our greenhouse is, it receives approximately the same amount of solar energy per square foot. The ventilation system should be designed to remove heat evenly from all parts of the greenhouse, with no ‘hot spots'. Make sure that open doors do not create 'short circuits' in the flow of ventilation system.

b) Pad and Fan

Mechanical pad & fan systems depend directly upon a continuous laminar airflow across the greenhouse. They can move a large volume of the hot greenhouse air out and pull fresh air in through the rear vent. They are very effective but there will always be a temperature gradient when they are in use, with the coolest air near the pads and the warmest air near the exhaust fans. Pad and fan systems are not easy to regulate since they are either all 'on' or all 'off'. Also, since the water in the pads takes a while to completely evaporate it can be difficult to achieve an in-between effect by switching the water supply on and off in a pulsed manner. For these reasons, pad systems are best used to cool and humidify incoming air.

c) Industrial Refrigeration

A water chiller is an industrial water refrigeration apparatus that produces cold water to cool industrial process equipment. A water chiller is a complete system filled with refrigeration equipment, including a condenser, refrigerant, pipes, coolant expansion reservoir, pumps, and so on. Water is cooled to temperatures around 20°C (68°F) and pumped through a hydraulic circuit to reach the process equipment.

d) Swamp cooler

A swamp cooler is a device that cools air through the simple evaporation of water. They can be configured to the appropriate size, as this varies depending on the length and width of the greenhouse, location where we live, and type of plants we wish to grow.

2.3.2. Heating Equipment

During winter seasons the temperature of the greenhouse goes below the required level of the plants and crops. The heating equipments are used to increase the internal temperature of the greenhouse. Following equipments can be used for increasing the temperature:

a) Electric Heater

Overhead infrared heating equipment combined with soil cable heat provides a localized plant environment, which allows plants to thrive even though the surrounding air is at a lower than normal temperature. Electric resistance type heaters are used as space heaters or in a forced air system.

b) Hot Water of Steam Heater

A hot water system with circulator or a steam system linked with automatic ventilation will give adequate temperature control. In some areas, coal or natural gas is readily available at low cost. This fuel is ideal for hot- water or a central steam system. Steam has an advantage in that it can be used to sterilize growing beds and potting soils.

2.4. Humidification System

To maintain the relative humidity of the greenhouse many evaporative cooling and humidifying systems are used. Such as foggers, mist system, and roof sprinkles which adds the vapor to the air, and may subsequently reduce the amount of water that the plants and crops need to transpire.

2.4.1. Roof Sprinklers

They add water vapor and cool the incoming air. On large ranges, it is possible to decrease the temperature by 3 ºC – 5 ºC and increase the humidity by 5-10%.

2.4.2. Mist and Fog System

Mist and fog system produce tiny water droplets that evaporate, thereby cooling and humidifying the greenhouse air. A misting system can provide needed moisture to maintain a healthy humidity level of 50 to 70%.

3 SYSTEM MODEL

3.1. Basic Model of the System

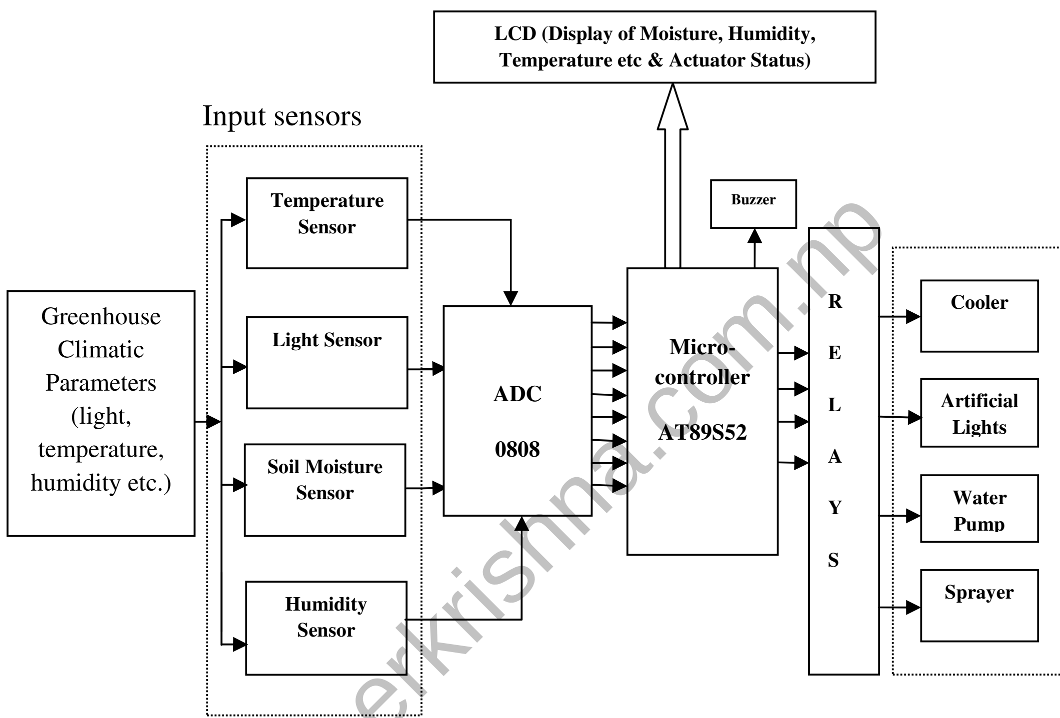

Figure 3.1: Block diagram of the system

3.2. Parts of the System

i. Sensors (Data acquisition system)

a. Temperature sensor (LM35)

b. Humidity sensor (HH10D)

c. Light sensor (LDR)

d. Moisture sensor

ii. Analog to Digital Converter (ADC 0808)

iii. Microcontroller (AT89S52)

iv. Liquid Crystal Display (JHD162A)

v. Actuators – Relays

vi. Devices controlled

a. Water Pump (simulated as a bulb)

b. Sprayer (simulated as a bulb)

c. Cooler (simulated as a fan)

d. Artificial Lights (simulated as 2 bulbs)

vii. Buzzer

3.3. Basic System Operation

The block diagram of the system is shown in figure 3.1 above. Here basically we are focused to control the climatic parameters: light, temperature, humidity and soil moisture. The four sensors viz. light dependent resistor (LDR), humidity sensor, temperature sensor and moisture sensor are used to sense the light intensity, relative humidity, temperature and moisture level of soil of a greenhouse respectively.

The output of each transducer are analog voltage which are then passed through signal conditioner like LM324 before giving input to the analog to digital converter (ADC). Thus obtained well refined electrical signal is applied to 28 channels ADC to convert analog electrical signal to digital signal.

The output of the ADC is 8-bit binary bits which fed to the micro-controller. The micro-controller is the main processing and controlling unit in the system. It process the data received from the ADC, manipulates it , sends the data to liquid crystal display (LCD) to display and actuates the actuator of the air conditioner accordingly to the received data from ADC. Beside this micro-controller generates the indication signal to the buzzer to indicate change in climatic parameters below or above the required level.

The LCD displays the variables like moisture level, relative humidity, temperature, light intensity and actuator status. Air conditioner units water pump, sprayer, artificial lights and cooler operates accordance to the control signal received from the micro-controller.

4 HARDWARE DESCRIPTIONS

4.1. Transducers

A transducer is a device which measures a physical quantity and converts it into an electrical quantity, which can be further read by an observer or by an instrument.

The sensors used in this system are:

1. Soil Moisture Sensor (Transistor amplifier)
2. Light Sensor (LDR (Light Dependent Resistor))
3. Humidity Sensor (HH10D)
4. Temperature Sensor (LM35)

4.1.1. Soil Moisture Sensor

In soil moisture, the two copper leads act as the sensor probes. They are immersed into the soil to a fair depth whose moisture content is under test. The soil is examined under three conditions explained below:

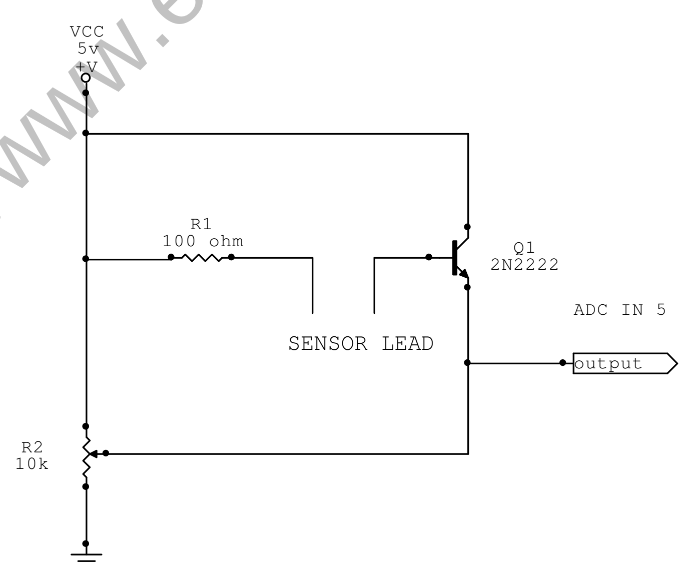

Figure 4.1: Soil Moisture Sensor

- **Dry condition-** Under dry conditions there is no conduction path between the two copper leads the sensor circuit remains open. The voltage output of the emitter led in this case ranges from 0 to 1.9V.

- **Optimum condition-** When water is added to the soil, it increases the moisture content of the soil. This leads to an increase in soil's conductivity which forms a conductive path between the two sensor probes leading to a close path for the current flowing from the supply to the transistor through the sensor probes. In the optimum condition the voltage output of the circuit taken at the emitter of the transistor ranges from approximately 1.9 to 3.4V.

- **Excess water condition-** If the water content increases beyond the optimum level, the conductivity of the soil increases drastically and a steady conduction path is established between the two sensor leads and the voltage output from the sensor do not increases further beyond a certain limit. The maximum possible value in this case is not more than 4.2V.

4.1.2. Light Sensor

Light Dependent Resistor (LDR) also known as photoconductor or photocell, is a device which has a resistance which varies according to the amount of light falling on its surface. Since LDR is extremely sensitive in visible light range, it is well suited for the proposed application.

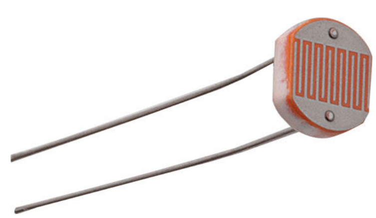

Fig. 4.2 Light Dependent Resistor

4.1.2.1. Functional Description

The figure below shows the functional circuit diagram of LDR. As shown in figure below, an LDR and a normal resistor are wired in series across a voltage. Depending on which is tied to the 5V and which to 0V, the voltage at the point between them, call it the sensor node, will either rise or fall with increasing light. If the LDR is the component tied directly to the 5V, the sensor node will increase in voltage with increasing light. The LDR's **3** resistance can reach 10 k ohms in dark conditions and about 100 ohms in full brightness. The circuit used for sensing light in our system uses a 10 k fixed resistor which is tied to +5V. Hence the voltage value decreases with increase in light intensity.

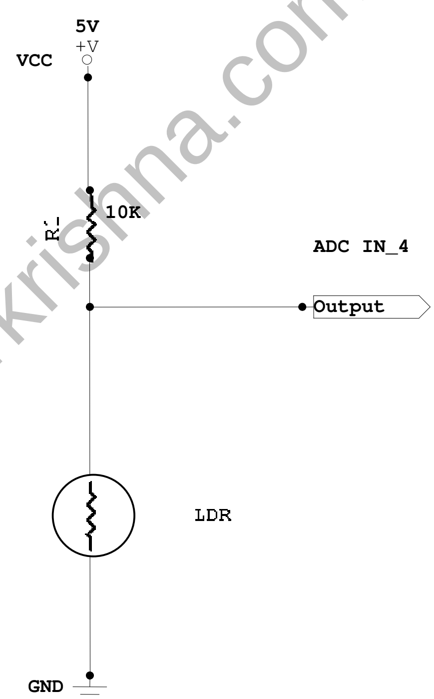

Figure 4.3: Light sensor circuit

The sensor node voltage is compared with the threshold voltages for different levels of light intensity corresponding to the four conditions- Optimum, dim, dark and night. The relationship between the resistance **RL** and light intensity **Lux** for a typical LDR is:

RL = 500/ **Lux** kΩ. … (3.1)

With the LDR connected to 5V through a 10K resistor, the output voltage of the LDR is:

Vo = 5*RL / (RL+10) … (3.2)

The illumination status and transducer optimum range is shown in the table below:

Illumination status	**Transducer optimum range**
Optimum	0V- 0.7V
Dim light	0.7V- 2.5V
Dark	2.5V- 3V
Night	3V- 3.47V

Table 4.1: Light sensor circuit characteristics

4.1.3. Humidity Sensor

As a humidity sensor we have used here sensor HH10D for sensing humidity. Relative humidity is measured in percentage, of the vapor in the air compared to the total amount of vapor that could be held in the air at a given temperature. HH10D gives the output in terms of frequency at a range of 5 kHz to 10 kHz from frequency output pin.

The figure below shows the basic humidity sensor circuit. 5V DC is applied to the sensor (HH10D) through 10KΩ resistor. The output is taken from sensor which is fed to the pin no 13 of the microcontroller for the controlling purpose.

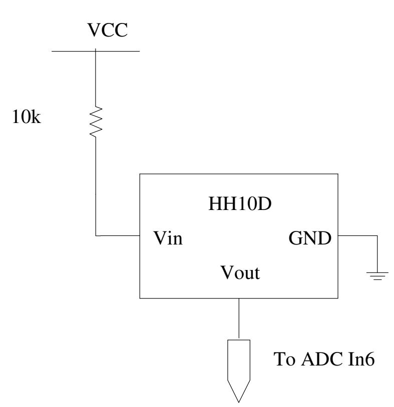

Figure 4.4: Humidity sensor circuit

4.1.4. Temperature Sensor

As a temperature sensor, we have used LM35 IC. It is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature in degree centigrade (ºC). The temperature can be measured more accurately with it than using a thermistor. The sensor circuitry is sealed and not subject to oxidation, etc. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.

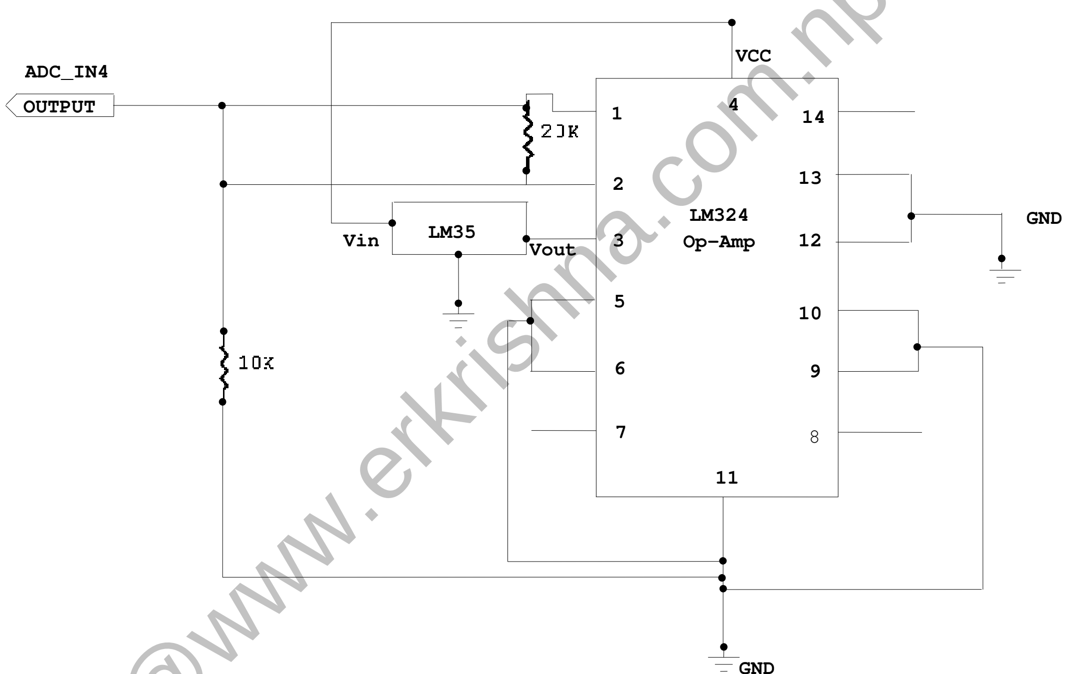

Figure 4.5: Temperature sensor circuit

4.1.4.1. Functional Description

The sensor has a sensitivity of 10mV / ºC . The output of LM35 is amplified using a LM324 single power supply (+5V) op-amp. The op-amp is designed to have a gain of 5.

The circuitry measures temperatures with a resolution of up to 0.5 ºC . The output voltage is converted to temperature by a simple conversion factor. The general equation used to convert output voltage to temperature is:

Temperature (ºC) = (Vout * 100) / 5 ºC …(3.3)

So if Vout is 5V, then, Temperature = 100 ºC . Here output voltage varies linearly with temperature.

4.2. Analog to Digital Converter (ADC 0808)

In physical world parameters such as temperature, pressure, humidity, and velocity are analog signals. A physical quantity is converted into electrical signals. We need an analog to digital converter (ADC), which is an electronic circuit that converts continuous signals into discrete form so that the microcontroller can read the data. Analog to digital converters are the most widely used devices for data acquisition.

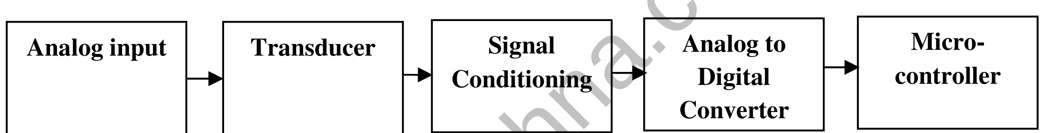

Figure4.6: Getting data from the analog world

4.2.1. Description

The ADC0808 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can directly access any of 8-single-ended analog signals. The design of the ADC0808 has been optimized by incorporating the most desirable aspects of several A/D conversion techniques. The device offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. These features make it ideally suited for applications from process and machine control to consumer and automotive applications.

4.2.2. Pin Diagram of ADC 0808

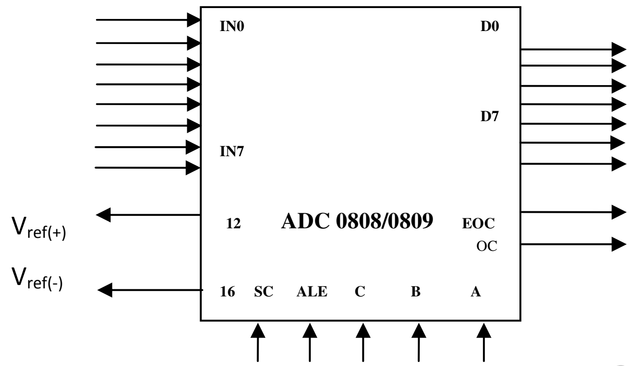

Figure 4.7: Pin diagram of ADC 0808

We use A, B, C addresses to select IN0-IN7 and activate Address latch enable (ALE) to latch in the address. SC is for Start Conversion. EOC is for End of Conversion and OE is for Output Enable. The output pins D0-D7 provides the digital output from the chip. Vref (-) and Vref (+) are the reference voltages.

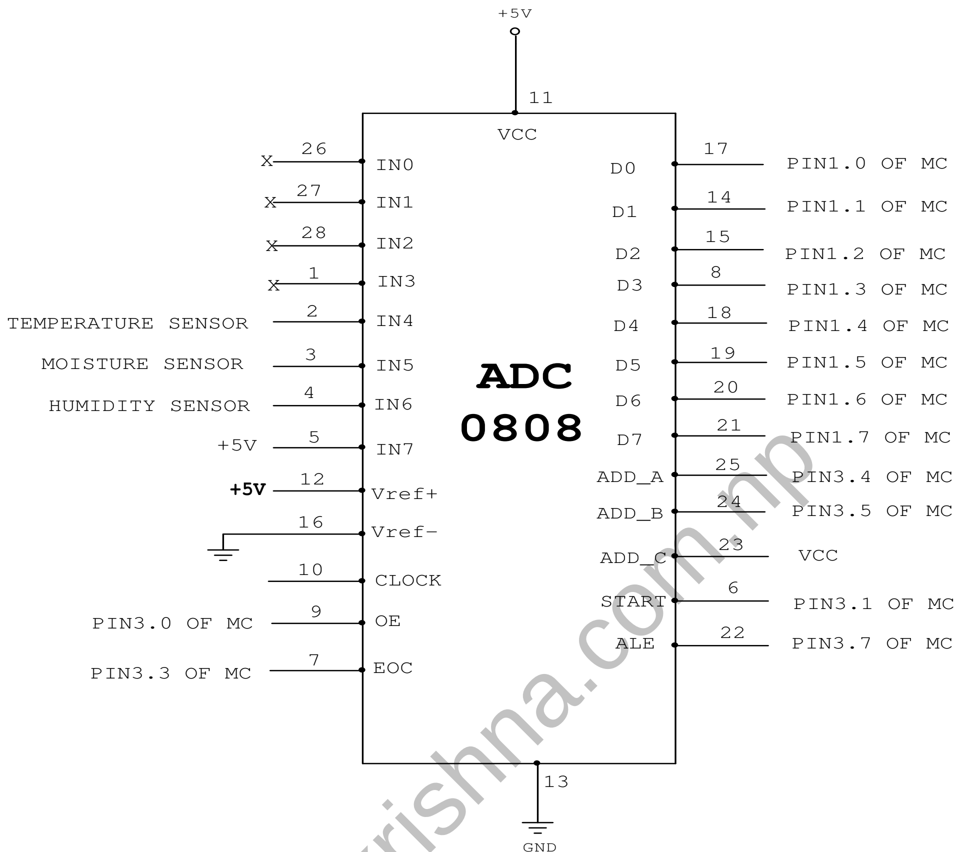

Figure 4.8: ADC 0808 pin details as used for this application

4.3. Clock Circuitry for ADC

4.3.1. Functional Description

The clock for the ADC is generated using the IC CD4093, which is a 2-input Schmitt triggered NAND gate. A Schmitt trigger is a comparator circuit that incorporates positive feedback. The Control pin is pulled high and the capacitor charges and discharges producing alternate patterns of 0's and 1, generating a square waveform. When the input is higher than a certain chosen threshold, the output is high; when the input is below another (lower) chosen threshold, the output is low; when the input is between the two, the output retains its value.

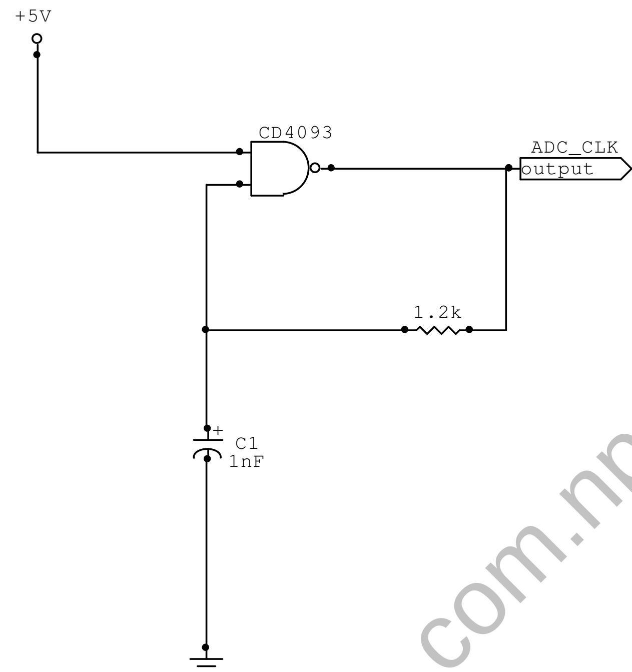

Figure 4.9: Clock circuitry for ADC

4.4. Microcontroller (AT89S52)

The microcontroller is the device that can perform various operations and computations on the data. It consists of the arithmetic and logic unit, input/output unit, control unit and various components.

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

4.4.1. Pin Configuration

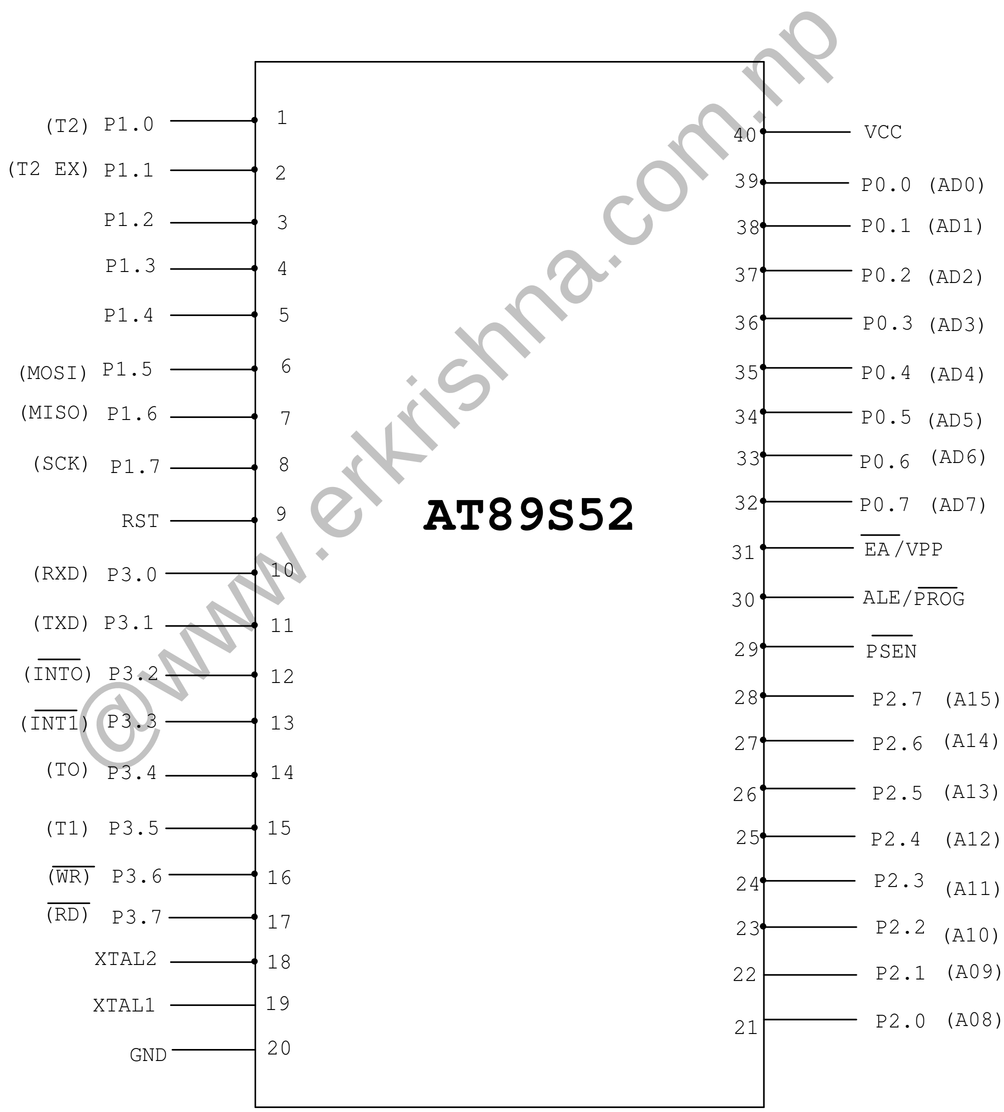

Figure 4.10: Pin diagram of AT89S52

4.4.2. Pin Description

• **Port 0:** Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port pins, the pins can be used as high-impedance inputs. Port 0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification. External pull-ups are required during program verification.

•**Port 1:** Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 1 also receives the low-order address bytes during Flash programming and verification.

•**Port 2:** Port 2 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16- bit addresses.

•**Port 3:** Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port 3 receives some control signals for Flash programming and verification.

•**RST:** Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

4.4.2.1. Power-On Reset Circuit

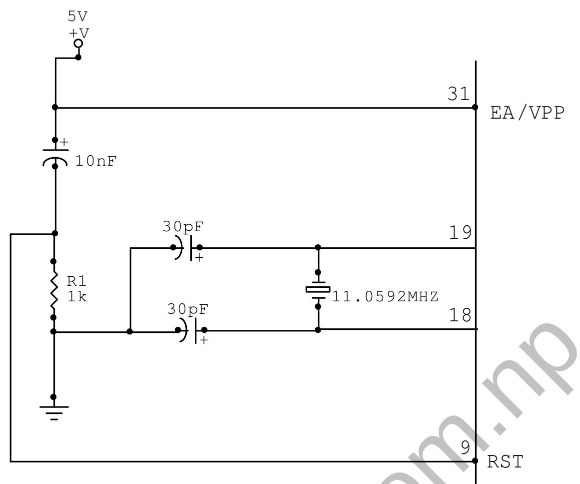

Figure 4.11: Power-on reset circuit

In order for the RESET input to be effective, it must have a minimum duration of two machine cycles.

•**ALE/PROG:** Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming.

•**PSEN:** Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

•**EA:** External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH.

•**XTAL1:** Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

•XTAL2: Output from the inverting oscillator amplifier.

•VCC: Supply voltage.

•GND: Ground.

4.4.2.2. The AT89S52 Oscillator Clock Circuit

We have used here in our project AT89S52 microcontroller, which uses a quartz crystal oscillator for giving clock with combination of the capacitor.We can observe the frequency on the XTAL2 pin. The crystal frequency is the basic internal frequency of the microcontroller. The internal counters must divide the basic clock rate to yield standard communication bit per second (baud) rates. An 11.0592 megahertz crystal, although seemingly an odd value, yields a crystal frequency of 921.6 kilohertz, which can be divided evenly by the standard communication baud rates of 19200, 9600, 4800, 2400, 1200, and 300 hertz.

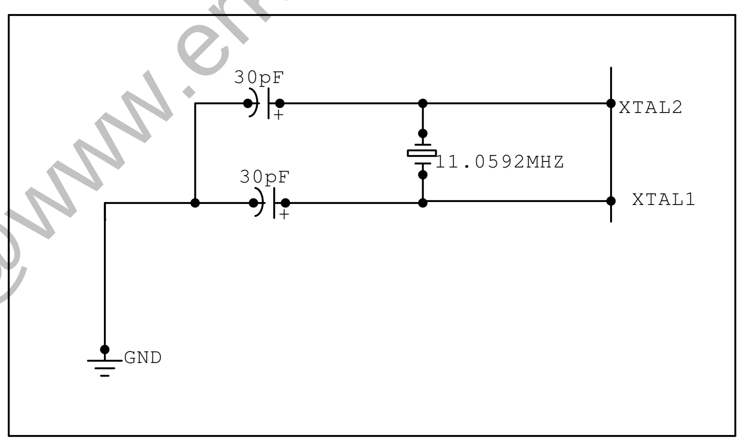

Figure 4.12: The AT89S52 oscillator clock circuit

4.4.3. Special Function Registers

The Special Function Registers (SFRs) contain memory locations that are used for special tasks. Each SFR occupies internal RAM from 0x80 to 0xFF.They are 8-bits wide.

•**Accumulator:** The A (accumulator) register or accumulator is used for most ALU operations and
Boolean Bit manipulations.

•**Register B:** Register B is used for multiplication & division and can also be used for general purpose storage.

•**Program Status Word:** PSW (Program Status Word) is a bit addressable register.

•**Program Counter:** PC or program counter is a special 16-bit register. It is not part of SFR. Program instruction bytes are fetched from locations in memory that are addressed by the PC.

•**Stack Pointer:** Stack Pointer (SP) register is eight bits wide. It is incremented before data I stored during PUSH and CALL executions. While the stack may reside anywhere in on-chip RAM, the Stack Pointer is initialized to 07H after a reset. This causes the stack to begin at location 08H.

•**Data pointer:** DPTR or data pointer is a special 16-bit register that is accessible as two 8- bit registers: DPL and DPH, which are used to used to furnish memory addresses for internal and external code access and external data access.

•**Control Registers:** Special Function Registers IP, IE, TMOD, TCON, SCON, and PCON contain control and status bits for the interrupt system, the Timer/Counter, and the serial port.

•Timer Registers: Register pairs (TH0, TL0) and (TH1, TL1) are the 16-bit Counter registers for Timer/Counters 0 and 1, respectively.

4.4.4. Memory Organization

MCS-51 devices have a separate address space for Program and Data Memory. Up to 64K bytes each of external Program and Data Memory can be addressed.

•Program Memory: If the EA pin is connected to GND, all program fetches are directed to external memory. On the AT89S52, if EA is connected to VCC, program fetches to addresses 0000H through 1FFFH are directed to internal memory and fetches to addresses 2000H through FFFFH are to external memory.

•Data Memory: The AT89S52 implements 256 bytes of on-chip RAM. The upper 128 bytes occupy a parallel address space to the Special Function Registers. This means that the upper 128 bytes have the same addresses as the SFR space but are physically separate from SFR space. When an instruction accesses an internal location above address 7FH, the address mode used in the instruction specifies whether the CPU accesses the upper 128 bytes of RAM or the SFR space. Instructions which use direct addressing access the SFR space. The lower 128 bytes of RAM can be divided into three segments.**Register Banks 0-3:** locations 00H through 1FH (32 bytes). The device after reset defaults to register bank 0. To use the other register banks, the user must select them in software. Each register bank contains eight 1-byte registers R0-R7. Reset initializes the stack point to location 07H, and is incremented once to start from 08H, which is the first register of the second register bank.

a) Bit Addressable Area: 16 bytes have been assigned for this segment 20H-2FH. Each one of the 128 bits of this segment can be directly addressed (0-7FH). Each of the 16 bytes in this segment can also be addressed as a byte.

b) Scratch Pad Area: 30H-7FH are available to the user as data RAM. However, if the data pointer has been initialized to this area, enough bytes should be left aside to prevent SP data destruction.

4.4.5. Interrupts

A computer has only two ways to determine the conditions that exist in internal and external circuits. One method uses software instructions that jump to subroutines on the states of flags and port pins. The second method responds to hardware signals, called interrupts that force the program to call a subroutine. The AT89S52 has a total of six interrupt vectors: two external interrupts (INT0 and INT1), three timer interrupts (Timers 0, 1, and 2), and the serial port interrupt. Each of these interrupt sources can be individually enabled or disabled by setting or clearing a bit in Special Function Register IE. IE also contains a global disable bit, EA, which disables all interrupts at once. Each interrupt forces the processor to jump at the interrupt location in the memory. The interrupted program must resume operation at the instruction where the interrupt took place. Program resumption is done by storing the interrupted PC address on to stack. RETI instruction at the end of ISR will restore the PC address.

4.4.6. Microcontroller Configuration Used In the Setup

The microcontroller is interfaced with the ADC in polling mode. INT0 is used for the LCD mode selection switch in order to switch between two modes of display:

1) Sensor output display

2) Actuator status display

Port details:

- Port 0: Interfaced with the LCD data lines.
- Port 1: Interfaced with the ADC data lines
- Port 2: Interfaced with the LCD Control lines and AC Interface control
- Port 3: Interfaced with the ADC control lines

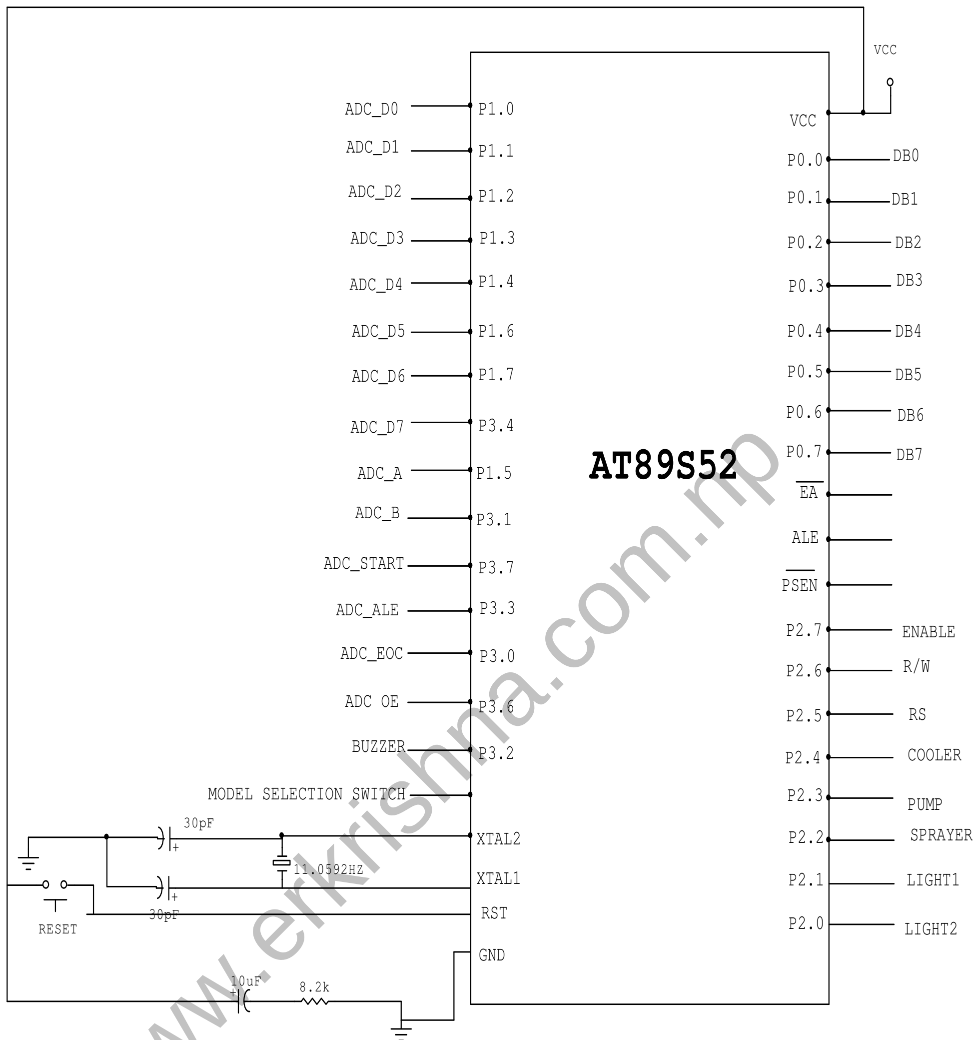

Figure4.13: Microcontroller Pin Details

4.5. Liquid Crystal Display (LCD)

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. LCD displays designed around LCD JHD162A module, are inexpensive and easy to use. They have a standard ASCII set of characters and mathematical symbols.

4.5.1. Signals to the LCD

The LCD also requires 3 control lines from the microcontroller:

a) 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.

b) 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.

c) Register selects (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.

4.5.2. Pin Description

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (Two pins are extra in both for back-light LED connections).

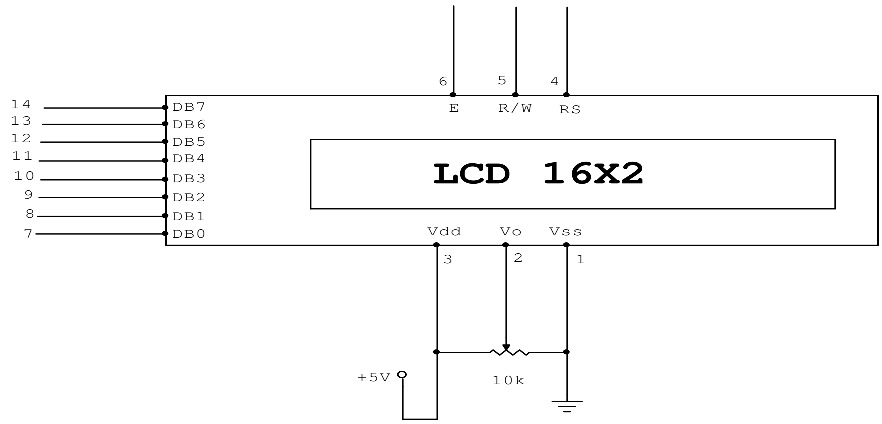

Figure 4.14: Pin Diagram of 2x16 Pin LCD

Pin no.	Name	Description
Pin no. 1	VSS	Power Supply (GND)
Pin no. 2	VCC	Power Supply (+5V)
Pin no. 3	VEE	Contrast Adjust
Pin no. 4	RS	0= Instruction Input 1= Data Input
Pin no. 5	R/W	0= Write to LCD module 1= Read from LCD module
Pin no. 6	EN	Enable Signal
Pin no. 7	D0	Data bus line 0 (LSB)
Pin no. 8	D1	Data bus line 1
Pin no. 9	D2	Data bus line 2
Pin no. 10	D3	Data bus line 3
Pin no. 11	D4	Data bus line 4
Pin no. 12	D5	Data bus line 5
Pin no. 13	D6	Data bus line 6
Pin no. 14	D7	Data bus line 7 (MSB)

Table 4.2: Pin Description of LCD

4.6. Alarm Circuitry

Buzzer: Buzzer is connected to the control unit through the transistor that acts as an electronic switch for it. When the switch forms a closed path to the buzzer, it sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. The transistor acts as a normal controlled by the base connection. It switches ON when a positive voltage from the control unit is applied to the base. If the positive voltage is less than 0.6V, the transistor switches OFF. No current flows through the buzzer in this case and it will not buzz. As can be seen in the buzzer circuitry given below, a protection resistor of 10k ohm is used in order to protect the transistor from being damaged in case of excessive current flow. Here in our system, the buzzer is designed to give a small beep whenever one of the devices such as a Sprayer or a bulb turns on in order to alert the user.

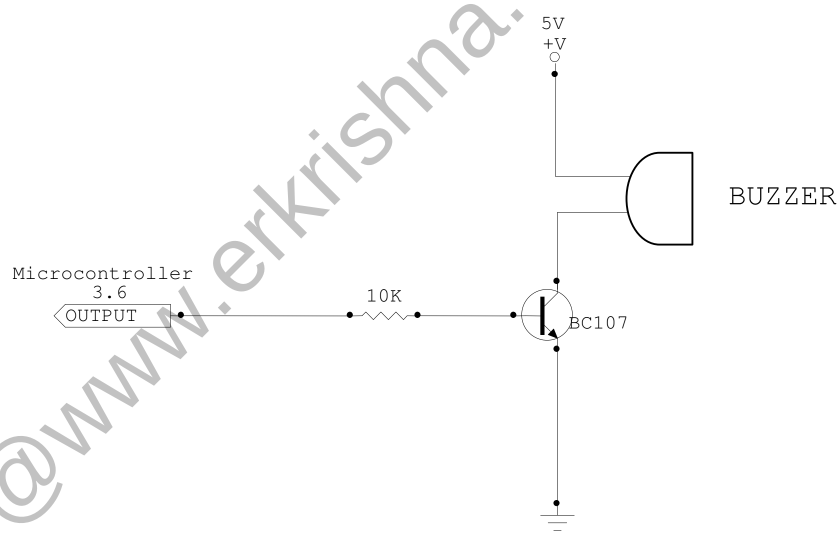

Figure 4.15: Buzzer circuitry

4.7. Relays

A relay is an electromagnetic device. It is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier. A relay will switch one or more poles, each of whose contacts can be thrown by energizing the coil in one of three ways:

a). **Normally - open (NO)** contacts connect the circuit when the relay is activate d; the circuit is disconnected when the relay is inactive. It is also called a FORM A contact or “make” contact.

b). **Normally - closed (NC)** contacts disconnect the circuit when the relay is activated; the circuit is connected when relay is inactive. It is also called FORM B contact or” break” contact.

c). **Change-over or double-throw** contacts control two circuits; one normally open contact and one normally –closed contact with a common terminal. It is also called a Form C “transfer “contact. The following types of relays are commonly encountered: "C" denotes the common terminal in SPDT and DPDT types

4.7.1. SPST

Single **P**ole **S**ingle **T**hrow: These have two terminals which can be connected or disconnected. Including two for the coil, such a relay has four terminals in total. It is ambiguous whether the pole is normally open or normally closed. The terminology "SPNO" and "SPNC" is sometimes used to resolve the ambiguity.

4.7.2. SPDT

Single **P**ole **D**ouble **T**hrow: A common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.

4.7.3. DPST

Double **P**ole **S**ingle **T**hrow: These have two pairs of terminals. Equivalent to two SPST switches or relays actuated by a single coil. Including two for the coil, such a relay has six terminals in total. It is ambiguous whether the poles are normally open, normally closed, or one of each.

4.7.4. DPDT

Double **P**ole **D**ouble **T**hrow: These have two rows of change-over terminals. Equivalent to two SPDT switches or relays actuated by a single coil. Such a relay has eight terminals, including the coil.

4.7.5. QPDT

Pole **D**ouble **T**hrow: Often referred to as Quad Pole Double Throw, or 4PDT. These have four rows of change-over terminals. Equivalent to four SPDT switches or relays actuated by a single coil or two DPDT relays. In total, fourteen terminals including the coil.

The Relay interfacing circuitry used in the application is:

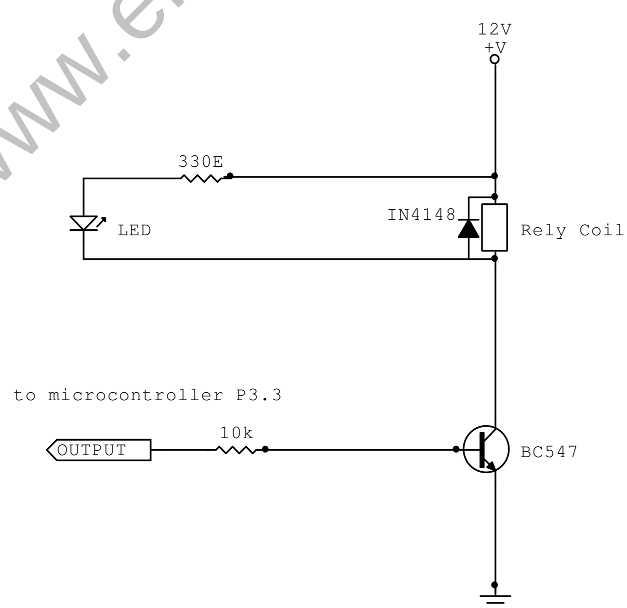

Figure 4.16: Relay circuitry

4.8. Power Supply Connection

The power supply section consists of step down transformers of 230V primary to 9V and 12V secondary voltages for the +5V and +12V power supplies respectively. The stepped down voltage is then rectified by 4 1N4007 diodes. The high value of capacitor 1000 µF charges at a slow rate as the time constant is low, and once the capacitor charges there is no resistor for capacitor to discharge. This gives a constant value of DC. IC 7805 is used for regulated supply of +5 volts and IC 7812 is used to provide a regulated supply of +12 volts in order to prevent the circuit ahead from any fluctuations.

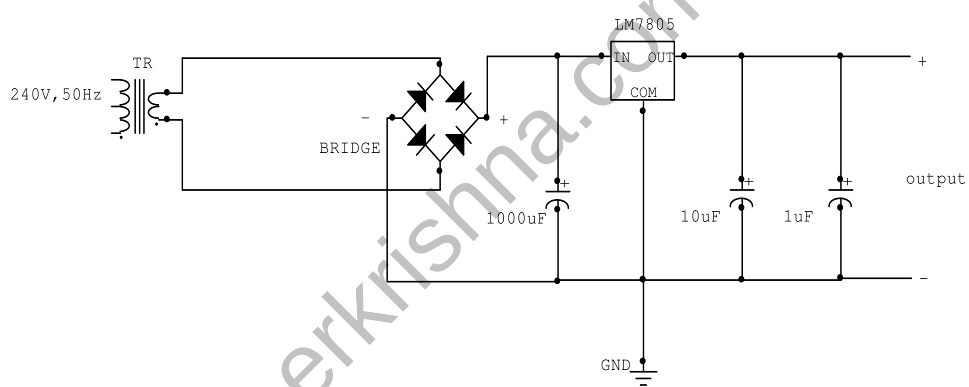

Figure 4.17: +5V Power supply circuit

The filter capacitors connected after this IC filters the high frequency spikes. These capacitors are connected in parallel with supply and common so that spikes filter to the common. These give stability to the power supply circuit. As can be seen from the above circuit diagrams, the rectified voltage from the 4 diodes is given to pin 1 of the respective regulators. Pin 2 of the regulators is connected to ground and pin 3 to Vcc. With adequate heat sinking the regulator can deliver 1A output current. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

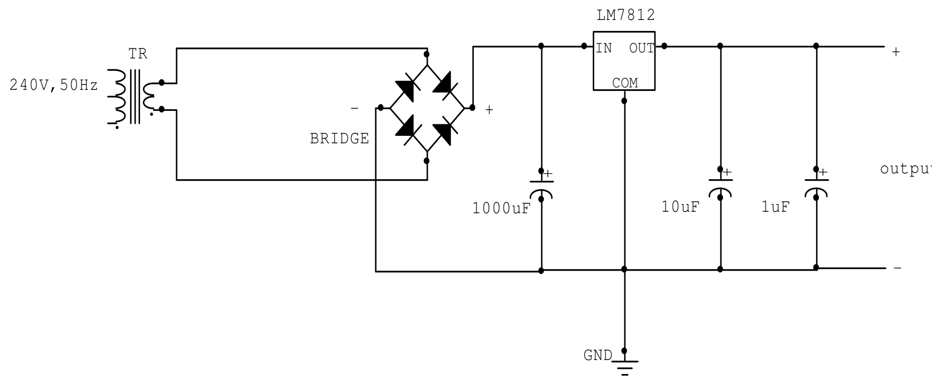

Figure 4.18: +12V Power supply Circuit

5 FULL SCHEMATIC CIRCUITS

5.1. Circuit Operation

The figure given below shows the full schematic circuit of our project. Two power supply is supplied to the circuit (or system) for its operation namely +5 volt and +12 volt. The major components of the circuit are ADC 0808, microcontroller (AT89S52), LCD, temperature sensor, humidity sensor, soil moisture sensor, light sensor, voltage regulator, and step down transformer, transistors, operational amplifier and Schmitt trigger.

The temperatures sensor LM35 senses the analog temperature of the greenhouse and produces the corresponding voltage across its output. Thus produce voltage required to be amplified for the suitable conversion. This is done by the quad amplifier LM324 whose output is connected to pin 2 (or In 4) of the ADC.

The soil moisture sensor uses the 2N2222 NPN transistor and lead sensor. The conduction between lead increases with the increase in moisture level (water level) of soil. The output is taken from the emitter of the transistor which is corresponds the analog voltage of soil moisture. The output is then fed to the pin 3 (or In 5) of ADC.

Similarly LDR’s output is connected to pin 5 (or In7) of ADC. The output of LDR decreases with increase in light intensity.

The humidity sensor HH10D produces the analog frequency that represents the relative humidity. The output of it is connected to pin 13 (port 3.3) of microcontroller. The frequency output of the sensor is manipulated and its corresponding relative humidity is calculated by microcontroller.

The clock to the ADC is provided by Schmitt trigger at pin 10. The ADC selects the input channel according to the address received from the microcontroller in pin 24 and 25 which is connected to pin 14 and 15 of microcontroller. On the reception of start signal ADC starts to convert the analog from sensor to the digital form. The converted digital data

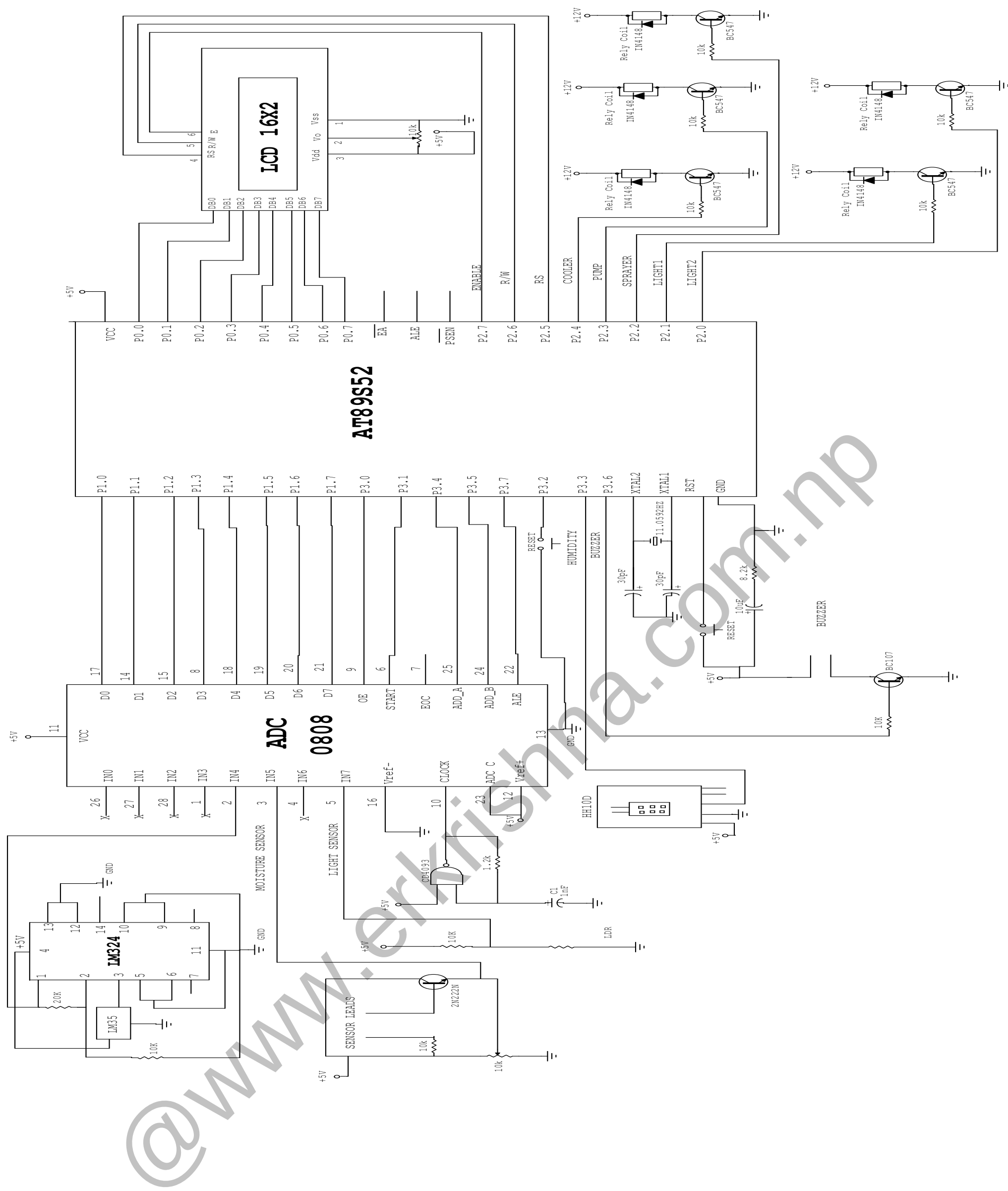

Figure 5.1: Full schematic circuit of system

is placed to the output port on the reception of address latch signal (ALE) from microcontroller.

Now the data received by the microcontroller from ADC is manipulated. It performs the necessary logical action and conversion according to the software installed in it. The microcontroller generates the control signal to drive the relay on the basis of inputted data. The relays are connected at pin 21 to pin 25. The port 0 of the microcontroller is connected to the LCD to display the corresponding value of sensors output. Also by pressing push button on pin 12 we can see status of the devices that maintain greenhouse atmosphere.

6 RESULTS AND CONCLUSIONS

6.1. Results

Here we have used four different sensors which perform according to their characteristics. When there is change in optimum level of all these sensors the question is arise “which one to be served first?” i.e. the priority of the sensors. According to our design we set the priority order in descending order of given sensors viz. humidity sensor, soil moisture sensor, temperature sensor and light sensor. For example if both the level of light and humidity is changed, then first priority will be given to the controlling and maintaining of humidity level before performing the activities related to light sensor. The output result obtained from the four different sensors is listed below:

Illumination status	**LDR sensor output (Vout)**
Optimum	0V- 0.69V
Dim light	0.7V- 2.5V
Dark	2.5V- 3V
Night	3V- 3.47V

Table 6.1: Performance range of LDR sensor

Soil moisture level	**Soil moisture sensor output (Vout)**
Dry	0V- 1.9V
Optimum	1.9V- 3.4V
Excess	3.4V- 4.2V

Table 6.2: Soil moisture level

Temperature range in degree Celsius (ºC)	Temperature sensor output (Vout)
10 to 20	0V- 1V
20 to 40	1V-2V
40 to 60	2V-3V
60 to 80	3V-4V
80 to 100	4V-5V

Table 6.3: Range of temperature sensor (LM35)

6.2. Conclusion

This project entitled "Automation of Artificial Greenhouse" is being undertaken by us as our final year project work for the Bachelor's degree in Electronics Engineering. The project consists of an automated system that monitors and controls the greenhouse climatic parameters for the well growth of the plants and crops. We have put our full effort for the accomplishment of project and make it more users friendly and efficient in terms of application.

Our country is agricultural based country where more than 71 per cent people of total population are engaged in agriculture. The main occupation of the Nepalese people is agricultural sectors. So the new technologies and skills should be adopted for the effective, scientific and efficient methods for farming. The people engaged in this occupation should be facilitating with the new equipments and knowledge to secure their occupation to maintain their livelihood.

We have proposed the microcontroller based automatic system to monitor and control the greenhouse climatic parameters i.e. temperature, soil moisture, humidity, and light intensity, for the proper growth and development of plants and crops. We have put more effort on the reliability of the system and the system performance. The whole system operation is monitored and controlled by a single microcontroller which is the main processing unit of the system. The uses the components like ADC 0808, sensors, operational amplifier, relay switches, LCD, etc. In response to the sensors and controlled signal received from microcontroller, the system will adjust the heating fans, lightening, irrigation immediately, hence protect greenhouse from damage.

The implementation of the automatic system for the automation of greenhouse has overcome many problems. Traditionally the main problems were wastage of water, difficult to maintain the temperature, no appropriate level to adjust the light required for the plants and difficult in maintaining all requirements for the plants and crops. This has overcome by our project. So far the automatic system provides the flexibility and precise form of maintaining the environment. The system consumes the low power and requires less maintenance.

Although the microcontroller is used in this project, the future enhancement should be done for better reliability. We have used microcontroller as according to our requirement.

6.3. Future Enhancement

The system we have proposed "Automation of Artificial Greenhouse" considers the requirements as per our need. This system can be upgraded by undertaking more greenhouse climatic parameters. In this project we have approached the automatic system to control the limited climate variables i.e. light, temperature, humidity, and soil moisture. This can be extended by introduction of methods to control the carbon-dioxide of the greenhouse. More effective use insecticides and pesticides can be done on time bound through drip irrigation method.

Further the system we used in microcontroller based can be replaced by using higher speed and capacity controllers like AVRs and PICs. The system can be connected to communication devices such as modems, cellular phones via wireless data transfer to notify the farmer.

A multiple greenhouse can be monitored and controlled by developing the master controller along with slave controllers that represents a single greenhouse. Also for the non-interrupting operation of system we may use power backup with the help of rechargeable batteries.

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APPENDIX A: FLOW CHART

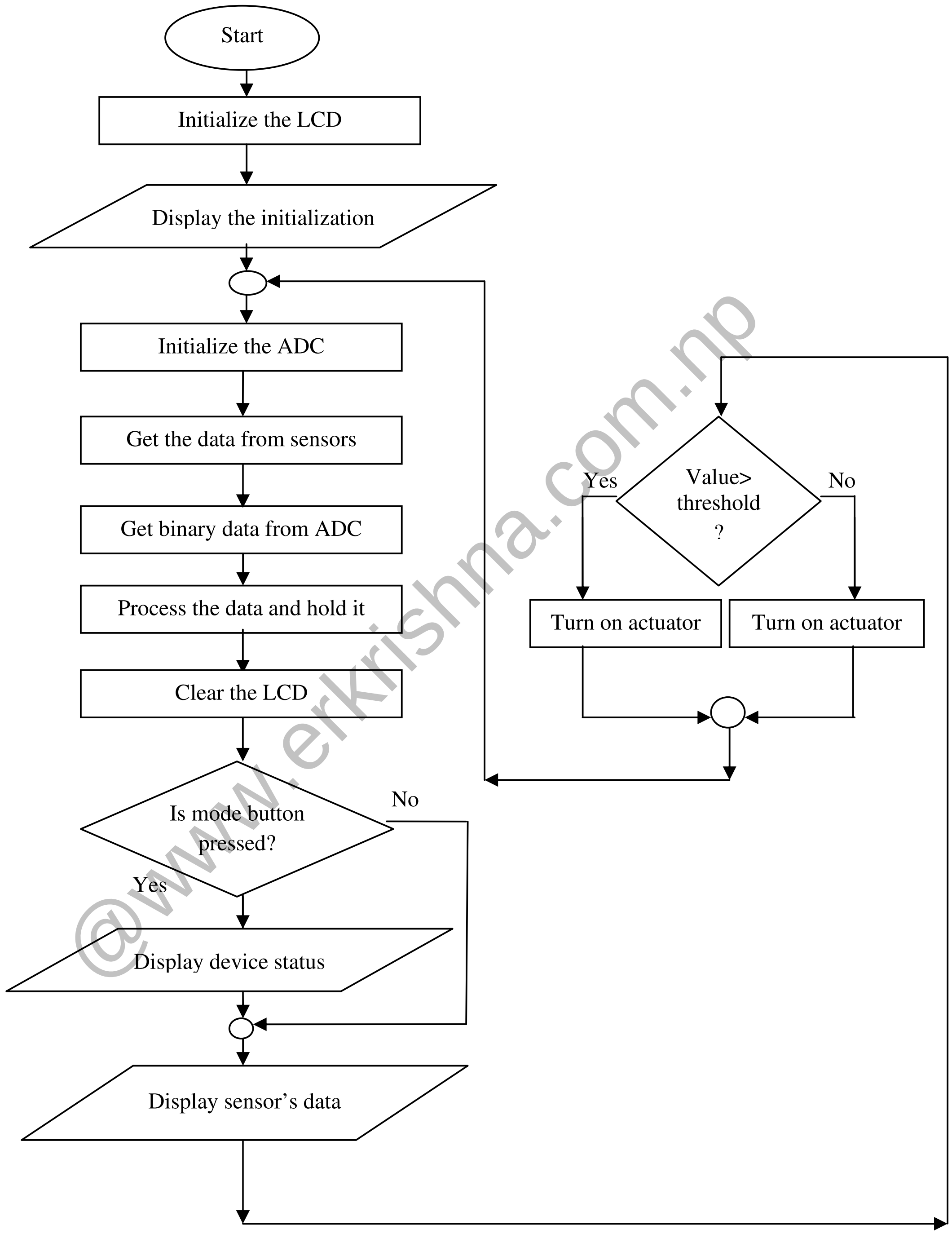

Figure: Flow chart

APPENDIX B: DATA SHEETS