A Project Report on

Plant Growth Monitoring and Automation Using IOT - Platform

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR, ANANTAPURAMU

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted by

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SREE RAMA ENGINEERING COLLEGE

Approved by AICTE, New Delhi - Affiliated to JNTUA, Ananthapuram, Accredited by NAAC with 'A' Grade An ISO 9001:2015 & ISO 14001:2015 certified Institution Rami Reddy Nagar, Karakambadi road, Tirupati-517507

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M2. Encourage the students to have a passion for continuous learning and enhance their abilities to flourish in their career or entrepreneurship.

M3. To instil creative thinking, leadership qualities, ethics, social responsibilities and attitude of gratitude towards the environment and society.

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After the completion of the Program, the graduates of B. Tech. (ECE) will be able to

PEO1. Be cognizant of fundamental engineering concepts and contemporary problem solving capabilities to pursue higher studies, confront the issues of industry and Society.

PEO2. Have the ability to identify, understand, analyze, design and intellectually adept The modern tools to solve engineering problems for their Successful technical and entrepreneurial career.

PEO3. Exhibit leadership skills, organizing capability, presentation skills and opportunities to work as a team on multidisciplinary projects with effective communication skills.

PEO4. Inculcate responsibility, accountability, multidisciplinary approach with ethical values for professional development and showing gratitude towards society.

PROGRAM SPECIFIC OUTCOMES (PSO)

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PSO1. Understand the concepts of engineering and acquire laboratory skills for building,testing and implement application specific electronic systems and apply them to various areas like Analog & Digital Devices, Signal processing, VLSI, Embedded systems, Communication Systems, etc.

PSO2. Demonstrate technical competency in analysis, design, realization of physical systems and validation of Electronics and Communication Engineering systems using latest hardware and software tools.

PSO3. Function in a multi-disciplinary work environment with good interpersonal skills having professional ethics and societal responsibilities for a successful career

PROGRAM OUTCOMES (PO)

On successful completion of the Program, the graduates of B. Tech. (ECE) Program will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

<u>Certificate</u>

This is to certify that the project report entitled

Plant Growth Monitoring and Automation Using IoT Platform

is the bonafide work done and submitted by

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to Jawaharlal Nehru Technological University Anantapur, Anantapuramu, in partial fulfillment of the requirements for the award of the degree of
Bachelor of Technology in **Electronics and Communication Engineering,**
SREE RAMA ENGINEERING COLLEGE

This work has been carried out under the guidance

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Submitted for the project viva-voice examination held on ________________

Examiner – 1

Examiner - 2

ABSTRACT

Agriculture is a very important economic sector that contributes to a nation's overall economic development. According to the UN Food and Agriculture Organization, with a rising population, the cereals demand will reach 3 billion tons by 2050. Also, the mission of Sustainable Development Goals (SDGs) is to provide zero hunger and sustainable agriculture by 2030. With a simultaneous decline in cultivable land and water scarcity, food production has to increase in order to achieve the above mission. Vertical farming is a current state of art agriculture technology to increase crop yield per unit area. This work focuses on designing and constructing an IoT-enabled smart vertical farming system with a controlled environment for plant growth. This system uses the hydroponic Deep Flow Technique (DFT), various sensors, and an auto pH and Total Dissolved Solids (TDS) balancing system. This paper provides a comparative analysis of IoT-based controlled environment vertical farming setup with the uncontrolled setup for Romaine lettuce in terms of plant growth parameters like plant height, maximum leaf length, maximum leaf width, and fresh and dry weight of the plant. The observed fresh weight of the aerial part for automated and unautomated setup is found to be 58.66 g and 48.81 g respectively. Also, the chemical analysis showed the plants possess the required optimum range of micro and macronutrients for both setups. The macronutrient results obtained for the controlled/automated (A setup), and uncontrolled/unautomated setup (U setup for Phosphorus (P), and Potassium (K) are (PA, PU) (5.91 g/Kg, 6.06 g/Kg), and (KA, KU) (67.03 g/Kg, 74.01 g/Kg) respectively

ACKNOWLEDGEMENTS

We are deeply indebted to our supervisor, ***Mrs. T. L. REKHA REDDY, M. Tech., Associate Professor, Department of Electronics and Communication Engineering,*** *for her valuable guidance, constant encouragement and keen interest evinced throughout the course of our Project work.*

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We express our gratitude to our Principal ***Dr. K. JAYACHANDRA, Ph.D.*** *and the* ***Management*** *of SRET for providing all kinds of support. We express our heartfelt thanks to all our* ***teachers*** *in the department of* ***ECE*** *of Sree Rama Engineering College for their moral support and good wishes.*

We Thank ***Sri M. ARAVIND KUMAR REDDY, BE., MBA,*** *the director of* ***Sree Rama Engineering College,*** *Tirupati for all necessary help in carrying out this seminar.*

Finally, we would like to express sincere thanks to our parents, one and all those who guided, inspired and helped us in completion of our Project work.

DECLARATION

We here by declare that the Project report entitled *"***Plant Growth Monitoring an Automation Using IoT Platform"** has been submitted by us under the guidance and supervision of ***Mrs. T. L REKHA REDDY*, M. Tech, Assistant professor** of Electronics and Communication Engineering**, Sree Rama Engineering College, Tirupati** in partial fulfillment for the of **Bachelor Of Technology** in Electronics and Communication Engineering is a record of bonafide work carried out by us and the work has been submitted during the final year second semester for the academic year 2020-2024

Place:

Date:

By

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LIST OF ABBREVIATIONS

ABBREVIATIONS		DESCRIPTION
LCD	:	Light depended resister
PH	:	Potential of hydrogen
PPM	:	Parts per million
PPFD	:	Photosynthetic photon flux density
LED	:	Light emitting diode
TDS	:	Total dissolved solids
FWAP	:	Fresh weight of aerial part
FWR	:	Fresh weight of root
DWAP	:	Dry weight of the aerial part
DWR	:	Dry weight of root
TNL	:	Total number of leaves
UHVF	:	Unwanted hydrogen vertical farming
NPK	:	Nitrogen phosphorus potassium
ROM	:	Read only memory
RAM	:	Random access memory

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CHAPTER – 1

INTRODUCTION

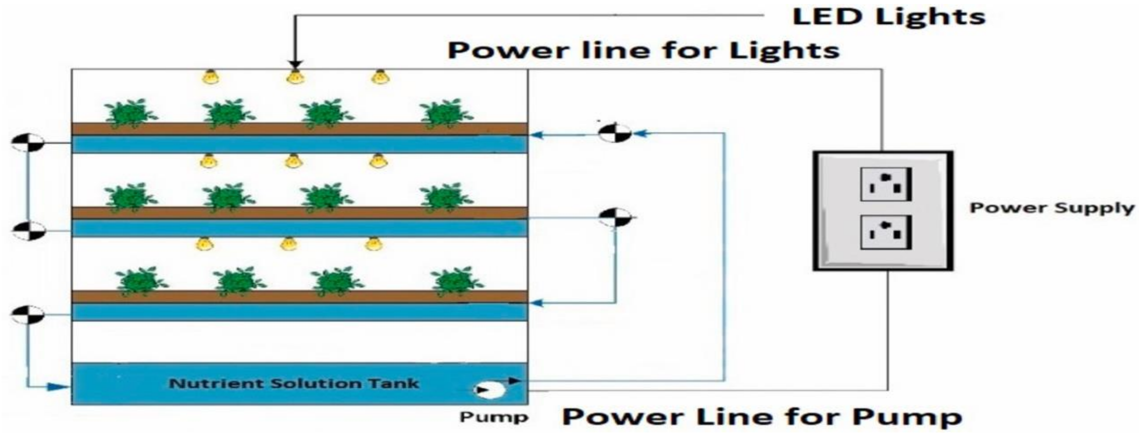
1.1 Introduction to project

The continuous increase in the world population greatly impacts the food demand, as it is estimated that, the global population could grow to around 9.7 billion in 2050, and 10.9 billion in 2100 when compared with the projected 7.7 billion people worldwide in 2019 (Nations, 2022). At the same time, it is an alarming situation for India. As India's population is expected to reach 1.7 billion which will make India the most populated country (Hamshere et al., 2014; Hinz et al., 2020). With the increasing population, as the food demands are increasing, cultivable/arable land is decreasing (Maja and Ayano, 2021). It was reported in (Jain, 2011) that there is a 42% increase in land requirement for food between 1963-2009 with about a 48% per capita decrease in the same for India

As per the estimation reported in (Nath et al., 2015), the demand for water and food in India is likely to increase by 2050. Food requirement is projected to reach 481 and 515 million tons by 2050 and 2065 respectively. As the Indian economy is highly dependent on agricultural fields, there is a need to shift to new agricultural practices to meet the increasing population's high food requirements with minimum land use. Further, as the population is rising, clean water availability is also reducing and there is a rapid depletion of usable groundwater reported for the year 2005-2013 (Mancosu et al., 2015). The study reported that there is a loss of 8.5 km3/year and 5 km3/year in northern and eastern parts of India respectively impending risks of severe drought, water scarcity, and food crisis (Mancosu et al., 2015).

. The dimensions of the Tashi Home system are 4.5 ft × 1.5 ft × 5 ft. Inside each planting hole, there are 2-inch net pots, coco peat, and clay balls used to hold the lettuce plant. Tashi system has an ABS tub with dimensions 4.5 ft × 1 ft × 0.5 ft which has a water holding capacity of roughly 70 liters to hold nutrient solution. However, other structures like Tashi Nino and Tashi Pro are also available at Pindfresh which are having plant capacities of 20 plants and 120 plants respectively could be used depending upon the requirement. As, Tashi Nino is single layered setup but we have a requirement of multiple layers, so Tashi home is used here. Hydroponic nutrient solutions are required for the growth of the plant in hydroponic vertical farming as there is no use of soil in hydroponic vertical farming. Apart from these, grow lights are also used by Pin fresh which uses full-spectrum lights to promote the use of photosynthesis, which provides energy to the plant for their growth.

The Tashi home setup could be used to grow plants in an indoor environment but it needs daily care and attention to maintain the required plant growth parameters in an indoor environment. 2.2. Automated and unautomated setup for hydroponic vertical farming



For comparative analysis of the unautomated and automated system, two Tashi Home systems are used to compare the plant growth parameters of Romaine lettuce and its chemical analysis. Romaine Lettuce is chosen here taking into consideration its shorter growth cycle. Also being a salad leaf, it is gaining popularity, especially after COVID when people are trying to implement healthy food habits. For experimental purposes, two setups are used. The first setup without any sensors is referred to as an unautomated setup as shown in Fig. 1.

The second setup is designed with all the sensors and actuators to reduce human intervention and is referred to as an automated setup as shown in Fig. 2. For an automated system, the integration of sensors and actuators is enabled using IoT for controlling and monitoring whereas for an unautomated system, sensors are only used for taking readings of parameters and it is controlled manually. In the hydroponic system, sensors are used to record the parameter values such as TDS, temperature, humidity , pH and water level, etc., for plant growth. However, in the automated system, these sensor values are used as a feedback system that automatically maintains the optimum parameters' values for proper plant growth whereas in the unautomated system these optimum values are achieved by manual controlling.

The block diagram of the hydroponic vertical farming system along with sensors requirements is shown in Fig. 3. These sensors are connected to the microcontroller to monitor these parameters. For recording the values of temperature/humidity, toxic gases, and light intensity- DHT 11, MQ2, and LDR sensors are used. Whereas for nutrient monitoring and control-pH, TDS, flow sensor, and Ultrasonic level sensors are employed.

Arduino Mega along with Raspberry pi are the main controller units. Both are connected serially using UART communication. The system employs a DHT-11 sensor to measure temperature and humidity. The required temperature for proper plant growth should have an optimum temperature range between 20 ◦ C-26 ◦ C. Based on the values received from the se-nsor, the relay switch is used to turn the FAN ON, if the value exceeds 26 ◦ C.

1.2 BLOCK DIAGRAM:

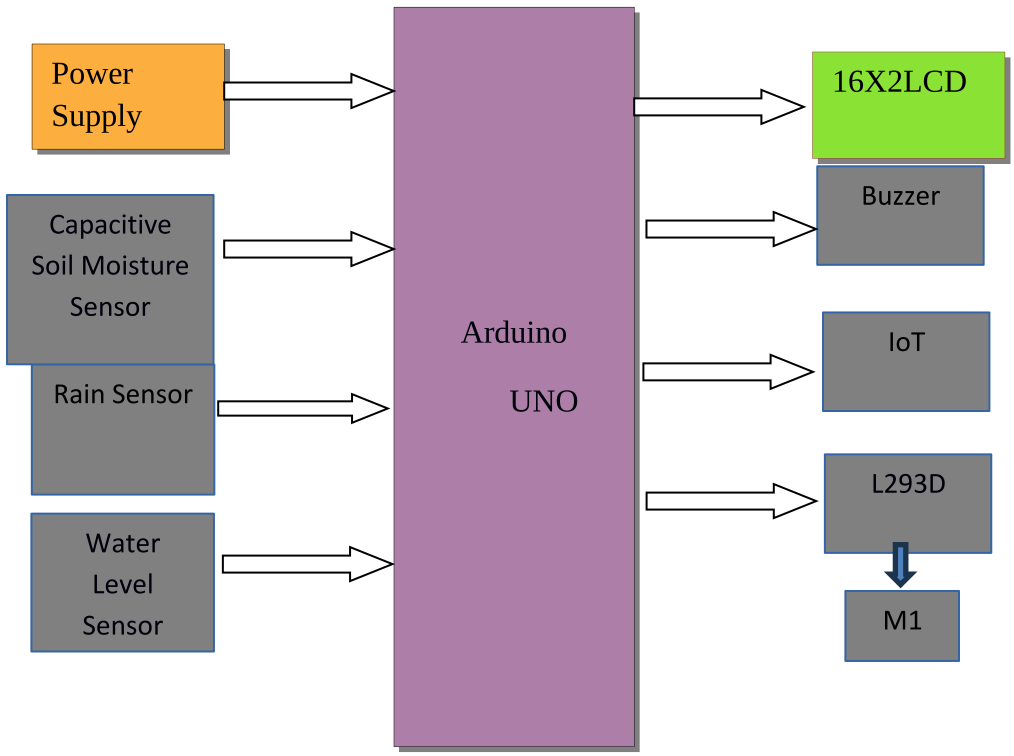


Fig 1.1 Block diagram

1.3 INTRODUCTION TO EMBEDDED SYSTEMS

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, sometimes with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Physically embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems — such as the operating systems and microprocessors which power them — but are not truly embedded systems, because they allow different applications to be load and peripherals to be connected.

An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular kind of application device. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines, and toys (as well as the more obvious cellular phone and PDA) are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with a programming interface, and embedded systems programming is a specialized occupation. Certain operating systems or language platforms are tailored for the embedded market, such as Embedded Java and Windows XP Embedded.

However, some low-end consumer products use very inexpensive microprocessors and limited storage, with the application and operating system both part of a single program. The program is written permanently into the system's memory in this case, rather than being loaded into RAM (random access memory), as programs on a personal computer are.

1.3.1 CHARACTERISTIC OF EMBEDDED SYSTEM

- Speed (bytes/sec): Should be high speed
- Power (watts): Low power dissipation
- Size and weight: As far as possible small in size and low weight
- Accuracy (%error): Must be very accurate
- Adaptability: High adaptability and accessibility
- Reliability: Must be reliable over a long period of time

1.3.2 APPLICATIONS OF EMBEDDED SYSTEMS

We are living in the Embedded World. You are surrounded with many embedded products and your daily life largely depends on the proper functioning of these gadgets. Television, Radio, CD player of your living room, Washing Machine or Microwave Oven in your kitchen, Card readers, Access Controllers, Palm devices of your work space enable you to do many of your tasks very effectively. Apart from all these, many controllers embedded in your car take care of car operations between the bumpers and most of the times you tend to ignore all these controllers.

- **Robotics:** industrial robots, machine tools, Robocop soccer robots
- **Automotive:** cars, trucks, trains
- **Aviation:** airplanes, helicopters
- **Aerospace:** rockets, satellites
- **Energy systems:** windmills, nuclear plants
- **Medical systems:** prostheses, revalidation machine.

1.3.3 MICROCONTROLLER VERSUS MICROPROCESSOR

What is the difference between a Microprocessor and Microcontroller? By microprocessor is meant the general purpose Microprocessors such as Intel's X86 family (8086, 80286, 80386, 80486, and the Pentium) or Motorola's 680X0 family (68000, 68010, 68020, 68030, 68040, etc). These microprocessors contain no RAM, no ROM, and no I/O ports on the chip itself. For this reason, they are commonly referred to as general-purpose Microprocessors.

A system designer using a general-purpose microprocessor such as the Pentium or the 68040 must add RAM, ROM, I/O ports, and timers externally to make them functional. Although the addition of external RAM, ROM, and I/O ports makes these systems bulkier and much more expensive, they have the advantage of versatility such that the designer can decide on the amount of RAM, ROM and I/O ports needed to fit the task at hand. This is not the case with Microcontrollers.

1.3.4 MICROCONTROLLERS FOR EMBEDDED SYSTEMS

In the Literature discussing microprocessors, we often see the term Embedded System. Microprocessors and Microcontrollers are widely used in embedded system products. An embedded system product uses a microprocessor (or Microcontroller) to do one task only. A printer is an example of embedded system since the processor inside it performs one task only; namely getting the data and printing it. Contrast this with a Pentium based PC. A PC can be used for any number of applications such as word processor, print-server, bank teller terminal, Video game, network server, or Internet terminal. Software for a variety of applications can be loaded and run

1.4 Microcontroller

1.4.1 Introduction to Microcontroller

Microcontroller as the name suggest, a small controller. They are like single chip computers that are often embedded into other systems to function as processing/controlling unit. For example, the control you are using probably has microcontrollers inside that do decoding and other controlling functions. They are also used in automobiles, washing machines, microwaves ovens, toys….etc, where automation is needed.

1.4.2 Arduino Uno Microcontroller

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means "One" in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5Vpin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.·
- **5V. The** regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3.3V.**A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

1.4.3 Memory

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

1.4.4 Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip .
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, arising or falling edge, or a change in value. See the attach Interrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication, which although provided by the underlying hardware, is not currently included in the Arduino language.
- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- **I2C: 4 (SDA) and 5 (SCL).** Support I2C (TWI) communication using the Wire library. There are a couple of other pins on the board:
- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

1.4.5 Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USBCOM drivers, and no external driver is needed. However, on Windows, an *.inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1.

1.5 ARDUINO UNO BOARD

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converters.

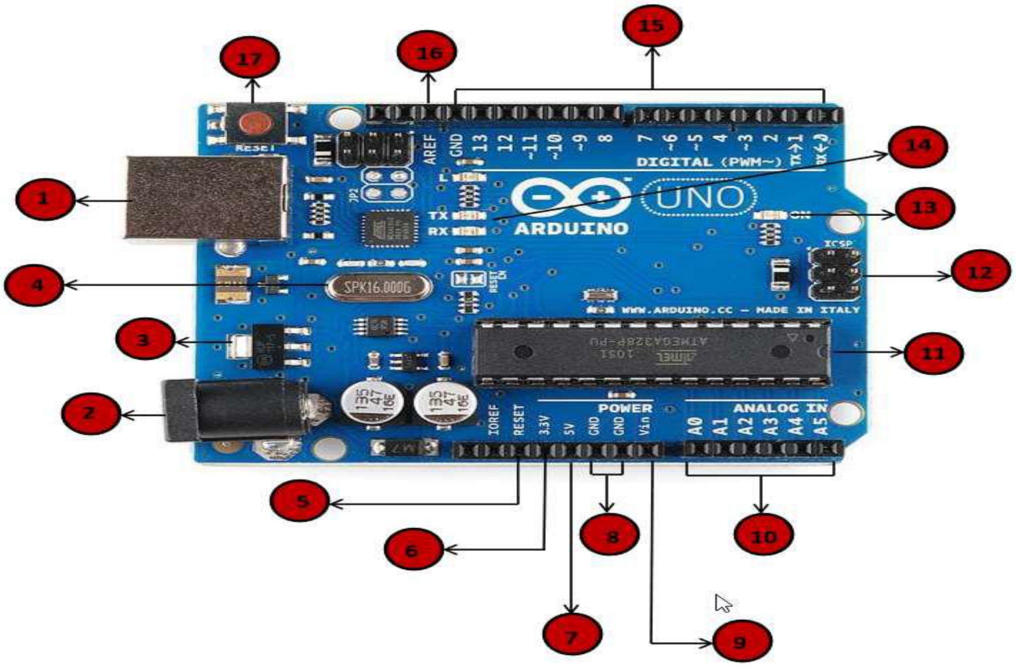


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Fig 1.2 -Arduino uno board

Technical specifications:

FEATURE	SPECIFICATION
Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Table-1: Arduino uno specifications

1.5.1 USB Interface

Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection

1.5.2 External power supply

Arduino boards can be powered directly from the AC mains power supply by connecting it to the power supply (Barrel Jack)

1.5.3 Voltage Regulator

The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.

1.5.4 Crystal Oscillator

The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz.

1.5.5 Arduino Reset

It can reset your Arduino board, i.e., start your program from the beginning. It can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).

1.5.6 Pins (3.3, 5, GND, Vin)

- 3.3V (6): Supply 3.3 output volt
- 5V (7): Supply 5 output volt
- Most of the components used with Arduino board works fine with 3.3 volt and 5 volt.
- GND (8)(Ground): There are several GND pins on the Arduino, any of which can be used to ground your circuit.
- Vin (9): This pin also can be used to power the Arduino board from an external power source, like AC mains power supply.

1.5.7 Analog pins

The Arduino UNO board has five analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

1.5.8 Main microcontroller

Each Arduino board has its own microcontroller (11). You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. You must know what IC your board has before loading up a new program from the Arduino IDE. This information is available on the top of the IC.The Atmega8U2 programmed as a USB-to-serial converter. "Uno" means "One" in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards

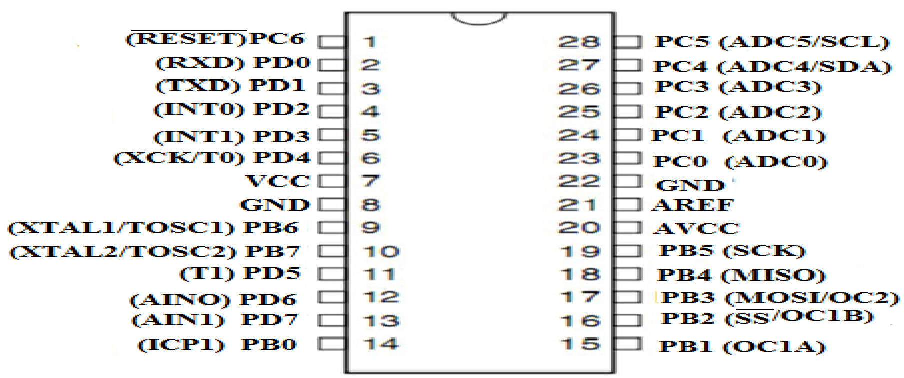


Fig 1.3: Pin diagram

1.5.8.1 Pin Description:

VCC: Digital supply voltage.

GND: Ground.

1.5.8.2 Port B (PB[7:0]) XTAL1/XTAL2/TOSC1/TOSC2:

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

Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier.

If the Internal Calibrated RC Oscillator is used as chip clock source, PB[7:6] is used as TOSC[2:1] input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

1.5.8.3 Port C (PC[5:0]):

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC[5:0] output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs,

Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

1.5.8.4 PC6/RESET:

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C.

If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a Reset.

1.5.8.5 Port D (PD[7:0]):

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

1.5.8.6 AVCC: AVCC is the supply voltage pin for the A/D Converter, PC[3:0], and PE[3:2]. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC[6:4] use digital supply voltage, VCC.

AREF: AREF is the analog reference pin for the A/D Converter.

1.5.8.7 ADC [7:6] (TQFP and VFQFN Package Only): In the TQFP and VFQFN package, ADC[7:6] serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

12. ICSP pin: Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the SPI bus.

13. Power LED indicator: This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection.

14. TX and RX LEDs: On your board, you will find two labels: TX (transmit) and RX (receive). They appear in two places on the Arduino UNO board. First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led (13). The TX led flashes with different speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process.

15. Digital I / O: The Arduino UNO board has 14 digital I/O pins (15) (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labeled “~” can be used to generate PWM.

16. AREF: AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins working.

1.6 Software

1.6.1 Introduction to Arduino IDE

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

1.6.2 The key features are:

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading
- not need an extra piece of hardware (called a programmer) in order to load a new software).
- Unlike most previous programmable circuit boards, Arduino does code onto the board. You can simply use a USB cable.
- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.
- Finally, Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

After learning about the main parts of the Arduino UNO board, we are ready to learn how to set up the Arduino IDE. Once we learn this, we will be ready to upload our program on the Arduino board.

1.6.3 Arduino data types:

Data types in C refers to an extensive system used for declaring variables or functions of different types. The type of a variable determines how much space it occupies in the storage and how the bit pattern stored is interpreted.

The following table provides all the data types that you will use during Arduino programming.

Void:

The void keyword is used only in function declarations. It indicates that the function is expected to return no information to the function from which it was called.

Example:

```
Void Loop ( )

{

// rest of the code

}
```

Boolean:

A Boolean holds one of two values, true or false. Each Boolean variable occupies one byte of memory.

Example:

Boolean state= false ; // declaration of variable with type boolean and initialize it with false.

Boolean state = true ; // declaration of variable with type boolean and initialize it with false.

Char: A data type that takes up one byte of memory that stores a character value. Character literals are written in single quotes like this: 'A' and for multiple characters, strings use double quotes: "ABC".

However, characters are stored as numbers. You can see the specific encoding in the ASCII chart. This means that it is possible to do arithmetic operations on characters, in which the ASCII value of the character is used. For example, 'A' + 1 has the value 66, since the ASCII value of the capital letter A is 65.

Example:

Char chr_a = ‘a’ ;//declaration of variable with type char and initialize it with character a.

Char chr_c = 97 ;//declaration of variable with type char and initialize it with character 97

Unsigned char:

Unsigned char is an unsigned data type that occupies one byte of memory. The unsigned char data type encodes numbers from 0 to 255.

Example:

Unsigned Char chr_y = 121 ; // declaration of variable with type Unsigned char and initialize it with character y

Byte:

A byte stores an 8-bit unsigned number, from 0 to 255.

Example:

byte m = 25 ;//declaration of variable with type byte and initialize it with 25

int:

Integers are the primary data-type for number storage. **int** stores a 16-bit (2-byte) value. This yields a range of -32,768 to 32,767 (minimum value of -2^15 and a maximum value of (2^15) - 1).

The **int** size varies from board to board. On the Arduino Due, for example, an **int** stores a 32-bit (4-byte) value. This yields a range of -2,147,483,648 to 2,147,483,647 (minimum value of -2^31 and a maximum value of (2^31) - 1).

Example:

int counter = 32 ;// declaration of variable with type int and initialize it with 32.

Unsigned int:

Unsigned ints (unsigned integers) are the same as int in the way that they store a 2 byte value. Instead of storing negative numbers, however, they only store positive values, yielding a useful range of 0 to 65,535 (2^16) - 1). The Due stores a 4 byte (32-bit) value, ranging from 0 to 4,294,967,295 (2^32 - 1).

Example:

Unsigned int counter= 60 ; // declaration of variable with type unsigned int and initialize it with 60.

Word:

On the Uno and other ATMEGA based boards, a word stores a 16-bit unsigned number. On the Due and Zero, it stores a 32-bit unsigned number.

Example

word w = 1000 ;//declaration of variable with type word and initialize it with 1000.

Long:

Long variables are extended size variables for number storage, and store 32 bits (4 bytes), from 2,147,483,648 to 2,147,483,647.

Example:

Long velocity= 102346 ;//declaration of variable with type Long and initialize it with 102346

Unsigned long: Unsigned long variables are extended size variables for number storage and store 32 bits (4 bytes). Unlike standard longs, unsigned longs will not store negative numbers, making their range from 0 to 4,294,967,295 (2^32 - 1).

Example:

Unsigned Long velocity = 101006 ;// declaration of variable with type Unsigned Long and initialize it with 101006.

Short:

A short is a 16-bit data-type. On all Arduinos (ATMega and ARM based), a short stores a 16-bit (2-byte) value. This yields a range of -32,768 to 32,767 (minimum value of -2^15 and a maximum value of (2^15) - 1).

Example:

short val= 13 ;//declaration of variable with type short and initialize it with 13

Float:

Data type for floating-point number is a number that has a decimal point. Floating-point numbers are often used to approximate the analog and continuous values because they have greater resolution than integers.

Floating-point numbers can be as large as 3.4028235E+38 and as low as 3.4028235E+38. They are stored as 32 bits (4 bytes) of information.

Example:

float num = 1.352;//declaration of variable with type float and initialize it with 1.352.

Double:

On the Uno and other ATMEGA based boards, Double precision floating-point number occupies four bytes. That is, the double implementation is exactly the same as the float, with no gain in precision. On the Arduino Due, doubles have 8-byte (64 bit) precision.

Example:

double num = 45.352 ;// declaration of variable with type double and initialize it with 45.352.

In this section, we will learn in easy steps, how to set up the Arduino IDE on our computer and prepare the board to receive the program via USB cable.

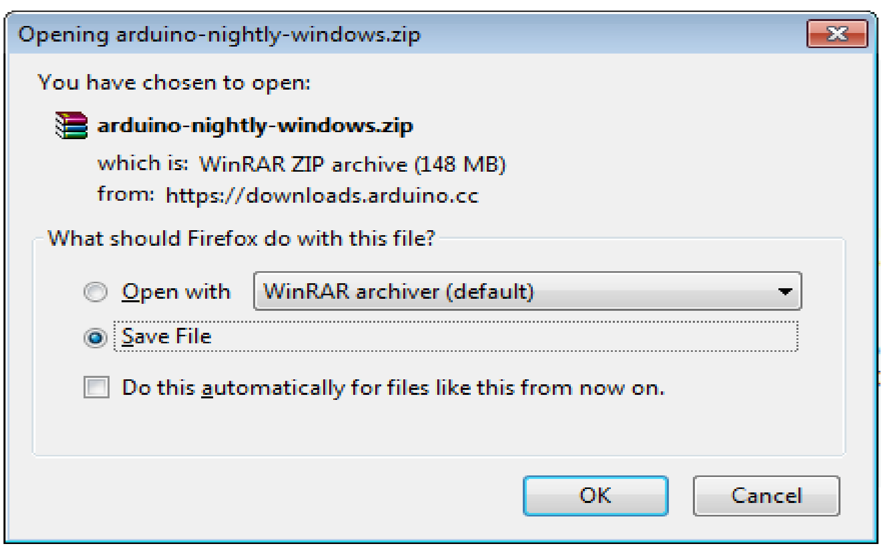
1.6.4 Steps to set up Arduino uno:

Step 1: First you must have your Arduino board (you can choose your favorite board) and a USB cable. In case you use Arduino UNO, Arduino Duemilanove, Nano, Arduino Mega2560, or Diecimila, you will need a standard USB cable (A plug to B plug), the kind you would connect to a USB printer as shown in the following image.

Fig 1.4: USB Cable

Step 2: Download Arduino IDE Software.

You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.

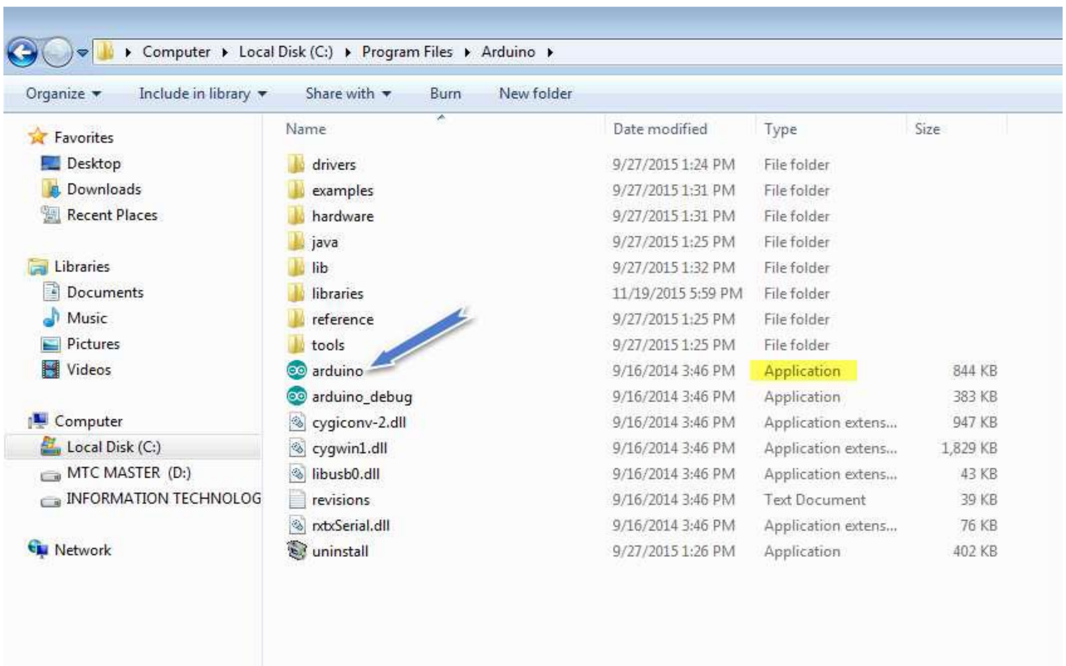


Step 3: Power up your board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If you are using an Arduino Diecimila, you have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it is on the two pins closest to the USB port. Connect the Arduino board to your computer using the USB cable. The green power LED (labeled PWR) should glow.

Step 4: Launch Arduino IDE.

After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double click the icon to start the IDE.



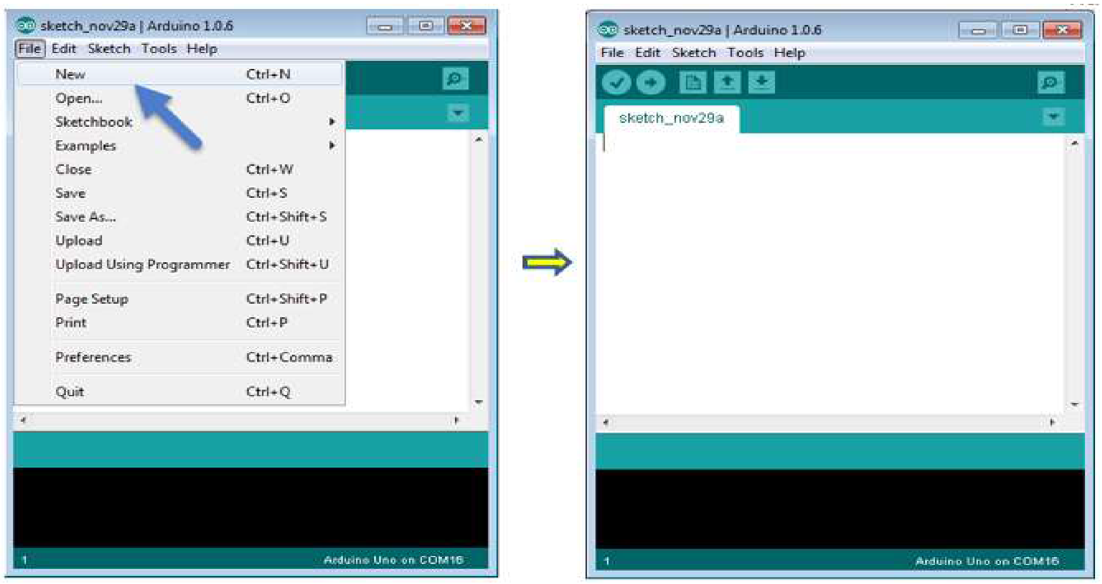
Step 5: Open your first project.

Once the software starts, you have two options:

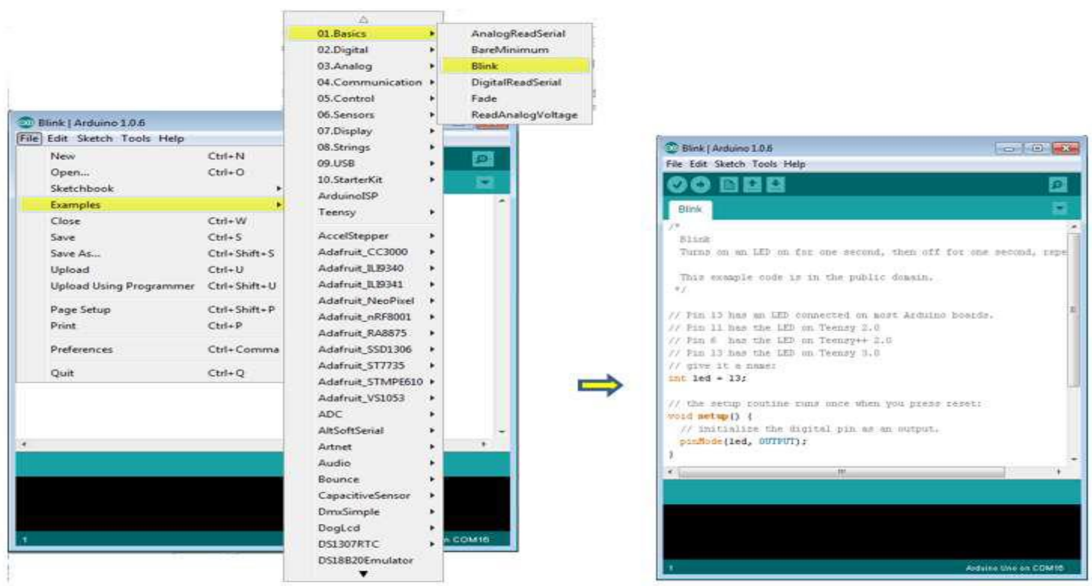
- Create a new project.

- Open an existing project example.

To create a new project, select File --> New. To open



To open an existing project example, select File -> Example -> Basics -> Blink.

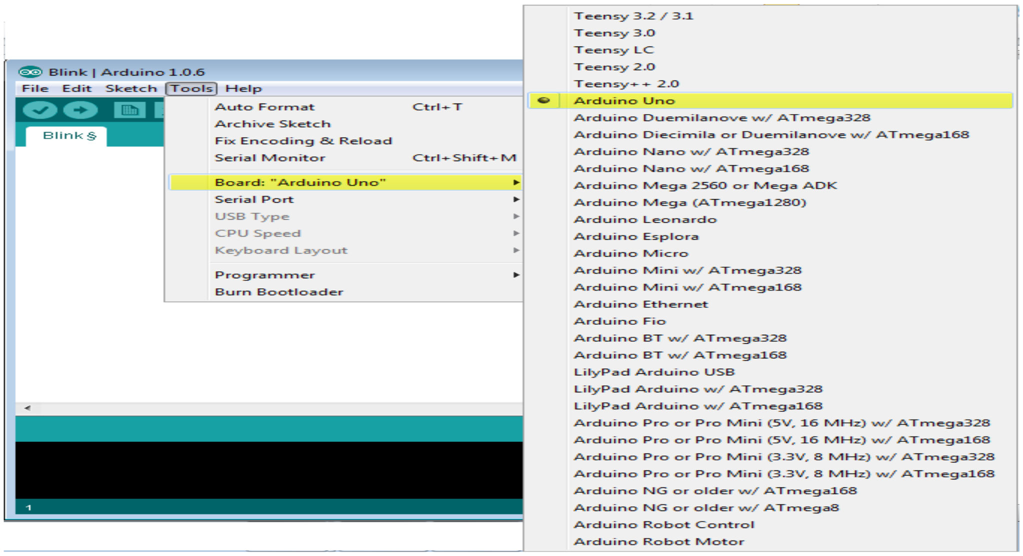


Here, we are selecting just one of the examples with the name **Blink**. It turns the LED on and off with some time delay. You can select any other example from the list.

Step 6: Select your Arduino board.

To avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

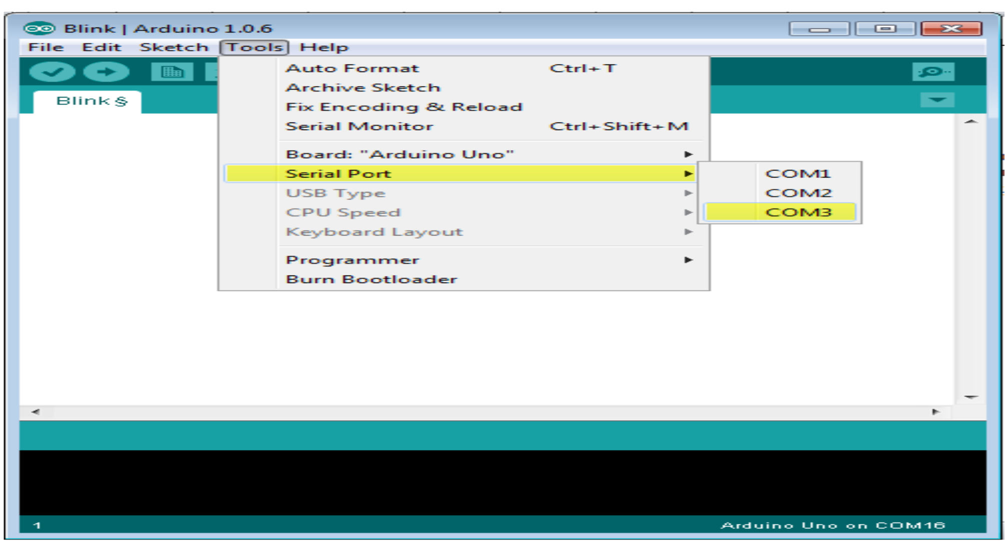
Go to Tools -> Board and select your board



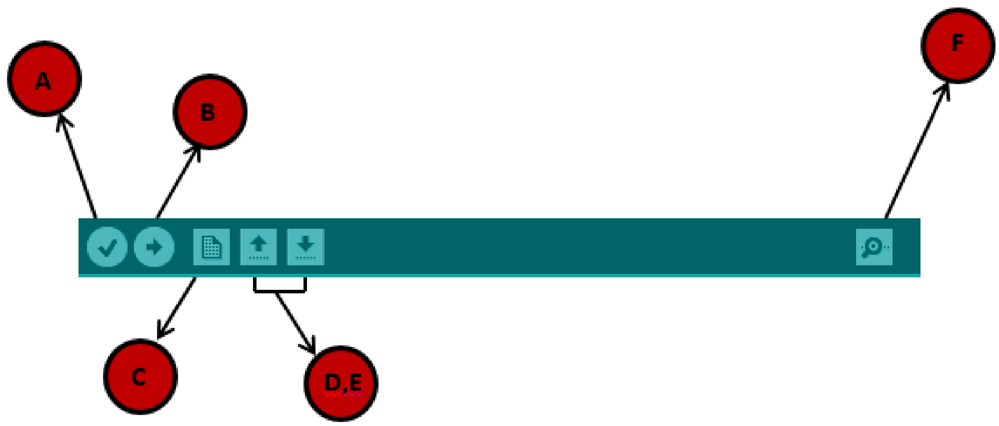
Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using

Step 7: Select your serial port.

Select the serial device of the Arduino board. Go to **Tools** ->**Serial Port** menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port.



Step 8: Upload the program to your board. Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.



A- Used to check if there is any compilation error.

B- Used to upload a program to the Arduino board.

C- Shortcut used to create a new sketch.

D- Used to directly open one of the example sketch.

E- Used to save your sketch.

F- Serial monitor used to receive serial data from the board and send the serial data to the board.

Now, simply click the "Upload" button in the environment. Wait a few seconds; you will see the RX and TX LEDs on the board, flashing. If the upload is successful, the message "Done uploading" will appear in the status bar.

Note: If you have an Arduino Mini, NG, or other board, you need to press the reset button physically on the board, immediately before clicking the upload button on the Arduino Software.

Arduino programming structure

In this chapter, we will study in depth, the Arduino program structure and we will learn more new terminologies used in the Arduino world. The Arduino software is open-source. The source code for the Java environment is released under the GPL and the C/C++ microcontroller libraries are under the LGPL.

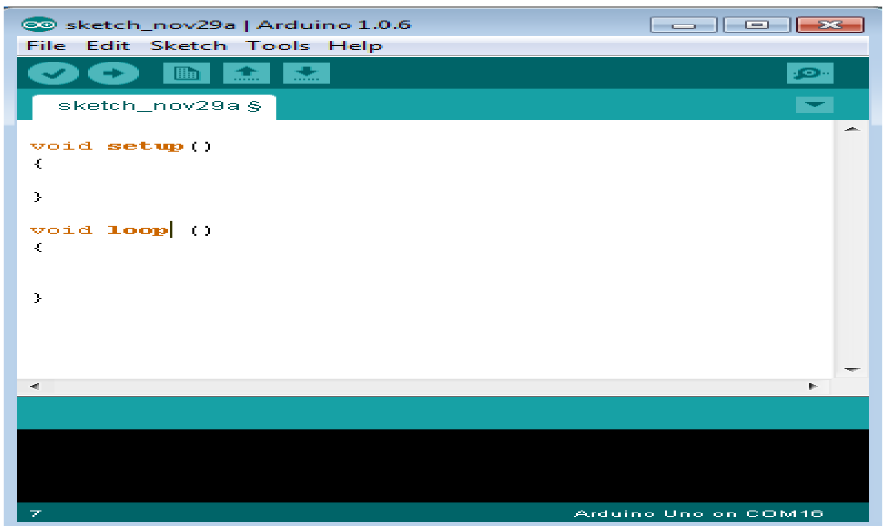
Sketch: The first new terminology is the Arduino program called "**sketch**".

Structure

Arduino programs can be divided in three main parts: **Structure**, **Values** (variables and constants), and **Functions**. In this tutorial, we will learn about the Arduino software program, step by step, and how we can write the program without any syntax or compilation error.

Let us start with the **Structure**. Software structure consist of two main functions:

- Setup( ) function
- Loop( ) function



Void setup ( )

{

}

PURPOSE:

The **setup()** function is called when a sketch starts. Use it to initialize the variables, pin modes, start using libraries, etc. The setup function will only run once, after each power up or reset of the Arduino board.

INPUT OUTPUT RETURN

Void Loop ( )

{

}

PURPOSE:

After creating a **setup()** function, which initializes and sets the initial values, the **loop()** function does precisely what its name suggests, and loops secutively, allowing your program to change and respond. Use it to actively control the Arduino board.

1.7 Hardware

1.7.1 POWER SUPPLY UNIT

The power supply for this system is shown below.

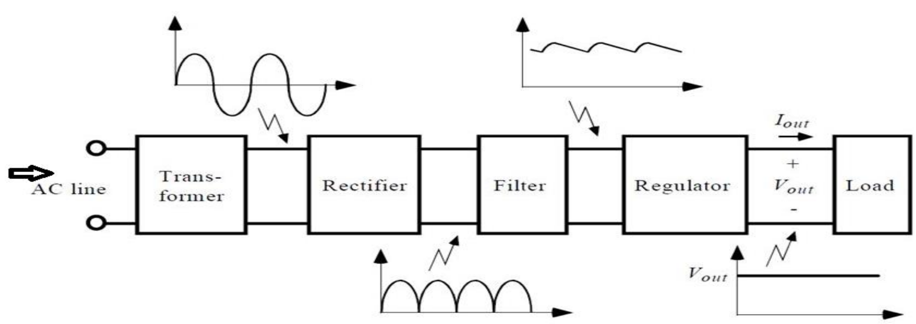


Fig 1.5: power supply

1.7.2 Transformer

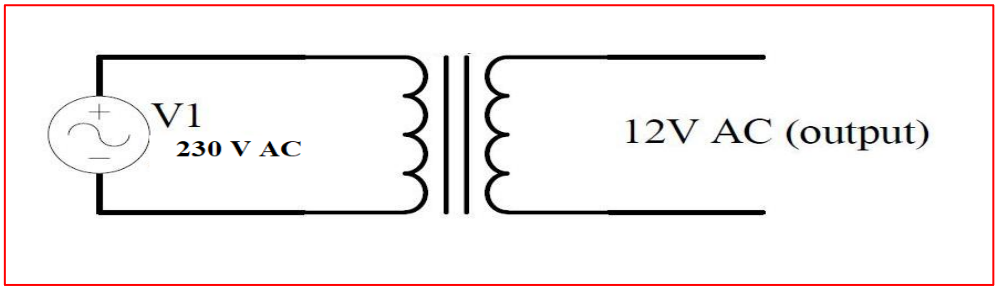
Transformer is a static device used to convert the voltage from one level to another level without change its frequency. There are two types of transformers

1. Step-up transformer
2. Step-down transformer

Step-up transformer converts low voltage level into high voltage level without change its frequency.

Step-down transformer converts high voltage level into low voltage level without change its frequency.

In this project we using step-down transformer which converts 230V AC to 12V AC [or] 230V AC to 5V as shown below.



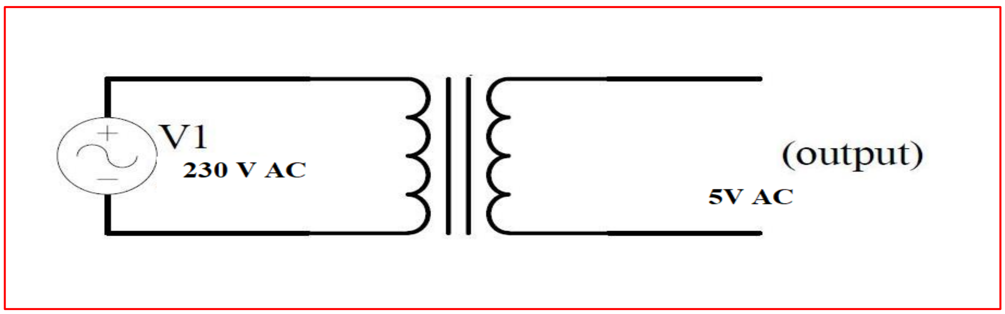


Fig1.6: Transformers

1.7.3 Diodes

Diodes allow electricity to flow in only one direction. The arrow of the circuit symbol shows the direction in which the current can flow. Diodes are the electrical version of a valve and early diodes were actually called valves.

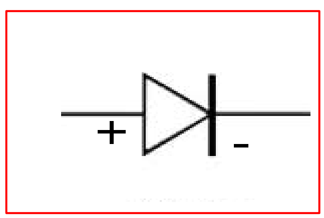


Fig1.7: Diode Symbol

A **diode** is a device which only allows current to flow through it in one direction. In this direction, the diode is said to be 'forward-biased' and the only effect on the signal is that there will be a voltage loss of around 0.7V. In the opposite direction, the diode is said to be 'reverse-biased' and no current will flow through it.

1.7.4 Rectifier

The purpose of a rectifier is to convert an AC waveform into a DC waveform (OR) Rectifier converts AC current or voltages into DC current or voltage. There are two different rectification circuits, known as **'half-wave'** and **'full-wave' rectifiers**. Both use components called **diodes** to convert **AC into DC**.

1.7.4.1 The Half-wave Rectifier

The half-wave rectifier is the simplest type of rectifier since it only uses one diode, as shown in figure.

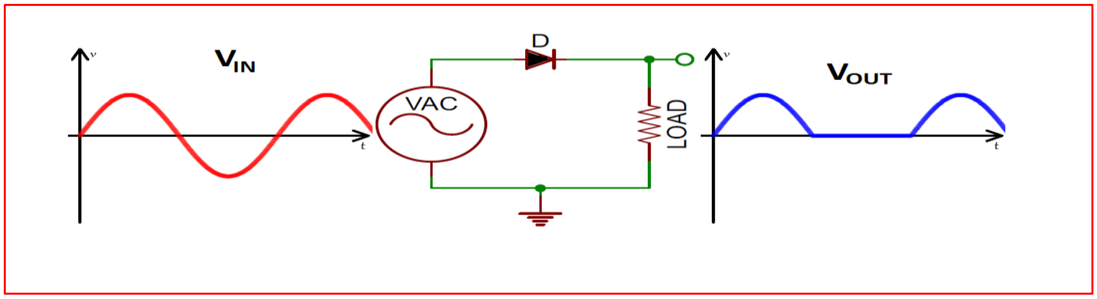


Fig1.8: Half Wave Rectifier

Figure 2 shows the AC input waveform to this circuit and the resulting output. As you can see, when the AC input is positive, the diode is forward-biased and lets the current through. When the AC input is negative, the diode is reverse-biased and the diode does not let any current through, meaning the output is 0V. Because there is a 0.7V voltage loss across the diode, the peak output voltage will be 0.7V less than Vs.

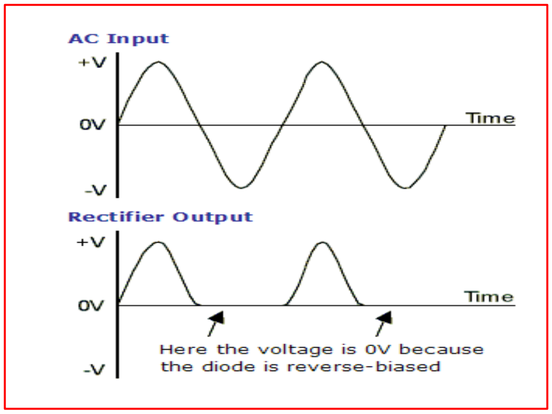


Fig 1.9: Half-Wave Rectification

While the output of the half-wave rectifier is DC (it is all positive), it would not be suitable as a power supply for a circuit. Firstly, the output voltage continually varies between 0V and Vs-0.7V, and secondly, for half the time there is no output at all.

1.7.4.2The Full-wave Bridge Rectifier

The circuit in figure 3 addresses the second of these problems since at no time is the output voltage 0V. This time four diodes are arranged so that both the positive and negative parts of the AC waveform are converted to DC. The resulting waveform is shown in figure 4.

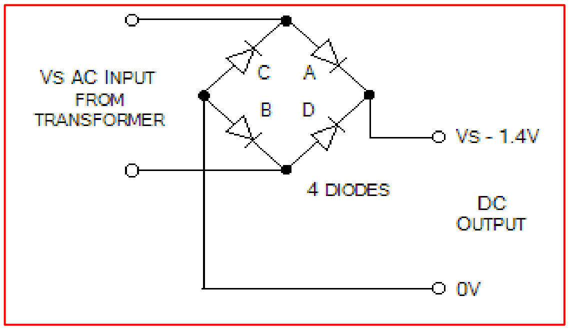


Fig 1.9.1: Full-Wave Rectifier

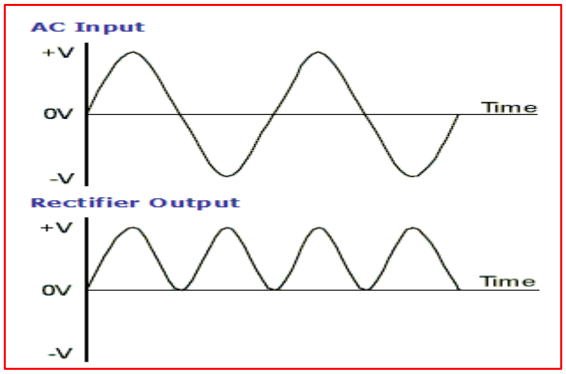


Fig 1.9.2 Full-Wave Rectification

When the AC input is positive, diodes A and B are forward-biased, while diodes C and D are reverse-biased. When the AC input is negative, the opposite is true - diodes C and D are forward-biased, while diodes A and B are reverse-biased.

While the full-wave rectifier is an improvement on the half-wave rectifier, its output still isn't suitable as a power supply for most circuits since the output voltage still varies between 0V and Vs-1.4V. So, if you put 12V AC in, you will 10.6V DC out.

1.8 LIQUID CRYSTAL DISPLAY

1.8.1 INTRODUCTION TO 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.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an controller is an LCD display. Some of the most common LCDs connected to the controllers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Many microcontroller devices use 'smart LCD' displays to output visual

information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursor of the display.

They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 10 I/O lines (RS,RW,D7, D6,D5,D4,D3,D2,D1,D0).

For a 4-bit data bus it only requires the supply lines plus 6 extra lines(RS,RW,D7,D6,D5,D4). When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller.

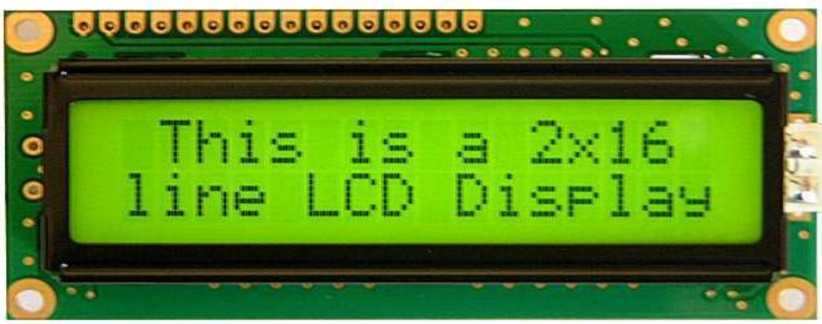


Fig 1.9.3: 2x16 LCD Display

USES

The LCD s used exclusively in watches, calculators and measuring instruments is the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCD s being extensively used in telecommunications and entertainment electronics. The LCD s has even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications

LCD PIN DIAGRAM

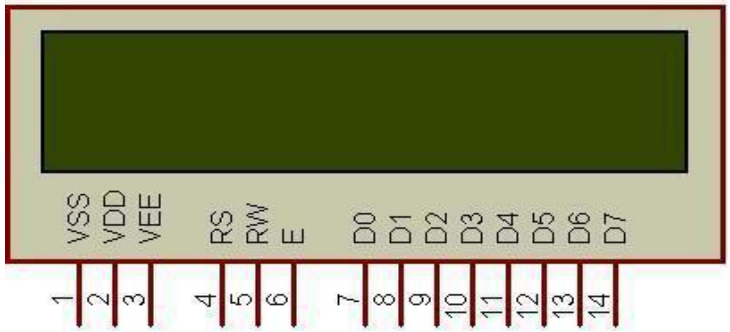


Fig 1.9.4: Pin Diagram of LCD

CONTROL LINES

<u>EN</u>:

Line is called "Enable." This control line is used to tell the LCD that you are sending it data. To send data to the LCD, your program should make sure this line is low (0) and then set the other two control lines and/or put data on the data bus. When the other lines are completely ready, bring EN high (1) and wait for the minimum amount of time required by the LCD datasheet (this varies from LCD to LCD), and end by bringing it low (0) again.

<u>RS</u>: Line is the "Register Select" line. When RS is low (0), the data is to be treated as a command or special instruction (such as clear screen, position cursor, etc.).When RS is high (1), the data being sent is text data which should be displayed on the screen.

<u>RW</u>:

Line is the "Read/Write" control line. When RW is low (0), the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively querying (or reading) the LCD. Only one instruction ("Get LCD status") is a read command. All others are write commands, so RW will almost always be low.

- **LOGIC STATUS ON CONTROL LINES**

- E - 0 Access to LCD disabled.
  1 Access to LCD enabled.
- R/W - 0 Writing data to LCD.
  1 Reading data from LCD
- RS - 0 Instructions..
  1 Character

- **CONTRAST CONTROL**

To have a clear view of the characters on the LCD, contrast should be adjusted. To adjust the contrast, the voltage should be varied. For this, a preset is used which can behave like a variable voltage device. As the voltage of this preset is varied, the contrast of the LCD can be adjusted.

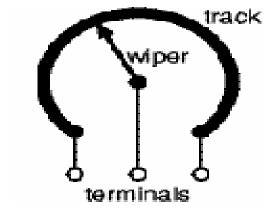


Fig 1.9.5: variable resistor

Potentiometer

Variable resistors used as potentiometers have all **three terminals** connected. This arrangement is normally used to **vary voltage**, for example to set the switching point of a circuit with a sensor, or control the volume (loudness) in an amplifier circuit. If the terminals at the ends of the track are connected across the power supply, then the wiper terminal will provide a voltage which can be varied from zero up to the maximum of the supply.

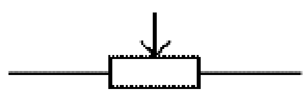


Fig 1.9.6: potentiometer symbol

Presets

These are miniature versions of the standard variable resistor. They are designed to be mounted directly onto the circuit board and adjusted only when the circuit is built. For example, to set the frequency of an alarm tone or the sensitivity of a light-sensitive circuit, a small screwdriver or similar tool is required to adjust presets.

Multiturn presets are used where very precise adjustments must be made. The screw must be turned many times (10+) to move the slider from one end of the track to the other, giving very fine control.

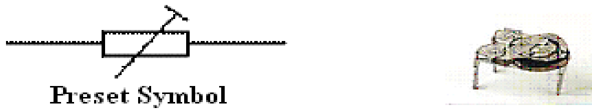


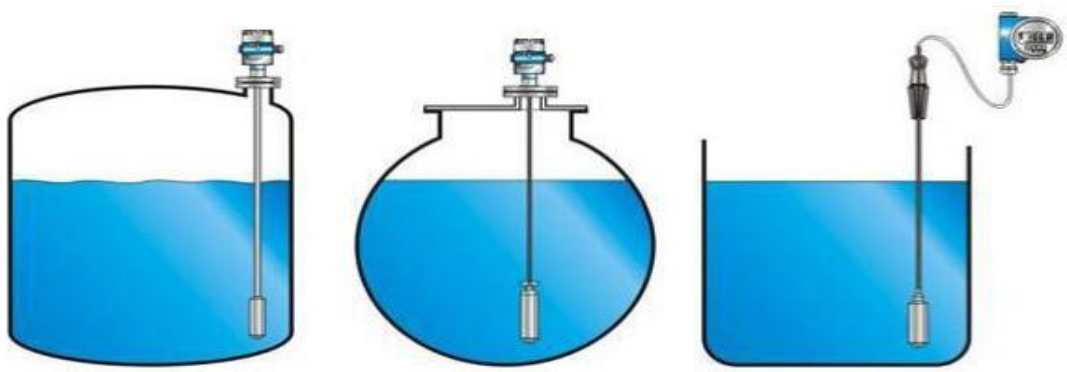
Fig 1.9.7: preset symbol

1.9 WATER LEVEL SENSOR

In the following circuit, the BC547B transistor is an essential component that works like a switch in this circuit. The rain sensor is very responsive to water drops or rainfalls. The circuit sensitivity can be adjusted through a variable resistor. Once the rain falls onto the sensor strips then the circuit will be activated because water is a great electricity conductor.

The voltage is supplied to the transistor to turn ON the transistor then it activates the buzzer which is connected to it. Here, the buzzer in this circuit works like an alarm to alert the user. For better performance, the sensor strip must be connected very close to the circuit. This sensor can be designed through different methods based on your choice & convenience.

The water level sensor is a device that measures the liquid level in a fixed container that is too high or too low. According to the method of measuring the liquid level, it can be divided into two types: contact type and non-contact type. The input type water level transmitter we call is a contact measurement, which converts the height of the liquid level into an electrical signal for output. It is currently a widely used water level transmitter.



Chapter -2

INTRODUCTION TO INTERNET OF THINGS

2.1 Introduction

What Is The Internet of Things (IoT)

The Internet of Things may be a hot topic in the industry but it's not a new concept. In the early 2000's, Kevin Ashton was laying the groundwork for what would become the Internet of Things (IoT) at MIT's Auto ID lab. Ashton was one of the pioneers who conceived this notion as he searched for ways that Proctor & Gamble could improve its business by linking RFID information to the Internet. The concept was simple but powerful. In a 1999 article for the RFID Journal Ashton wrote:

"If we had computers that knew everything there was to know about things—using data they gathered without any help from us -- we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory. RFID and sensor technology enable computers to observe, identify and understand the world—without the limitations of human-entered data."

At the time, this vision required major technology improvements. After all, how would we connect everything on the planet? What type of wireless communications could be built into devices? What changes would need to be made to the existing Internet infrastructure to support billions of new devices communicating? What would power these devices? What must be developed to make the solutions cost effective? There were more questions than answers to the IoT concepts in 1999.

Today, many of these obstacles have been solved. The size and cost of wireless radios has dropped tremendously. IPv6 allows us to assign a communications address to billions of devices. Electronics companies are building Wi-Fi and cellular wireless connectivity into a wide range of devices. ABI Research estimates over five billion wireless chips will ship in 2013.2 Mobile data coverage has improved significantly with many networks offering broadband speeds. For example, Cisco's Internet of Things Group (IOTG) predicts there will be over 50 billion connected devices by 2020.

IoT describes a system where items in the physical world, and sensors within or attached to these items, are connected to the Internet via wireless and wired Internet connections. These sensors can use various types of local area connections such as RFID, NFC, Wi-Fi, Bluetooth, and Zigbee. Sensors can also have wide area connectivity such as GSM, GPRS, 3G, and LTE. The Internet of Things will:

• **Connect both inanimate and living things:** Early trials and deployments of Internet of Things networks began with connecting industrial equipment. Today, the vision of IoT has expanded to connect everything from industrial equipment to everyday objects. The types of items range from gas turbines to automobiles to utility meters. It can also include living organisms such as plants, farm animals and people. For example, the Cow Tracking Project in Essex uses data collected from radio positioning tags to monitor cows for illness and track behavior in the herd..

• **Use sensors for data collection:**

The physical objects that are being connected will possess one or more sensors. Each sensor will monitor a specific condition such as location, vibration, motion and temperature. In IoT, these sensors will connect to each other and to systems that can understand or present information from the sensor's data feeds. These sensors will provide new information to a company's systems and to people.

• **Change what types of item communicate over an IP Network:** In the past, people communicated with people and with machines. Imagine if all of your equipment had the ability to communicate. What would it tell you? IoT-enabled objects will share information about their condition and the surrounding environment with people, software systems and other machines. This information can be shared in realtime or collected and shared at defined intervals. Going forward, everything will have a digital identity and connectivity, which means you can identify, track and communicate with objects. IoT data differs from traditional computing. The data can be small in size and frequent in transmission.

What It Means For Your Business?

IoT impacts every business. Mobile and the Internet of Things will change the types of devices that connect into a company's systems. These newly connected devices will produce new types of data. The Internet of Things will help a business gain efficiencies, harness intelligence from a wide range of equipment, improve operations and increase customer satisfaction. IoT will also have a profound impact on people's lives. It will improve public safety, transportation and healthcare with better information and faster communications of this information. While there are many ways that the Internet of Things could impact society and business, there are at least three major benefits of IOT that will impact every business, which include: communication, control and cost savings.

2.2 The Three Causes of IOT

Communication: IoT communicates information to people and systems, such as state and health of equipment (e.g.it's on or off, charged, full or empty) and data from sensors that can monitor a person's vital signs. In most cases, we didn't have access to this information before or it was collected manually and infrequently. For example, an IOT-enabled HVAC system can report if its air filter is clean and functioning properly. Almost every company has a class of assets it could track. GPS-enabled assets can communicate their current location and movement. Location is important for items that move, such as trucks, but it's also applicable for locating items and people within an organization. In the healthcare industry, IoT can help a hospital track the location of everything from wheelchairs to cardiac defibrillators to surgeons. In the transportation industry, a business can deliver real-time tracking and condition of parcels and pallets. For example, Maersk can use sensors to track the location of a refrigerated shipping container and its current temperature.

Control and Automation: In a connected world, a business will have visibility into a device's condition. In many cases, a business or consumer will also be able to remotely control a device. For example, a business can remotely turn on or shut down a specific piece of equipment or adjust the temperature in a climate-controlled environment. Meanwhile, a consumer can use IoT to unlock their car or start the washing machine. Once a performance baseline has been established, a process can send alerts for anomalies and possibly deliver an automated response. For example, if the brake pads on a truck are about to fail, it can prompt the company to take the vehicle out of service and automatically schedule maintenance.

Cost Savings: Many companies will adopt IoT to save money. Measurement provides actual performance data and equipment health, instead of just estimates. Businesses, particularly industrial companies, lose money when equipment fails. With new sensor information, IoT can help a company save money by minimizing equipment failure and allowing the business to perform planned maintenance. Sensors can also measuring items, such as driving behavior and speed, to reduce fuel expense and wear and tear on consumables. New smart meters in homes and businesses can also provide data that helps people understand energy consumption and opportunities for cost savings.

2.3 How to Get Started

These are just a few examples of how IoT can help a business save money, automate processes and gain new insight into the business. To reap the benefits IoT can provide, a business should address at least the following four items:

1.Define what you'd like to learn from sensors: Over the next three years, a majority of the devices purchased will have sensors and many existing items can be retrofitted with sensors. This will produce a wide range of new data sources for people and systems to use to improve their lives and existing business processes. For example, sensor data that highlights anomalies in equipment vibration can be used to predict and avoid equipment failure.

2. Build an IOT network and security foundation: Many industrial IoT deployments have used proprietary networks. Instead of building proprietary networks, IT should connect IoT devices with standards-based IP networks. An IP-based network will help businesses deliver the performance, reliability and interoperability that are required to support global IoT networks and connections with partner ecosystems. Additionally, many businesses are focused on building security strategies for smartphones and tablets, but this is just one aspect of the new mobile world. Identity and authentication structures will also need to be updated to support "things" as well as people.

3. Collect as much data as possible: Businesses that don't plan carefully for IoT will be overwhelmed with the volume and variety of data that IoT will generate. While each sensor may only produce a small amount of data, a company will be collecting data from thousands to millions of sensors. A company should collect any data that is relevant to existing processes. If possible and cost-effective, a company should also collect additional data that will enable the business to answer new questions in the future.

4.Review the size and scale of IoT providers: IoT is a complicated landscape with numerous categories and many vendors within each category. The four main categories of an IoT solution are: a sensor(s) and radio(s) that often sits in the machine, a M2M device-management platform, a solution delivery platform and apps that enable IoT devices to report or act on data. While there are many vendors, no single vendor offers a complete solution without building partnerships. As a firm begins its IoT voyage, IT and line of business executives should build a cross-functional team to evaluate strategic partners. The team should evaluate the financial position of the vendors, industry knowledge, partnerships and breadth of offerings.

2.4 Advantages

Here are some advantages of IoT:

1. **Data**: The more the information, the easier it is to make the right decision. Knowing what to get from the grocery while you are out, without having to check on your own, not only saves time but is convenient as well.

2. **Tracking**: The computers keep a track both on the quality and the viability of things at home. Knowing the expiration date of products before one consumes them improves safety and quality of life. Also, you will never run out of anything when you need it at the last moment.

3. **Time**: The amount of time saved in monitoring and the number of trips done otherwise would be tremendous.

4. **Money**: The financial aspect is the best advantage. This technology could replace humans who are in charge of monitoring and maintaining supplies.

2.5 The Internet of Things applications

- Smart home. Smart Home clearly stands out, ranking as highest Internet of Things application on all measured channels.
- Wearable's.
- Smart City.
- Smart grids.
- Industrial internet.
- Connected car.
- Connected Health (Digital health/Telehealth/Telemedicine).
- Smart retail.

L293D- Current Driver

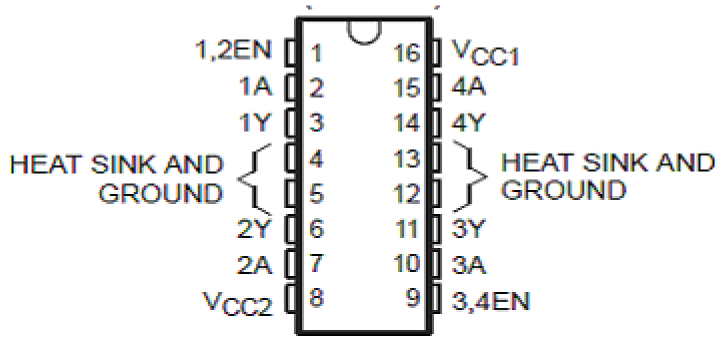


Fig 2.1 Pin diagram

Features

- Wide Supply-Voltage Range: 4.5 V to 36 V
- Separate Input-Logic Supply
- Internal ESD Protection
- Thermal Shutdown
- High-Noise-Immunity Inputs
- Functionally Similar to SGS L293 and SGS L293D
- Output Current 1 A Per Channel (600 mA for L293D)
- Peak Output Current 2 A Per Channel (1.2 A for L293D)
- Output Clamp Diodes for Inductive Transient Suppression (L293D)

Description

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state.

A VCC1 terminal, separate from VCC2, is provided for the logic inputs to minimize device power dissipation. The L293 and L293D are characterized for operation from 0 to 70 degree Celsius.

Block Diagram

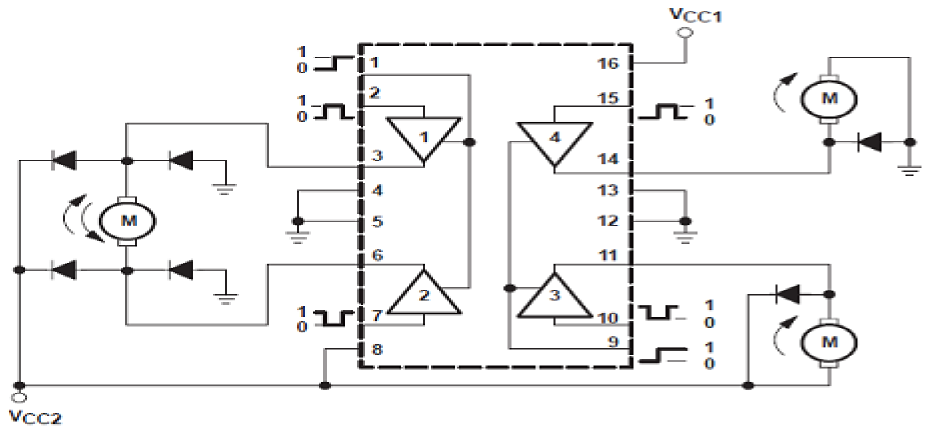


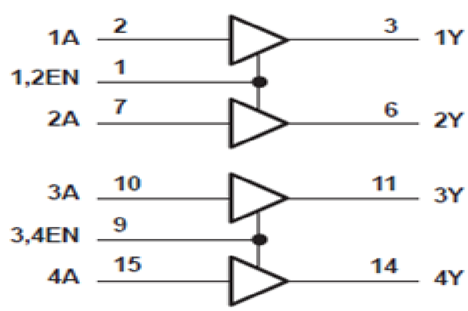
Fig 2.2: Block diagram

FUNCTION TABLE
(each driver)

INPUTS†		OUTPUT
A	EN	Y
H	H	H
L	H	L
X	L	Z

H = high level, L = low level, X = irrelevant,
Z = high impedance (off)
† In the thermal shutdown mode, the output is in the high-impedance state, regardless of the input levels.

Table 2: Function table



Logic Diagram

Fig 2.3: Logic diagram

This chip contains 4 enable pins. Each enable pin corresponds to 2 inputs. Based on the input values given, the device connected to this IC works accordingly.

L293D Interfacing with 8051:

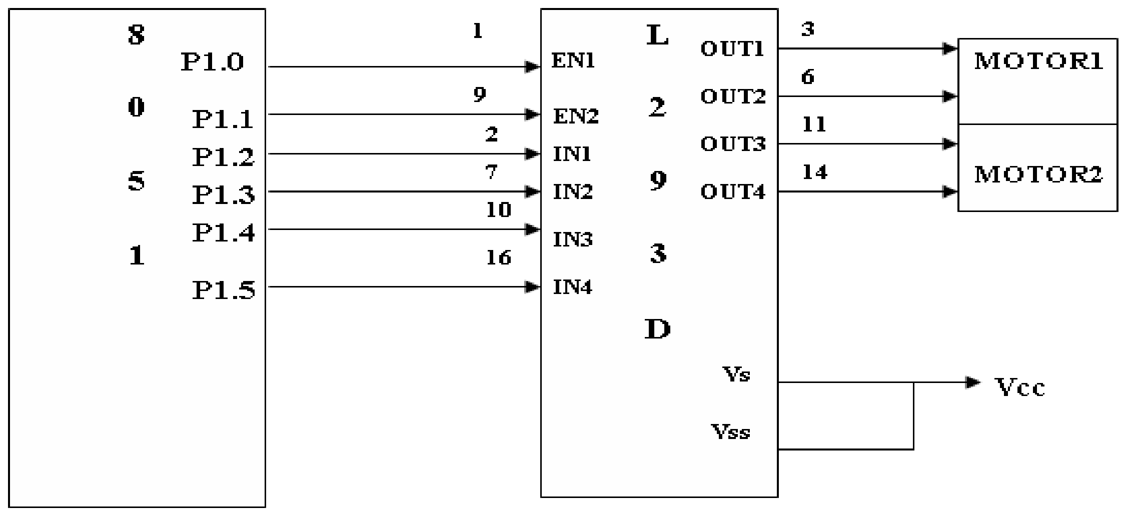


Fig 2.4: Interfacing with 8051

Controlling the Robot to obtain the different directions of movement

	Left Wheel	Right Wheel	Movement
1	Forward	Forward	Forward
2	Backward	Backward	Backward
3	Forward	Stop	Right Turn
4	Stop	Forward	Left Turn
5	Forward	Backward	Sharp Right Turn
6	Backward	Forward	Sharp Left Turn

Table 3: Controlling the robot

The DC motor description is carried out in the next section. The L293D output pins will be connected to the two motors of Robot. Thus, the output of L293D depends on the input provided from the microcontroller and the enable pins. It should be remembered that unless the enable pins are not high, whatever input values given to L293D IC will not be applied to the motors in any way.

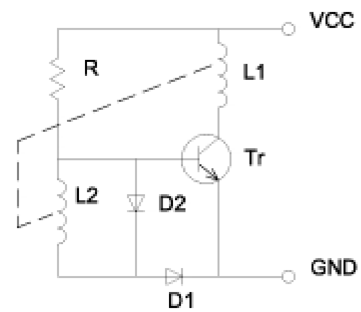
2.6 BUZZER

2.6.1 Magnetic Transducer

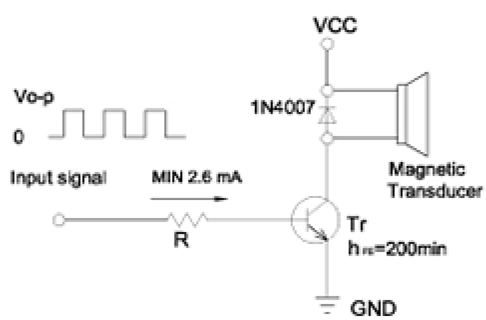
Magnetic transducers contain a magnetic circuit consisting of a iron core with a wound coil and a yoke plate, a permanent magnet and a vibrating diaphragm with a movable iron piece. The diaphragm is slightly pulled towards the top of the core by the magnet's magnetic field.

When a positive AC signal is applied, the current flowing through the excitation coil produces a fluctuating magnetic field, which causes the diaphragm to vibrate up and down, thus vibrating air. Resonance amplifies vibration through resonator consisting of sound hole(s) and cavity and produces a loud sound.

2.6.2 Magnetic Buzzer (Sounder)



Buzzers like the TMB-series are magnetic audible signal devices with built-in oscillating circuits. The construction combines an oscillation circuit unit with a detection coil, a drive coil and a magnetic transducer. Transistors, resistors, diodes and other small devices act as circuit devices for driving sound generators. With the application of voltage, current flows to the drive coil on primary side and to the detection coil on the secondary side. The amplification circuit, including the transistor and the feedback circuit, causes vibration. The oscillation current excites the coil and the unit generates an AC magnetic field corresponding to an oscillation frequency. This AC magnetic field magnetizes the yoke comprising the magnetic circuit. The oscillation from the intermittent magnetization prompts the vibration diaphragm to vibrate up and down, generating buzzer sounds through the resonator.



Recommended Driving Circuit for Magnetic Transducer

CHAPTER-3

LITERATURE SURVEY

3.1 LITERATURE SURVEY

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https://www.mdpi.com/1660-4601/12/6/6879.

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Hamshere, P., Sheng, Y., Moir, B., Gunning-Trant, C., Mobsby, D., 2014. What India wants: analysis of India's food demand to 2050. Technical Report. https:// doi.org/10.13140/RG.2.2.18626.94406.

3.2 EXISTING SYSTEM

He system is developed for irrigation is on two ways: I) System Software II) System hardware Software is web page designed by using PHP and hardware consists of embedded system which monitors soil content. In this system open source Arduino boards along with moisture sensors, it is applicable to create devices that can monitor the soil moisture content and accordingly irrigating the fields as when needed. This system introduced a GSM-SMS remote measurement and control system for farms based on PC-based database system connected with base station, which is developed by using a microcontroller, GSM module, actuators and sensors.

It informs users about many conditions like status of electricity, dry running motor, increased /decreased temperature, water content in soil via SMS on GSM network or by Bluetooth. In practical the central station receives and sends messages through GSM module Values of temperature, air humidity and moisture which are set by central station are measure in every base station information is exchanged between far end and designed system via SMS on GSM network. A SIM with 3G data pack inserted into system which provide IOT features to the system.

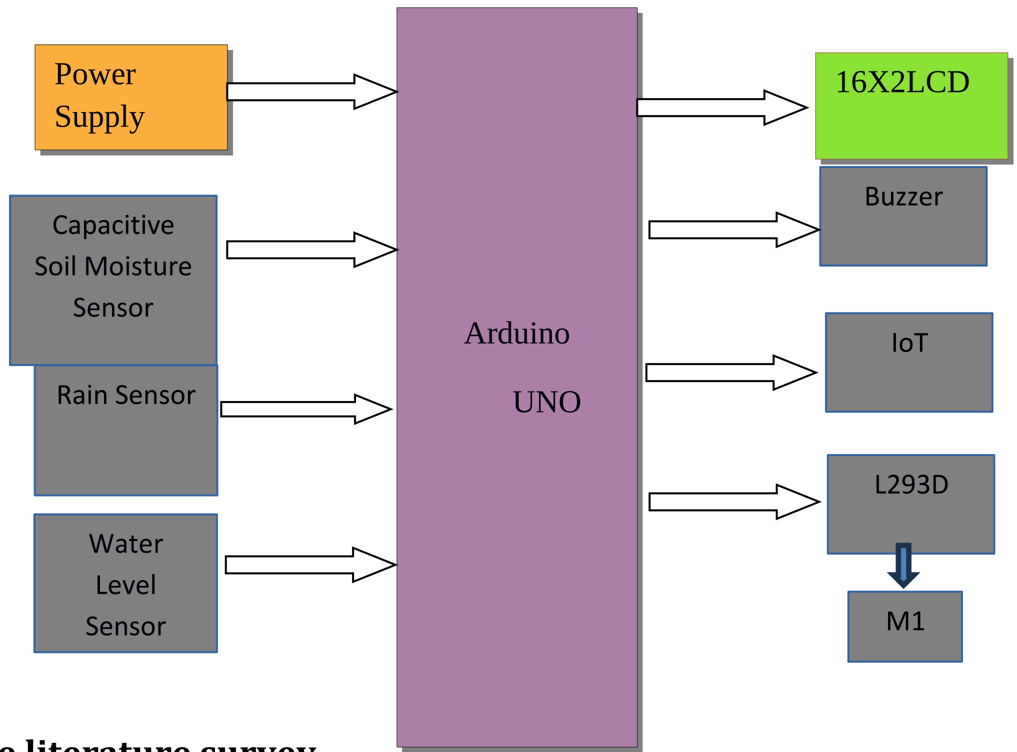
This system sets the irrigation time depending on reading from sensors and type of crop and it can automatically irrigate the field when needed, by using GSM-GPRS SIM900A parameter from sensor regularly updated on a webpage. This application makes use of the GPRS feature of mobile phone as a solution for irrigation control system. This system was used to cover lower range of land and not economically affordable

In the current scenario, conventional greenhouses face several challenges related to plant cultivation. Here are some key points about the existing system:

1. **Resource Limitations**: Conventional greenhouses lack smart environments, suffer from plant diseases, have limited farmland, and face soil degradation. These factors lead to decreased crop production.
2. **Manual Monitoring**: Monitoring plant health parameters manually is time-consuming and often impractical. Environmental conditions (such as high temperatures, abnormal humidity, and poor soil quality) can adversely affect plant growth.

3. **Inefficient Resource Utilization**: Efficient resource utilization (energy and water) is crucial for increased crop yield. However, existing systems struggle to optimize resource usage effectively.

3.2.1 BLOCK DIAGRAM



3.3 From the literature survey

• By using this literature survey, this project proposes to have a device which is the integration of multiple devices, hardware comprises of a wearable "Smart band" that endlessly communicates with sensible phone that has access to the web.

• The device consists of a trigger, microcontroller (MSP 430), GSM module (SIM900), GPS module (Neo-6M), IoT module (ESP-12E), Neuro Stimulator, Buzzer and Vibrating Sensor.

• In this project, when a woman senses danger she has to hold ON the trigger of the device. Once the device is activated, it tracks the current location using GPS (Global Positioning System) and sends emergency message usingGSM (Global System for Mobile communication) to the registered mobile number and near by police station.

• IoT module is used to track the location continuously and update into thewebpage. Neuro Stimulator will produce non-lethal electric shock in emergency situations to detect the attacker, buzzer is used as an alarm to alert the nearby people

Chapter -4

PROPOSEDSYSTEM

4.PROPOSEDSYSTEM

The system is combination of hardware and software components.

1. Hardware components:
    a. Sensors (Moisture, DHT22, Ultrasonic)
    b. ESP8266 Wi-Fi module
    c. Arduino Uno
    d. Water pump
2. Software components:
    a. Android application

4.1 Sensor Section

4.1.1 Moisture sensor

Soil moisture sensor is used to detect the moisture of the soil. This sensor is made up of two pieces: the electronic board at the right, and the probe with two pads, that detects the moisture content of soil.

How does it work?
The voltage of the sensor outputs changes accordingly to the moisture level in the soil.

When the soil is:

Wet: The output voltage decrease

Dry: The output voltage increase

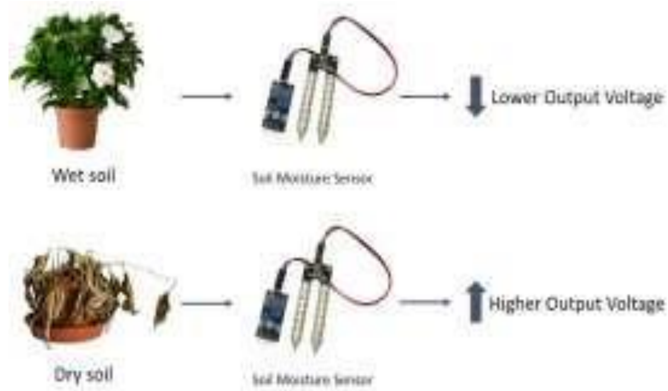
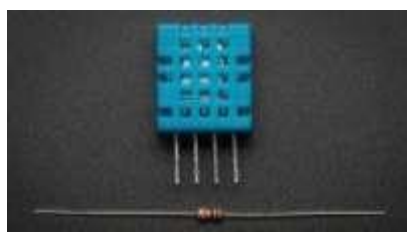


Fig4.1: Moisture sensor

4.1.2 DHT 11 (Temperature and Humidity)

DHT11 consist of both humidity and temperature sensor. For measuring humidity there are two electrodes with moisture holding substrate between them. So when the humidity changes, the resistance between these electrodes changes and conductivity of the substrate changes. This change in resistance are measured and processed by the IC which makes it ready to be read by a microcontroller.



4.2: DHT 11

On the other side for measuring temperature DHT11 sensor use a NTC temperature sensor or a thermistor. A thermistor changes its resistance with change of the temperature because it is variable resistor. These sensors are made by sintering of semi-conductive materials (ceramic and polymers), which provide large changes in the resistance with just small changes in temperature. The term "NTC" means "Negative Temperature Coefficient", which means that the resistance decreases with increase of the temperature

4.2 Control Section

4.2.1 ESP 8266 Wi-Fi module

The ESP8266 Wi-Fi Module is used to give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of hosting an application or it also offloads all Wi-Fi network functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set so you can simply hook this up to your Arduino device and get about Wi-Fi-ability. The ESP8266 Wi-Fi module is used to transfer the data from Arduino to dummy sever and from server to Arduino.

Fig4.3: ESP 8266 Wi-Fi module

4.2.2 Arduino Uno

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and Analog I/O pins that may be interfaced to various shields and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus(USB) on some models, which are also used for loading programs from personal computers.

4.3 IOT Section

AT	This will check that module is connected properly and is it functioning, the module gives acknowledgment.
AT+RST	This will reset the Wi-Fi module
AT+CWLAP	This will detect the Access points and their signal strengths available nearby.
AT+CWJAP	”SSID”,”PASSWORD” This connects the ESP8266 to the specified SSID
AT+CWMODE=1	This sets the Wi-Fi mode. It should be always set to Mode 1.

Table 4: AT Commands

4.4. Working principle

Fig 4. Shows the block diagram of Automatic Plant Watering System with I0T. Farmer monitors and control system in order to improve the efficiency with help of sensor parameters like temperature, humidity, soil moisture.

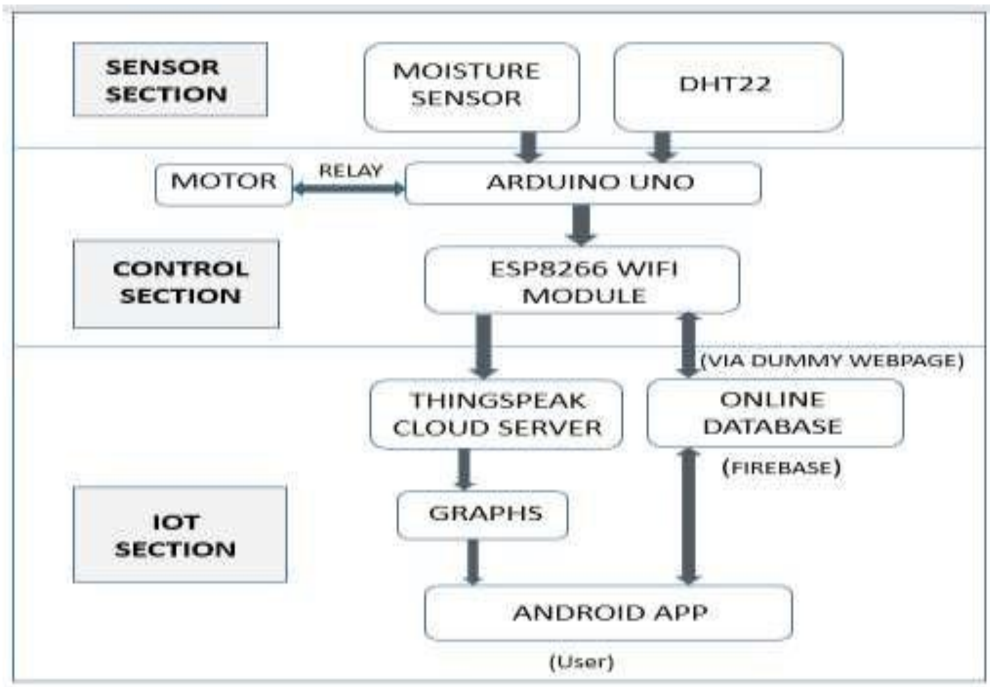


Fig4.4: Block Diagram

1) When power supply is ON, the input module of three sensors (DHT22, moisture) start to activate.
2) When sensors get ON it will read the data from soil and from surrounding.
3) According to the values that are detected by sensors motor will turn ON/OFF.
4) If Moisture below threshold value, then the motor is turn ON.
5) If moisture level is high, then it will stop the motor and water supply will also stop.

4) If Water level is low in tank, then it will also have detected by the ultrasonic sensor.

6) All the values that are collected from sensor is send via ESP8266 Wi-Fi module to Thing speak cloud server and it store in online database(firebase) via dummy server.
7) Thing speak will create the graph for the data received by WI-FI module.
8) And, then whole information will show on the Android app.

User can easily control the motor manually by using Android app

CHAPTER-5

EXPERIMENTAL RESULTS

System Boot UP and Module Check:

Fig.5.1: introductory message on system boot up

At system boot up, the project will show as plant growth monitoring system shown in Fig 5.1.

Fig.5.2: checking Temperature and Humidity

After system boot up, the system will check for the temperature and humidity around the plant, result will show on the LCD Fig:5.2

Fig.5.3: Empty tank indication

The above fig 5.3 system check either tank is empty or full if the tank is empty system display on the LCD as shown in Fig:5.3

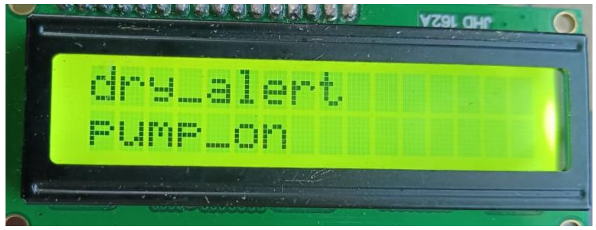


Fig.5.4: Dry alert indication

If the root feel dry land around the plant soil sensor indicates soil is dry then motor switches on automatically to pump the water through pipes it continues until soil sensor senses wet land. After sensing as wet land motor stops pumping the water to plant.

Fig.5.5: measuring height and distance

The above fig:5.5. If the leaf falls the plant system detectes the height and distance of the leaves of the plant. Then the result will be display on the LCD as shown in the Fig.5.5.

When the system is switched on led blinks indicated system is functioning well as shown in the Fig.5.6. DHT11 sensor detects the temperature and humidity and displays on LCD as sown in the figure 5.7. Then soil sensor senses the whether soil is dry or wet if the soil is dry then motor will be swiched on then it pumpes the water to plant as shown in the Fig 5.8. While water is pumping water sensor reads the water level how much water is watered to the plant after soil is wet motor stops pumping water.

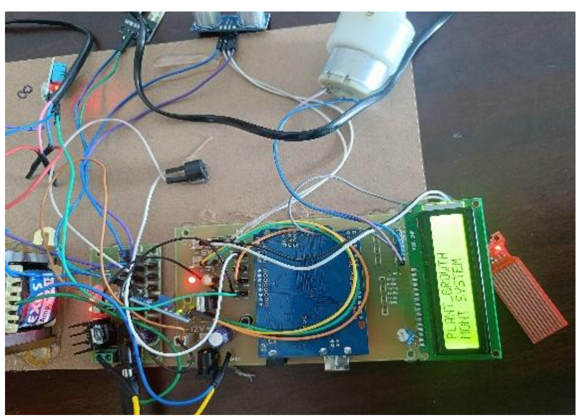


Fig.5.6: system is switched on

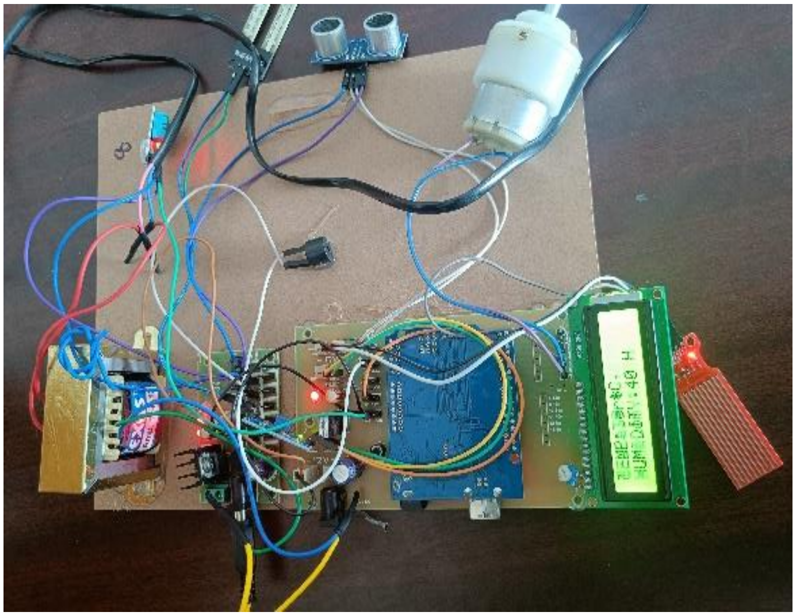


Fig.5.7: temperature and humidity alert

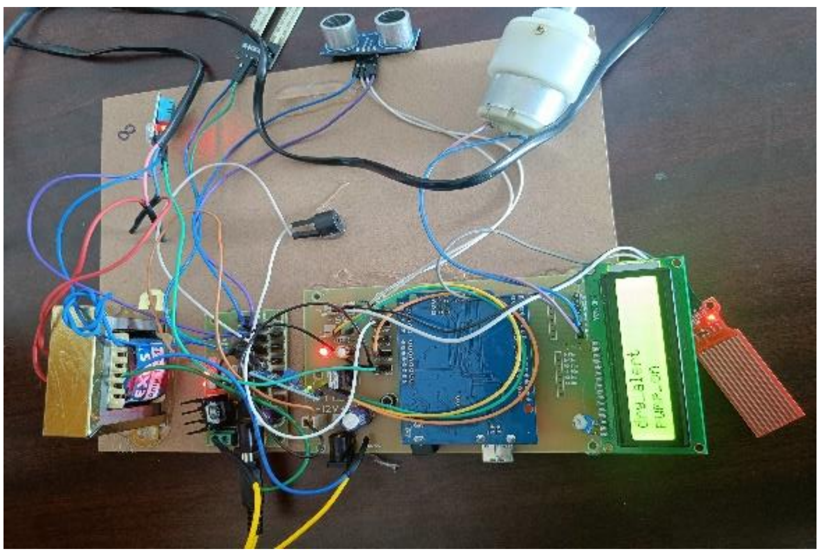


Fig.5.8: dry alert system

CHAPTER-6

Conclusion and future scope

Due to the increasing world population, loss of arable land, and increasing food demands, new agricultural practices are required. As it has been reported that the amount of arable land has declined 48% per capita with a 42% increase in the requirement of the same for India. There is a huge requirement for new agricultural practices. Therefore, this research work has focused on the latest farming technique which Environmental Research 222 (2023) 115313 11 G. Kaur, P. Upadhyaya and P. Chawla Table 4 Growth environmental conditions recorded for automated and unautomated setup. Parameter Optimum range Automated Unautomated Mean Max Min Mean Max Min pH 5.5-6.5 6.06 6.50 5.51 4.91 7.53 4.25 TDS 540-900 736.90 884.12 561.61 859.94 1105.21 684.76 Air temperature 20-26 ◦ C 25.16 26.75 24.12 30.12 32 26 Humidity 40-70% 56.09 69.27 40.15 85.57 95 91 is vertical farming. It is the latest technique to deal with the crisis as it offers high yield, less water usage, and is not affected by climate conditions. It is categorized as unautomated and automated based on monitoring and control methods. An automated system employs the use of various sensors along with IoT to maintain optimum plant growth parameters whereas an unautomated system is manually controlled. This paper presents the comparative study of plant growth using vertical farming which is based on an automated and unautomated system for climate conditions in the Punjab region.

For comparative analysis, the agronomic and chemical parameters are evaluated using the Tashi Home system by Pind fresh. The proposed automated system is capable of maintaining optimum plant growth parameters. Comparing the agronomic characteristics, the mean average improvement of 11.85, 1.04, 0.74, and 0.10 was observed in the case of FWAP, FWR, DWAP, and DWR respectively. The overall higher growth in the automated setup accounts for the optimum growth environment given to plants whereas in the unautomated setup, there were drastic changes observed in the case of temperature, pH, and TDS. Higher leaf length and leaf width are also recorded in the case of automated setup. Chemical analysis shows macro and micronutrient values falling in the optimum range for both setups. At the same time, the overall cost and energy consumption of an automated setup are much higher on account of the use of sensors and high electrical expenses.

On the other hand, an unautomated system requires regular maintenance which leaves it unattended on Saturdays and Sundays. So, for small-scale setups or home-based setups, unautomated systems seem to be a feasible solution. During extreme summers, the system could be put up in well-ventilated areas. An automated setup could be of good use in industry or large-scale setups where cost could be ignored at the cost of skilled manpower required, lack of time and human error. 5. Future scope In this present system, automation is done using an IoT system. Considering the next generation, ML algorithms could be further used to improve the performance of the automated system. Also, in this article, CO_2 enhancement is not done due to its lower feasibility but could be considered for future work to study plant growth enhancement with automated CO_2 generation. Credit authorship contribution statement Author 1: Have made a substantial contribution to the concept and design of the article. Collected the data and have done the interpretation of results present in manuscripts. Also, contributed in writing the manuscript. Author 2: Have helped in writing and revising the manuscript. Also, verified the results reported in the manuscript and provided the interpretation of the results present in the manuscripts. Author 3: Helped in providing the idea for implementing the task. Declaration of competing interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Data availability No data was used for the research described in the article

Future scope:

- In this present system, automation is done using an IoT system. Considering the next generation, ML algorithms could be further used to improve the performance of the automated system.
- Also, in this article, CO_2 enhancement is not done due to its lower feasibility but could be considered for future work to study plant growth enhancement with automated CO_2 generation

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