CHAPTER-1

INTRODUCTION

As we know that Indian economy is one of the largest developing economies of the world. The agricultural sector has its largest contribution in the Indian economy. To achieve maximum utilisation of man power and to obtain maximum profit in a given stipulated there is a need in the upgradation of various engineering techniques that are being used today. Thus maintaining proper amount of water level in the soil is one of the necessary requirements to harvest a good crop that can be a source of various types of nutrients whether micro or macro for their proper growth. If we talk about Indian farmers they are worst hit by the famines that occurs due to failure of crops depending upon various drought factors. Rain plays the key role in deciding the future of these crops as well as the farmers every year. The over utilisation of ground water has drastically reduced the ground water level in the last 15 years.So it is the need of hour to utilise each and every drop of water wisely so that it can also be used by our coming generations also. Also we should develop some new methods that use the renewable sources of energy. The development of these new techniques are going to reach our goal of sustainable development as well as to cut off the emission of greenhouse gases to a minimum level.As the name of our project that is AUTOMATIC IRRIGATION SYSTEM with the help of the Solar power is a step to utilise some new engineering techniques. This technique will be a very good option for the small and medium farmers who suffer every year just because of failure of crops that took place every year. The implementation of this technology has a wide scope in the nearby future.

The main objective of this project was to design a small scale irrigated system that would use water in more well-organized way in order to prevent excess water loss and minimize the cost of labor.The following aspects were considered in the choice of design solution

- Installation cost
- Water saving
- Human intervention
- Reliability
- Power consumption
- Maintenance
- Expandability

1.1 WIRELESS SENSOR NETWORK

A **wireless sensor network** (WSN) is a computer network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. The development of wireless sensor networks was originally motivated by military applications such as battlefield surveillance. However, wireless sensor networks are now used in many civilian application areas, including environment and habitat monitoring, healthcare applications, home automation, and traffic control.

In addition to one or more sensors, each node in a sensor network is typically equipped with a radiotransceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery. The size a single sensor node can vary from shoebox-sized nodes down to devices the size of grain of dust. The cost of sensor nodes is similarly variable, ranging from hundreds of dollars to a few cents, depending on the size of the sensor network and the complexity required of individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth. In computer science, wireless sensor networks are an active research area with numerous workshops and conferences arranged each year.

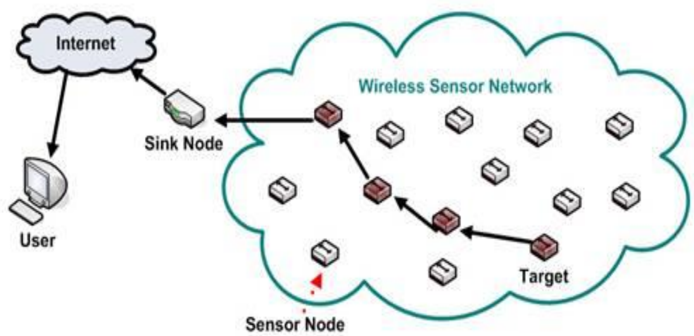


Fig 1.1 Wireless Sensor

1.1.1 Applications

The applications for WSNs are many and varied. They are used in commercial and industrial applications to monitor data that would be difficult or expensive to monitor using wired sensors. They could be deployed in wilderness areas, where they would remain for many years (monitoring some environmental variable) without the need to recharge/replace their power supplies. They could form a perimeter about a property and monitor the progression of intruders (passing information from one node to the next). There are a many uses for WSNs.

Typical applications of WSNs include monitoring, tracking, and controlling. Some of the specific applications are habitat monitoring, object tracking, nuclear reactor controlling, fire detection, traffic monitoring, etc. In a typical application, a

WSN is scattered in a region where it is meant to collect data through its sensor nodes.

- Environmental monitoring
- Habitat monitoring
- Acoustic detection
- Seismic Detection
- Military surveillance
- Inventory tracking
- Medical monitoring
- Smart spaces
- Process Monitoring

1.1.2 Area monitoring

Area monitoring is a typical application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. As an example, a large quantity of sensor nodes could be deployed over a battlefield to detect enemy intrusion instead of using landmines. When the sensors detect the event being monitored (heat, pressure, sound, light, electro-magnetic field, vibration, etc), the event needs to be reported to one of the base stations, which can take appropriate action (e.g., send a message on the internet or to a satellite). Depending on the exact application, different objective functions will require different data-propagation strategies, depending on things such as need for real-time response, redundancy of the data (which can be tackled via data aggregation techniques), need for security, etc.

1.1.3 Characteristics

Unique characteristics of a WSN are:

- Small-scale sensor nodes
- Limited power they can harvest or store
- Harsh environmental conditions
- Node failures
- Mobility of nodes
- Dynamic network topology
- Communication failures
- Heterogeneity of nodes
- Large scale of deployment
- Unattended operation

Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components. They usually consist of a processing unit with limited computational power and limited memory, sensors (including specific conditioning circuitry), a communication device (usually radio transceivers or alternatively optical), and a power source usually in the form of a battery.

The base stations are one or more distinguished components of the WSN with much more computational, energy and communication resources. They act as a gateway between sensor nodes and the end user.

The ability to accurately detect a vehicles location and its status is the main goal of automobile trajectory monitoring systems. Also the high demand of automobiles has also increased the traffic hazards and the road accidents. This is because of the lack of best emergency facilities available in our country this design is a system which can detect accidents in significantly less time and sends the basic information to first aid center within a few seconds covering geographical coordinates, the time and angle in which a vehicle accident had occurred. This alert message is sent to the rescue team in a short time, which will help in saving the valuable lives. These systems are implemented using several hybrid techniques that include wireless communication, geographical positioning and embedded applications.

Our project aims to present a technology automatically detecting the accident and a hardware tracking device based on GSM/GPS technology informing at the occurrence of accident with sufficient details like exact location and time at which accident happened. This project will establish a communication between the control station and the unit installed in vehicles. Vehicles will have GPS/GSM enabled tracking modules and will be tracked in real time using cellular networks. The software embedded in the microcontroller will control the various operations of the device by monitoring waveform from the vibration sensor. In case of accident the device will send an alert message along with location data from GPS module to control station using GSM network. It is a comprehensive and effective solution to the poor rescue response in case of accident. The accident reporting can automatically find a traffic accident, search for the spot and then send the basic information to the rescue agency covering geographical coordinates and the time and circumstances in which a traffic accident took place. At the server end, a control function will extract relevant data and store it in a database, to which accident information from prototypes will be polled in real time. Our system combines advanced hardware design and sophisticated control technology into a compact, reliable package.

CHAPTER-2

LITERATURE SURVEY

REMOTE MONITORING OF CROP FIELD USING WIRELESS SENSOR NETWORK- V.Swathi, A. Krishnamurthy

This paper presents the design and implementation of wireless sensor network that can monitor the air temperature, Humidity, light intensity in a crop field and from remote places also. The system consists of nodes, which are equipped with small size application specific sensors and radio frequency modules. The sensor data is transmitted via radio frequency link to the centrally localized computer terminal for data logging and analysis. This data can be monitor from the remote places by uploading the data into the internet, also the sensor nodes can additionally be programmed from the computer terminal itself according to the changing needs of farmers thus preventing the need for redeployment of the wireless sensor network every time some changes are to be made. Since the energy is the main operating constraint sleep mode of the core component is utilized

AUTOMATIC IRRIGATION CONTROL SYSTEM FOR EFFICIENT USE OF WATER RESOURCES BY USING ANDROID MOBILE B.Prabhushankar, R.Jayavadivel, S.Saravanakumar

Agriculture is a source of livelihood of majority Indians and has great impact on the economy of the country. In dry lands or in case of insufficient rainfall, irrigation becomes difficult. So, it needs to be automation required for proper yield and handled remotely for farmer usage and safety. In this paper we suggest a Wireless sensor network and Embedded based technique to control water flow level for sectored, sprinkler or drip method section irrigation system. This system will be very economical in terms of the hardware cost, man power, and power consumption. In places such as agriculture land areas must be a continuous need for monitoring the water level at particular field. In places such as drip irrigation for coconuts, bananas and some vegetable plants, the water is let out through pipes directly to each field. A person has to carefully watch the water level at regular intervals. His job becomes difficult at night times and for frequent power cut. Sometimes there is wastage of water and electricity due to negligence and other times there is a hard job for the formers. This is highly helpful in places such as drip irrigation system where there are many flow pipes but does not require any change in the agricultural fields. When the motor is switched on the sensors are activated and the fields are irrigated automatically without man power. Once the water reaches a particular level which may take several hours, this system takes appropriate steps to regulate or even stop the water flow.

GSM BASED AUTOMATED IRRIGATION CONTROL USING RAIN GUN IRRIGATION SYSTEM - R.suresh, S.Gopinath, K.Govindaraju, T.Devika, N.SuthanthiraVanitha

The green house based modern agriculture industries are the recent requirement in every part of agriculture in India. In this technology, the humidity and temperature of plants are precisely controlled. Due to the variable atmospheric conditions sometimes may vary from place to place in large farmhouse, which makes very difficult to maintain the uniformity at all the places in the farmhouse manually .The proposed system implemented GSM is used to report the detailed about irrigation. The report from the GSM is send through the android mobile. The keil software is used for simulated the result

AUTOMATED IRRIGATION SYSTEM USING ZIGBEE – GSM- Shikha,Vibha

In recent years, Distributed Wireless sensor technology becomes very popular and extensively used in the scientific world. The WSN helps in the advancement of the current developing and rapidly changing technology. Power management, cost-saving and labor saving is always a major issue in the research field of wireless sensor networks. This paper gives a review of some existing or proposed systems based on the different technologies and also focuses on generic automated irrigation system based on WSN with GSM-ZigBee for remote monitoring and controlling devices. The objective is to make use of wireless sensor network and communication technology such as ZigBee and GSM in industrial field to make low-cost automated irrigation system to monitor the condition of the soil and to lower the energy consumption. The system helps the farmer to monitor and control the parameters of the soil such as air temperature, humidity, soil moisture. At any abnormal condition, the farmer is informed and will be able to take actions remotely by using GSM. Due to its lower energy consumption and low cost, the system has the potential to be useful in semiarid or arid areas.

MICROCONTROLLER BASED CONTROLLED IRRIGATION SYSTEM FOR PLANTATION- S. R. Kumbhar, Arjun P. Ghatule

The population of India has reached beyond 1.2 billion. If the population goes on increasing with the present rate then after 25-30 years there will be a serious problem of food, so in order to meet the demand of food one has to give more emphasis on the development of agriculture. Today, man has occupied all the suitable land but the land located far away from the human settlement is not developed properly and not utilized fully because it requires more manpower, time and expenditure. But now a day it is possible to pay more attention with the help of modern available controlled devices like computer, microprocessor, sensor, integrated circuits and microcontroller. In the present work a Microcontroller based controlled remote irrigation system is developed for the agricultural plantation. The developed system is placed at the remote location and required water provides for plantation whenever the humidity of the soil goes below the set-point value.

Humidity sensor provides proportional amount of output with mchange in humidity, which is compared, to the set-point and the data is taken through the channel. If the set-point data is high, then after motor is turned ON, which provides water to the plant till the humidity goes above set-point value. After reaching the humidity above set-point value motor is turned OFF and scans the next channel. This provides right amount of water at right time. The required software program is developed in assembly level language.

REMOTE SENSING AND CONTROL OF AN IRRIGATION SYSTEM USING A DISTRIBUTED WIRELESS SENSOR NETWORK - Yunseop (James) Kim, Robert G. Evans, and William M. Iversen

Efficient water management is a major concern in many cropping systems in semiarid and arid areas. Distributed in-field sensor-based irrigation systems offer a potential solution to support site-specific irrigation management that allows producers to maximize their productivity while saving water. This paper describes details of the design and instrumentation of variable rate irrigation, a wireless sensor network, and software for real-time in-field sensing and control of a site-specific precision linear-move irrigation system.

Field conditions were site-specifically monitored by six in-field sensor stations distributed across the field based on a soil property map, and periodically sampled and wirelessly transmitted to a base station. An irrigation machine was converted to be electronically controlled by a programming logic controller that updates georeferenced location of sprinklers from a differential Global Positioning System (GPS) and wirelessly communicates with a computer at the base station. Communication signals from the sensor network and irrigation controller to the base station were successfully interfaced using low-cost Bluetooth wireless radio communication. Graphic user interface-based software developed in this paper offered stable remote access to field conditions and real-time control and monitoring of the variable-rate irrigation controller.

A WIRELESS APPLICATION OF DRIP IRRIGATION AUTOMATION SUPPORTED BY SOIL MOISTURE SENSORS - MahirDursun and SemihOzden

Highly increasing demand for freshwater, optimal usage of water resources has been provided with greater extent by automation technology and its apparatus such as solar power, drip irrigation, sensors and remote control. Traditional instrumentation based on discrete and wired solutions, presents many difficulties on measuring and control systems especially over the large geographical areas.

This paper describes an application of a wireless sensor network for low-cost wireless controlled irrigation solution and real time monitoring of water content of soil. The designed system has 3 units namely: base station unit (BSU), valve unit (VU) and sensor unit (SU).The obtained irrigation system not only prevents the moisture stress of trees and calcification, but also provides an efficient use of fresh water resource. In addition, the developed irrigation method removes the need for workmanship for flooding irrigation. The designed system was applied to an area of 8 de cares in a venue located in central Anatolia for controlling drip irrigation of dwarf cherry trees.

CHAPTER 3

EXISTING SYSTEM

Most of the crop maintenance systems in our country are done manually. Farmers stay in the agricultural lands for longer duration for crops irrigation and field maintenance. The accurate value of the soil moisture level, crop wetness, PH level and growth level are not known. Present there is emerging global water crisis where managing scarcity of water has become a tedious job and there are conflicts between users of water. This is an era where human use and pollution of water resource have crossed the levels which lead to limit food production and low down the ecosystem. The major reason for these limitations is the growth of population which is increasing at a faster rate than the production of food and after a few years this population will sum up to 3-4 billion. Thos growth can be seen in countries which have shortage of uniform crop maintenance and are economically poor. Because of growth in population there is a huge demand to raise food production by 50% in the next half century to maintain the capita, based on an assumption that productivity of existing farm land does not decline. The crop water stress index called as CWSI existed around 30 years ago. This crop water stress index was then integrated using measurements of infrared canopy temperatures, ambient air temperatures, and atmospheric vapor pressure values to determine when to irrigate using drip irrigation. The management of these farms which are in greenhouses will require a data acquisition to be located in each greenhouse and the control room where a control unit is located. These are separated from the production area. At present, the data is transferred using wired communication called field bus. This data is transferred between greenhouses and control room. All the problems related here is presented using CAN and ZigBee protocols.

CHAPTER 4

PROPOSED SYSTEM

By automatic crop monitoring process, farmers would be able to know the right amount of water and Nutritionists at the right time thus to maintain the growth of crop. The farmer can measure the water level, PH level and crop growth at any place. These values in agricultural land are measured by using sensors. It also assists the farmer to maintain the crop. The WSN for remote monitoring of crop field consists of set of wireless sensor nodes distributed in an area called end devices or sensor nodes. They have a stronger battery, a larger memory and more computation power, the sensor nodes collects the data from the field by using sensors and this data is send to he path between end devices. The collected data is send to the internet and pc through WSN.

Here in this paper an experimental scale within rural areas where there is an enormous disposition of irrigation system which is executed using arm controller and wireless communication. The main of this implementation was to demonstrate that the automatic irrigation system can be used to optimize /reduce water usage. The system has a water level sensor which will indicate the presence of water level in tank. A software application was advanced by programming the verge values of soil moisture water level that was automated into a microcontroller.The proposed hardware of this system includes arduino, Temperature, humidity,PH level and soil moisture sensors, LCD. The system is low cost & low power consuming so that anybody can afford it. The data monitored is collected at the server. It can be used in precision farming. The system should be designed in such a way that even illiterate villagers can operate it. They themselves can check different parameters of the soil like salinity, acidity, moisture etc. from time to time. During irrigation period they have to monitor their distant pump house throughout the night as the electricity supply is not consistent.

In the event an ambiguity or discrepancy between the general requirements described in Section IV (Proposed System) and the specific technical requirements set forth in Section VI (Technical Requirements) is detected after the opening of bids, Section VI, and the bidder's response thereto, shall have priority over Section IV, and the bidder's response thereto.

Overview of Proposed System / Scope of Services This section of the proposal should include a general discussion of the proposer’s overall understanding of the project and the scope of work, as defined in Section 5, proposed.

Deposit all SIC surcharges within 30 days of collection with a fiscal agent.3. Establish and maintain a separate account into which all billed SIC revenue and interest was to be recorded and reduced by the withdrawal of monies used to design infrastructure and any fees for the trust account.4. Within 90 days after completion of the preliminary engineering design, submit to the Commission’s Division of Water and Audits (DWA), a20-year Proposed System Improvement Plan (PSIP) for improvements to its system.

Proposed System Conceptual Design, Technical Specifications, and Quality of Equipment to be Used.Proposers should therefore use the descriptions of the Proposed System as a general guide, not as an exhaustive or fixed list of all specifications.

If during the term of this Agreement Ciba makes the determination to engage a third party (other than Dermion) to develop a System for a Drug owned, licensed or manufactured by Ciba (other than a Ciba Proprietary Drug for treatment of the Specified Indication, which shall be covered by Section 3.5(a) above) (a "Ciba Proposed System"), prior to initiating discussions with such third party, Ciba shall notify Dermion in writing.

Notwithstanding any other provision of this Agreement, Ciba shall be free to pursue the development of any System (including any Ciba Proposed System) independently without the assistance of a third party at any time without complying with Section 3.5(b) or any other provision of this Agreement (other than Section 3.5(a) which shall apply only in the case of a Ciba Proposed Proprietary System), and without any other restriction or limitation of any kind.

If the Proposed Field is not a Ciba Field and if the Drug proposed to be delivered pursuant to the Dermion Proposed System is not a Ciba Proprietary Drug for treatment of the Specified Indication, Dermion may freely develop the Dermion Proposed System for a third party (which development may be pursuant to an agreement under which Dermion grants exclusive licenses to such third party).

Proposed System (if different from existing) Provide a detailed description of the proposed system.If the Proposed Field is in whole or in part a Ciba Field, Dermion shall be prohibited from pursuing the development of the Dermion Proposed System during the Exclusivity Period without the prior written consent of Ciba, which may be given or withheld in Ciba's sole discretion.

4.1 ADVANTAGES

- Saves water, time, electricity and human energy.
- Discourage weeds.
- Farmer income is increased.
- Crop growth, PH level, water level is intimated alternatively.

4.2 BLOCK DIAGRAM

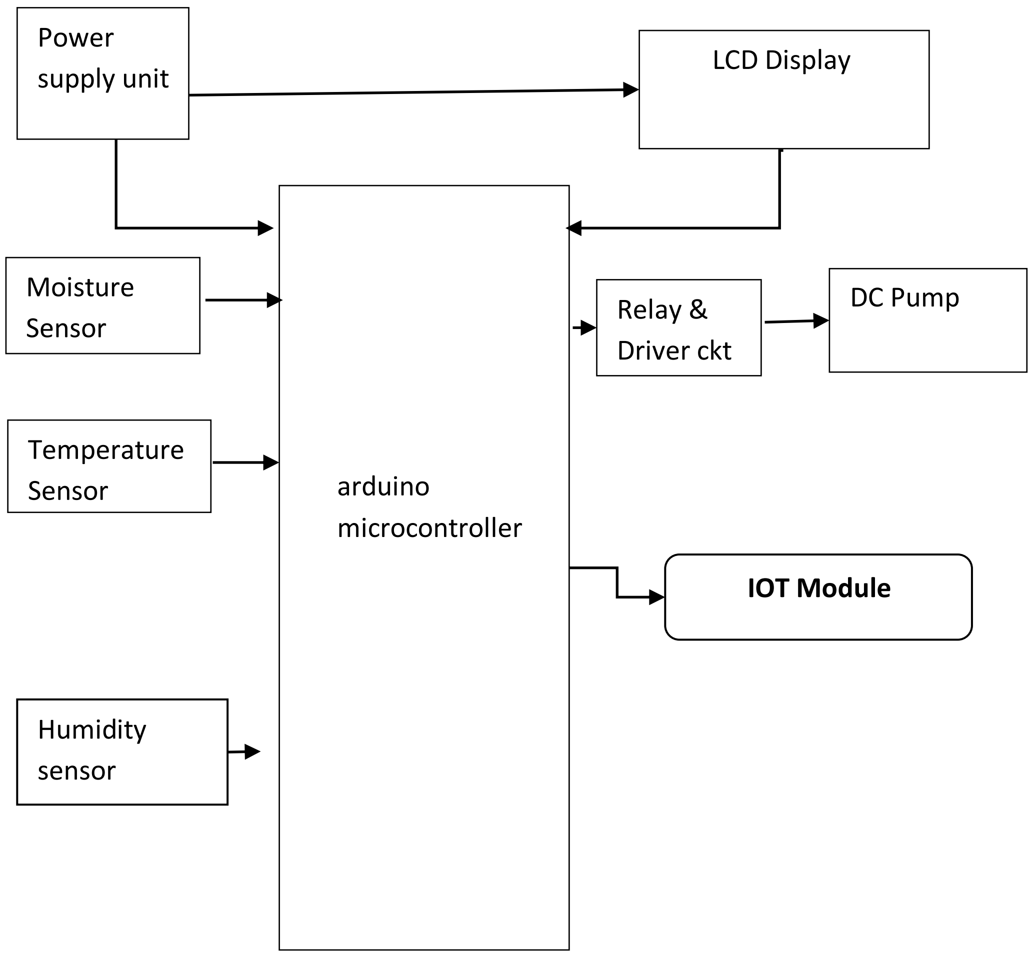


Fig 4.1 Block Diagram

4.3 ARCHITECTURE DIAGRAM

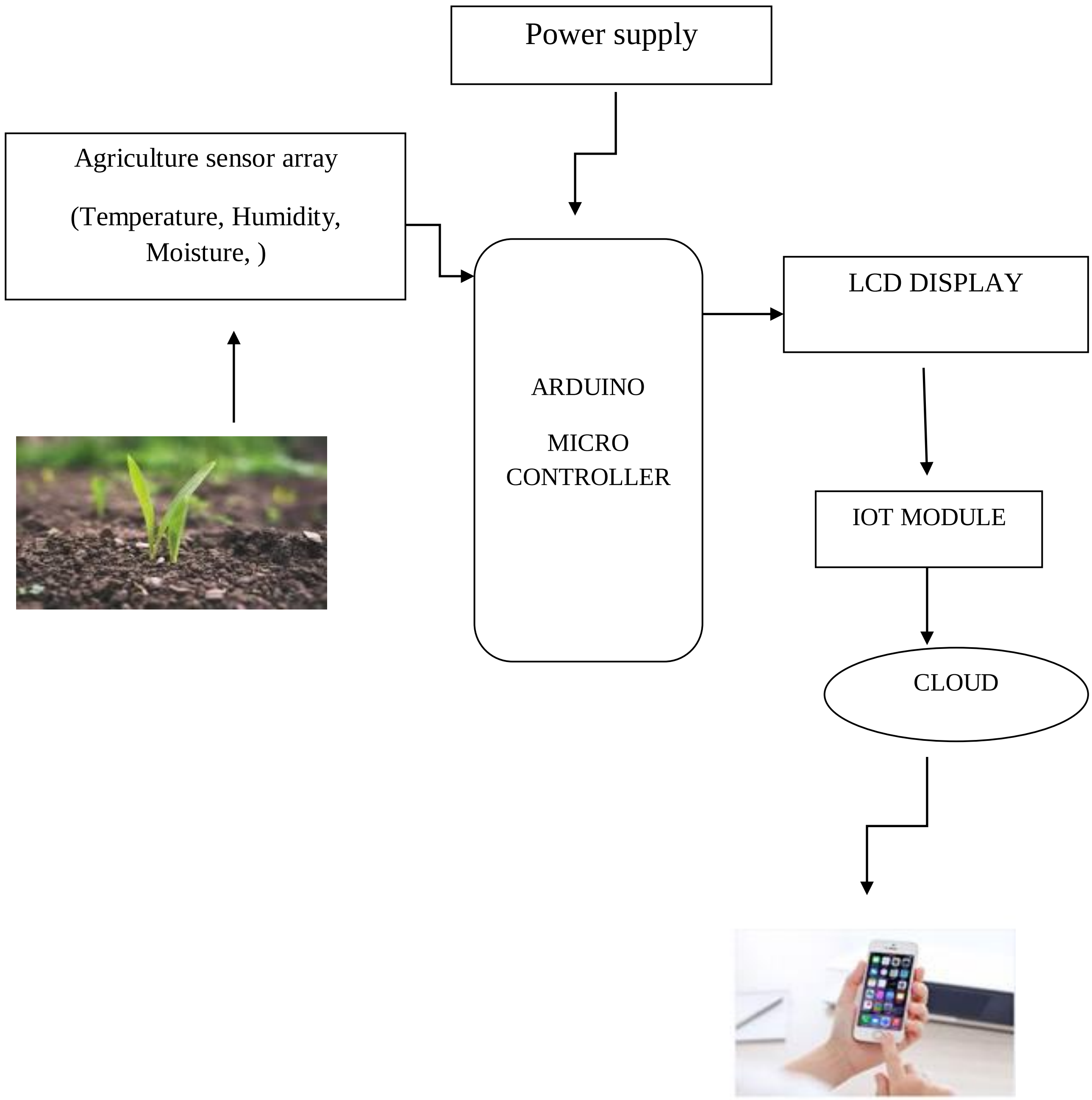
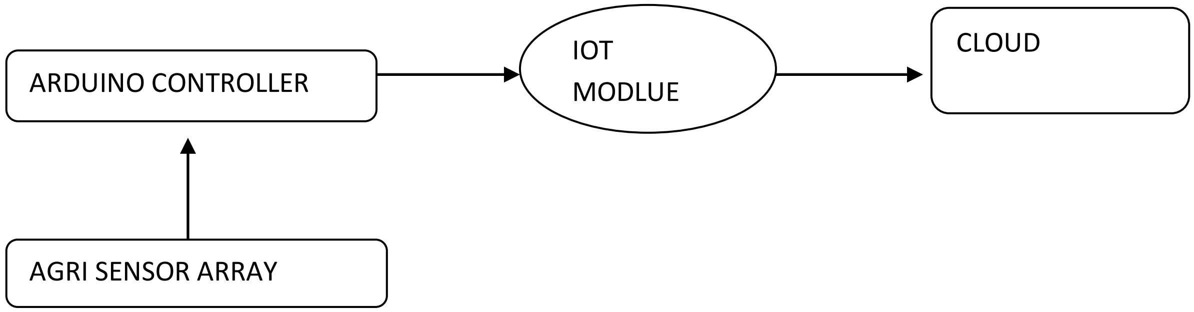


Fig 4.2 Architecture Diagram

MODULE 1



The Internet of things refers to a type of network to connect anything with the Internet based on stipulated protocols through information sensing equipments to conduct information exchange and communications in order to achieve smart recognitions, positioning, tracing, monitoring, and administration. In this paper we briefly discussed about what IOT is, how IOT enables different technologies, about its architecture, characteristics & applications, IOT functional view & what are the future challenges for IOT.

Internet of Things is a new revolution of the Internet. Objects make themselves recognizable and they obtain intelligence by making or enabling context related decisions thanks to the fact that they can communicate information about themselves. They can access information that has been aggregated by other things, or they can be components of complex services. This transformation is concomitant with the emergence of cloud computing capabilities and the transition of the Internet towards IPv6 with an almost unlimited addressing capacity.

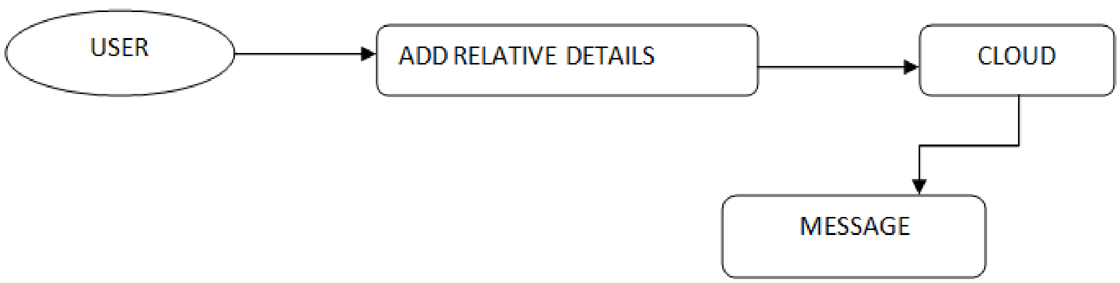
Reference of Arduino:

- ATmega16U2 instead 8U2 as USB-to-Serial converter
- Stronger RESET circuit

MODULE 2

Today we are going to build a registration system that keeps track of which users are admin and which are normal users. The normal users in our application are not allowed to access admin pages. All users (Admins as well as normal users) use the same form to login. After logging in, the normal users are redirected to the index page while the admin users are redirected to the admin pages.

MODULE 3



Smart phones are basic needs of our daily life. It’s likea small computer which gives you many facilities such as webbrowsing, downloading and many more but small data storagespace and backup are major problem. On the other hand cloudcomputing provides efficient computational resources andsecure data hosting services. But the data transmission amongtwo secure networks is performed over unsecured network. Soneed a design to secure data transfer.

CHAPTER 5

HARDWARE REQUIREMENTS

5.1 ARDUINO UNO R3 MICROCONTROLLER

The Arduino Uno R3 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 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 Atmega16U2(Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Revision 2 of the Uno board (A000046) has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

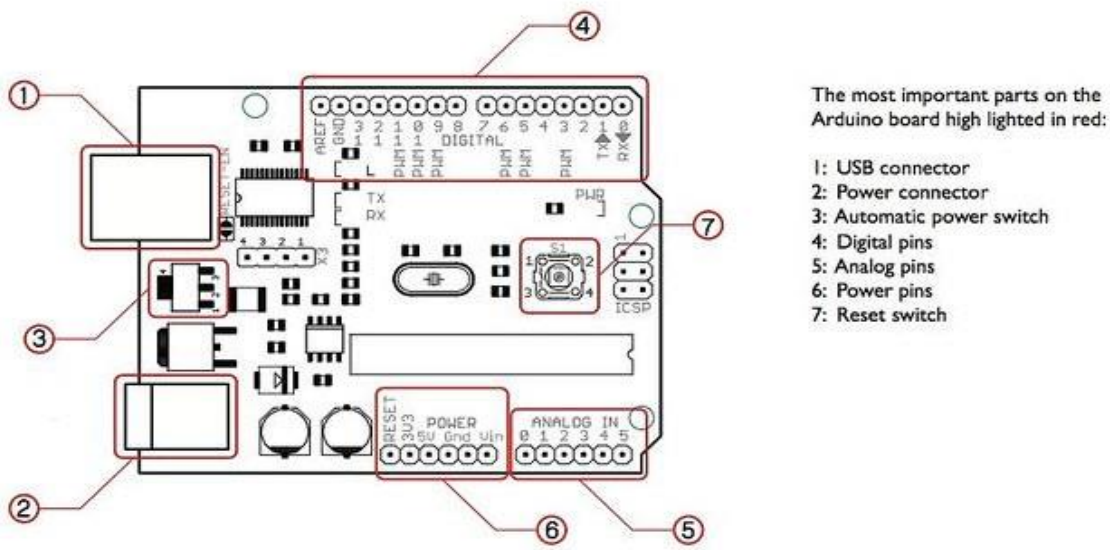


Fig 5.1 Arduino UNO R3

Revision 3 of the board (A000066) has the following new features:

- 1.0 pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

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: 40mA
- DC Current for 3.3V Pin: 50mA
- Flash Memory: 32KB (ATmega328) of which 0.5 KB used by boot loader
- SRAM: 2KB(ATmega328)
- EEPROM: 1KB(ATmega328)
- Clock Speed: 16MHz

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm

Table 5.1 Micro Controller

Power

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 centre-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 5V pin 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 to 5 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.

3V3 – A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

GND. Ground pins.

Battery – Some boards come with a Li-Po (Lithium-ion Polymer) battery socket that fits this kind of batteries. For example, MKR boards (except MKR FOX and

WAN 1300) come with this feature. These types of batteries supply 3.7V, are rechargeable and they can provide higher energy than other lithium batteries.

Please make sure the battery connector suits your board's battery connector. For MKRs the connector is JST PHR-2.

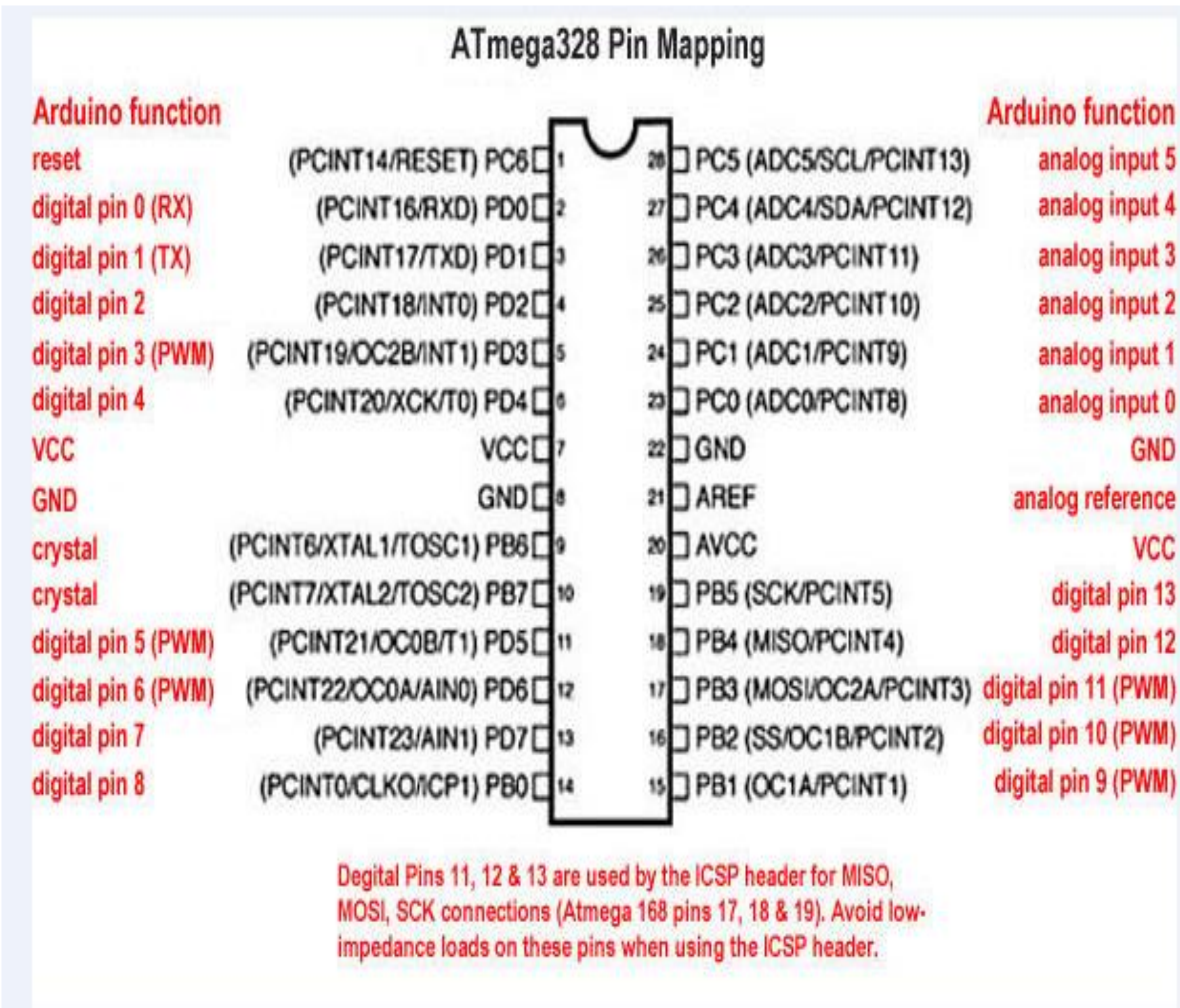


Fig : 5.2 Atmega328

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 m A and has an internal pull-up resistor (disconnected by default) of 20-50 k Ohms. 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, a rising 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 analog Write() function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).

These pins support SPI communication using the SPI library.

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. 3 | P a g e 3 Arduino Uno The Uno has 6 analog inputs, 25abeled A0 through A5, 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 analog Reference() function. Additionally, some pins have specialized functionality:

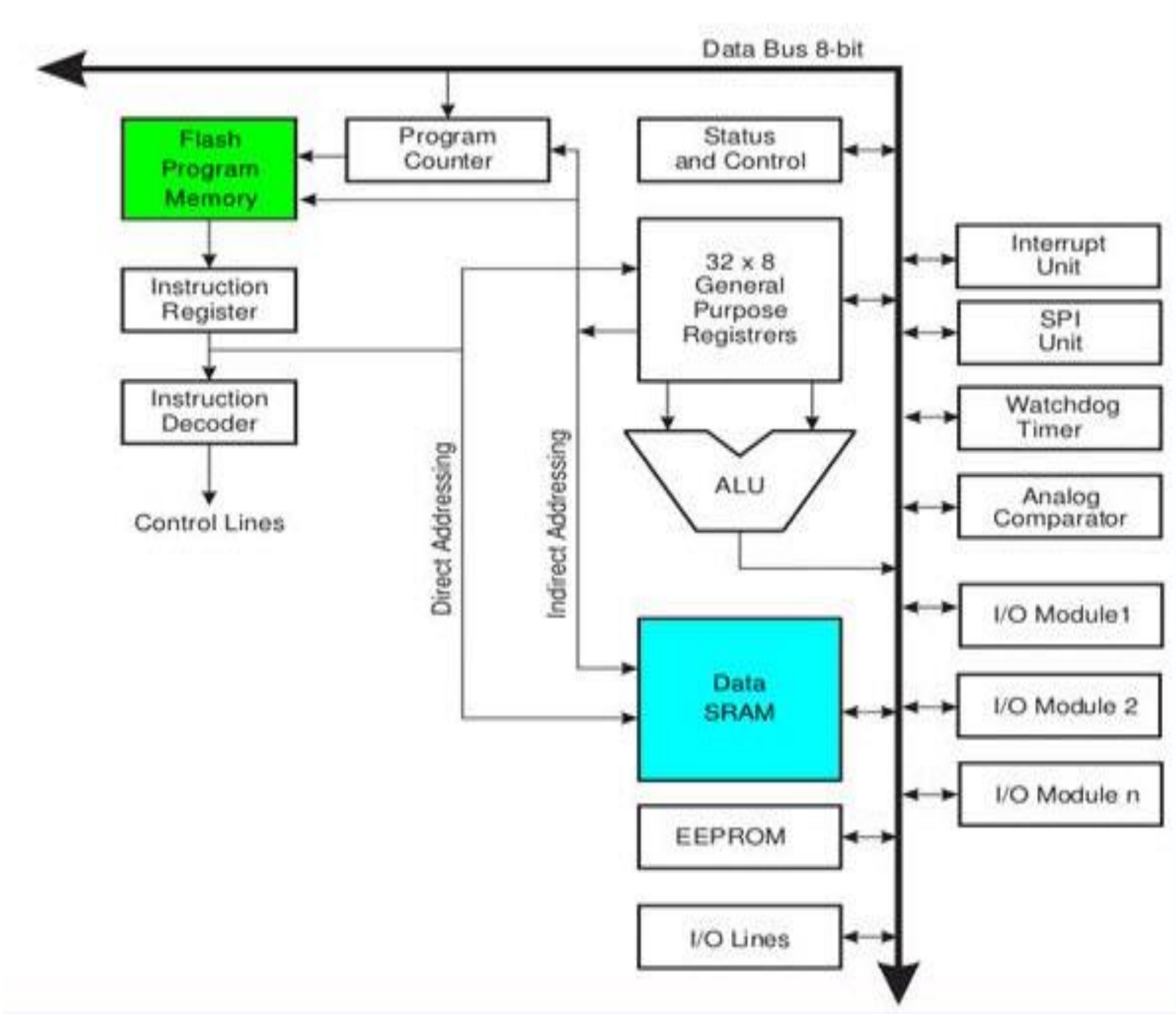


Fig : 5.3 SDA and SCL

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 USB COM drivers, and no external driver is needed. However, on Windows, a .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). A Software Serial library allows for serial communication on any of the Uno's digital pins. The Atmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Programming

The Arduino Uno can be programmed with the Arduino software. Select "Arduino Uno from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials. The Atmega328 on the Arduino Uno comes preburned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files). You can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details. The Atmega8U2 firmware source code is available . The Atmega8U2 is loaded with a DFU boot loader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU boot loader). See this user-contributed tutorial for more information. Arduino Uno

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the Atmega8U2 is connected to the reset line of the Atmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half second or so, the boot loader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data. The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's 28abeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Over current Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and over current. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16”), not an even multiple of the 100 mil spacing of the other pins.

RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called “protective relays”.

5.2 BASIC DESIGN AND OPERATION:

A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two in the relay pictured). The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

When an electric current is passed through the coil it generates a magnetic field that activates the armature, and the consequent movement of the movable contact(s) either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing.

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit components. Some automotive relays include a diode inside the relay case. Alternatively, a contact protection network consisting of a capacitor and resistor in series (snubber circuit) may absorb the surge. If the coil is designed to be energized with alternating current (AC), a small copper "shading ring" can be crimped to the end of the solenoid, creating a small out-of-phase current which increases the minimum pull on the armature during the AC cycle.

APPLICATION:

Relays are used for:

- Amplifying a digital signal, switching a large amount of power with a small operating power. Some special cases are:
    - A telegraph relay, repeating a weak signal received at the end of a long wire
    - Controlling a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers,
    - Controlling a high-current circuit with a low-current signal, as in the startersolenoid of an automobile,
- Detecting and isolating faults on transmission and distribution lines by opening and closing circuit breakers (protection relays)
- Vehicle battery isolation. A 12v relay is often used to isolate any second battery in cars, 4WDs, RVs and boats.
- Switching to a standby power supply.

LCD:

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.

The LCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. Liquid crystals were first discovered in 1888. By 2008, worldwide sales of televisions with LCD screens exceeded annual sales of CRT units; the CRT became obsolete for most purposes.

Fig:5.4 16x2 LCD

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

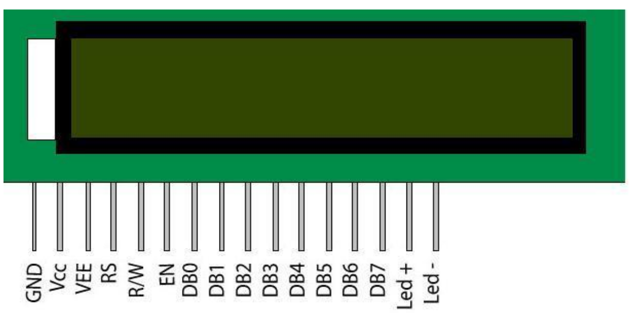


Fig: 5.5 LCD pin details

LCD 16×2:

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

Features of LCD16x2

- The features of this LCD mainly include the following.
- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

PIN DESCRIPTION:

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table 5.2 Pin Description

ADVANTAGES

- Very compact and light.
- Low power consumption. On average, 50-70% less energy is consumed than CRT monitors.
- No geometric distortion.
- The possible ability to have little or no flicker depending on backlight technology.
- Usually no refresh-rate flicker, as the LCD panel itself is usually refreshed at 200 Hz or more, regardless of the source refresh rate.
- Is very thin compared to a CRT monitor, which allows the monitor to be placed farther back from the user, reducing close-focusing related eye-strain.
- Razor sharp image with no bleeding/smearing when used at native resolution.
- Emits less electromagnetic radiation than a CRT monitor.
- Not affected by screen burn-in, though an identical but less severe phenomenon known as image persistence is possible.
- Can be made in almost any size or shape.
- No theoretical resolution limit

SPECIFICATION

Important factors to consider when evaluating an LCD:

Resolution versus range

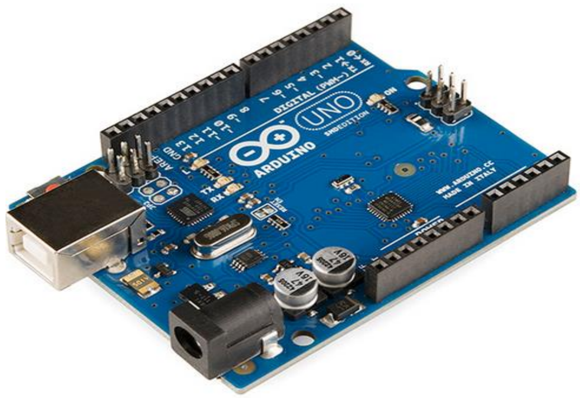
Fundamentally resolution is the granularity (or number of levels) with which a performance feature of the display is divided. Resolution is often confused with range or the total end-to-end output of the display. Each of the major features of a display has both a resolution and a range that are tied to each other but very different. Frequently the range is an inherent limitation of the display while the resolution is a function of the electronics that make the display work.

5.3 ARDUINO

Arduino is a computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[1] permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.

The project's board designs use a variety of microprocessors and controllers. These systems provide sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. The microcontrollers are mainly programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2005 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors



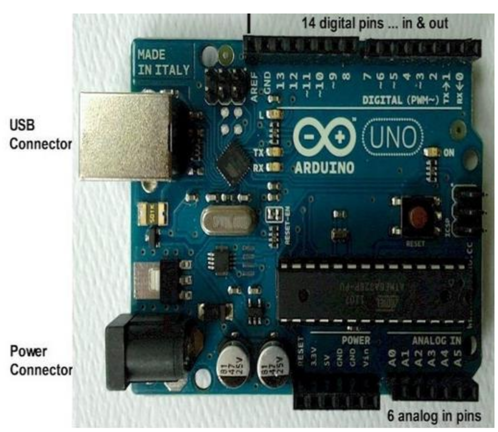


Fig: 5.6 Arduino Uno SMD R3

Developer	Arduino
Manufacturer	Many
Type	Single-board microcontroller
Operating system	None
CPU	Atmel AVR (8-bit), ARM Cortex-M0+ (32-bit), ARM Cortex-M3 (32-bit), Intel Quark (x86) (32-bit)
Memory	SRAM
Storage	Flash, EEPROM

5.3.1 POWER SUPPLY

Block diagram

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

Fig:5.7 Flowchart of Power Supply

Working Principle

Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC; rest of the circuits will give only RMS output.

Bridge rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit. This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 v0lts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

5.3.2 IC Voltage regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A voltage regulator is an integrated circuit (IC) that provides a constant fixed output voltage regardless of a change in the load or input voltage. It can do this many ways depending on the topology of the circuit within, but for the purpose of keeping this project basic, we will mainly focus on the linear regulator.

A linear voltage regulator works by automatically adjusting the resistance via a feedback loop, accounting for changes in both load and input, all while keeping the output voltage constant

Configuring Power Rails

Power your board with any 2.1mm DC power source rated 6-18V – do not exceed the 35VDC max! The power regulator will warm when powered with over 12V (that's OK). If you don't want to use it on a breadboard, use the solder pads labeled "+ -" on the end nearest the barrel jack for 5V regulated power output.

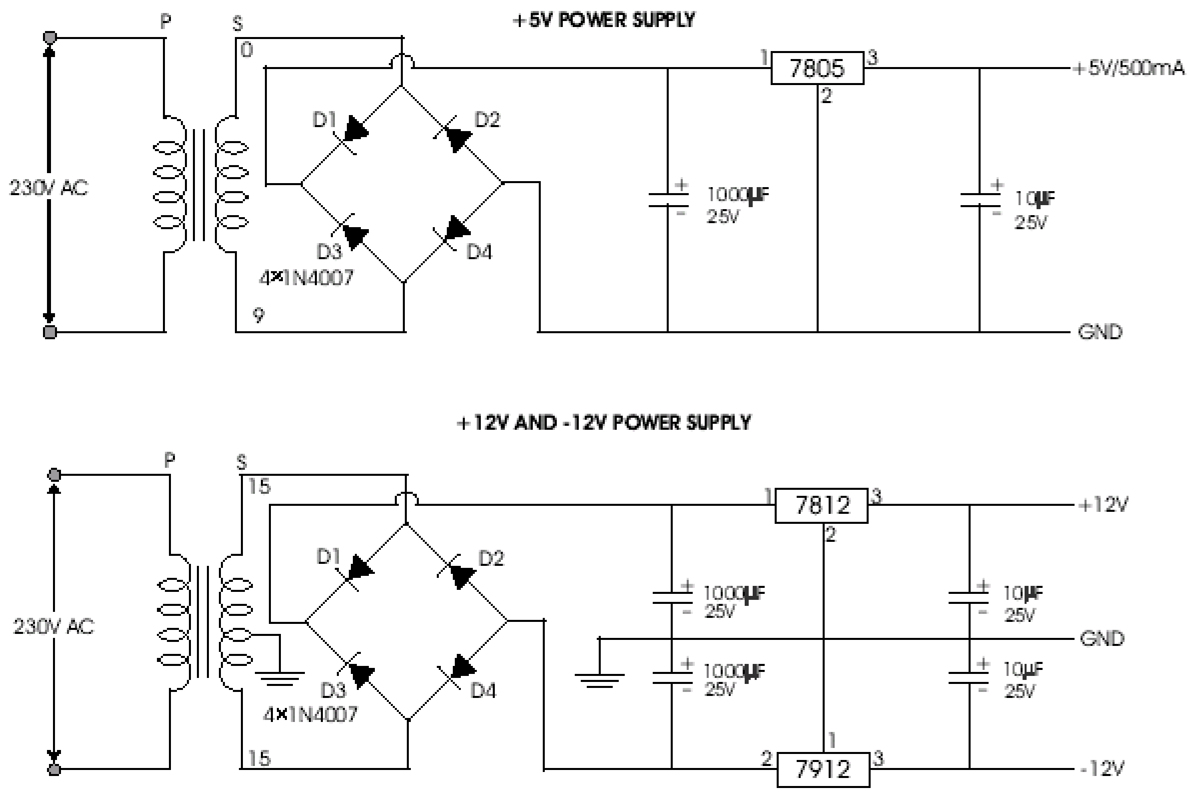


Fig: 5.8 IC Voltage Regulators

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

- For ICs, microcontroller, LCD 5 volts
- For alarm circuit, op-amp, relay circuits 12 volts

5.3.3 SOIL MOISTURE SENSORS

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity.

Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include tensiometers and gypsum blocks Measuring soil moisture is important for agricultural applications to help farmers manage their irrigation systems more efficiently.

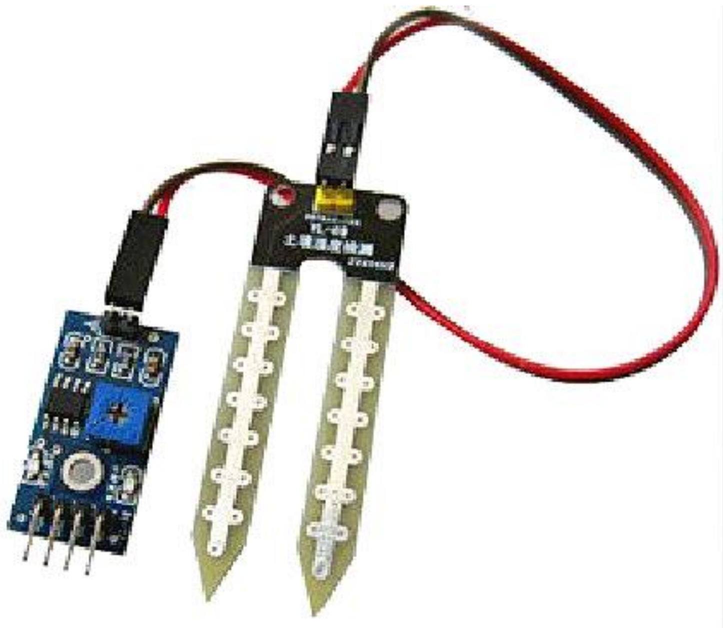


Fig : 5.9 Moisture Sensors

Knowing the exact soil moisture conditions on their fields, not only are farmers able to generally use less water to grow a crop, they are also able to increase yields and the quality of the crop by improved management of soil moisture during critical plant growth stages. In urban and suburban areas, landscapes and residential lawns are using soil moisture sensors to interface with an irrigation controller. Connecting a soil moisture sensor to a simple irrigation clock will convert it into a "smart" irrigation controller that prevents irrigation cycles when the soil is already wet, e.g. following a recent rainfall event. Golf courses are using soil moisture sensors to increase the efficiency of their irrigation systems to prevent over-watering and leaching of fertilizers and other chemicals into the ground.

TEMPERATURE SENSORS

Temperature sensors are vital to a variety of everyday products. For example, household ovens, refrigerators, and thermostats all rely on temperature maintenance and control in order to function properly. Temperature control also has applications in chemical engineering. Examples of this include maintaining the temperature of a chemical reactor at the ideal set-point, monitoring the temperature of a possible runaway reaction to ensure the safety of employees, and maintaining the temperature of streams released to the environment to minimize harmful environmental impact.

While temperature is generally sensed by humans as “hot”, “neutral”, or “cold”, chemical engineering requires precise, quantitative measurements of temperature in order to accurately control a process. This is achieved through the use of temperature sensors, and temperature regulators which process the signals they receive from sensors.

From a thermodynamics perspective, temperature changes as a function of the average energy of molecular movement. As heat is added to a system, molecular motion increases and the system experiences an increase in temperature. It is difficult, however, to directly measure the energy of molecular movement, so temperature sensors are generally designed to measure a property which changes in response to temperature. The devices are then calibrated to traditional temperature scales using a standard (i.e. the boiling point of water at known pressure). The following sections discuss the various types of sensors and regulators.

Temperature sensors are devices used to measure the temperature of a medium. There are 2 kinds on temperature sensors: 1) contact sensors and 2) noncontact sensors. However, the 3 main types are thermometers, resistance temperature detectors, and thermocouples. All three of these sensors measure a physical property (i.e. volume of a liquid, current through a wire), which changes as a function of temperature. In addition to the 3 main types of temperature sensors, there are numerous other temperature sensors available for use.

Contact Sensors

Contact temperature sensors measure the temperature of the object to which the sensor is in contact by assuming or knowing that the two (sensor and the object) are in thermal equilibrium, in other words, there is no heat flow between them.

Examples (further description of each example provide below)

- Thermocouples
- Resistance Temperature Detectors (RTDs)
- Full System Thermometers
- Bimetallic Thermometers

Non contact Sensors

Most commercial and scientific noncontact temperature sensors measure the thermal radiant power of the Infrared or Optical radiation received from a known or calculated area on its surface or volume within it.

An example of noncontact temperature sensors is a pyrometer, which is described into further detail at the bottom of this section.

Thermometers

Thermometers are the most common temperature sensors encountered in simple, everyday measurements of temperature. Two examples of thermometers are the Filled System and Bimetal thermometers.

Filled System Thermometer

The familiar liquid thermometer consists of a liquid enclosed in a tube. The volume of the fluid changes as a function of temperature. Increased molecular movement with increasing temperature causes the fluid to expand and move along calibrated markings on the side of the tube. The fluid should have a relatively large thermal expansion coefficient so that small changes in temperature will result in detectable changes in volume. A common tube material is glass and a common fluid is alcohol. Mercury used to be a more common fluid until its toxicity was realized. Although the filled-system thermometer is the simplest and cheapest way to measure temperature, its accuracy is limited by the calibration marks along the tube length. Because filled system thermometers are read visually and don't produce electrical signals, it is difficult to implement them in process controls that rely heavily on electrical and computerized control.

Bimetal Thermometer

In the bimetal thermometer, two metals (commonly steel and copper) with different thermal expansion coefficients are fixed to one another with rivets or by welding. As the temperature of the strip increases, the metal with the higher thermal expansion coefficients expands to a greater degree, causing stress in the materials and a deflection in the strip. The amount of this deflection is a function of temperature. The temperature ranges for which these thermometers can be used is limited by the range over which the metals have significantly different thermal expansion coefficients. Bimetallic strips are often wound into coils and placed in thermostats. The moving end of the strip is an electrical contact, which transmits the temperature thermostat.

Resistance Temperature Detectors

A second commonly used temperature sensor is the resistance temperature detector (RTD, also known as resistance thermometer). Unlike filled system thermometers, the RTD provides an electrical means of temperature measurement, thus making it more convenient for use with a computerized system. An RTD utilizes the relationship between electrical resistance and temperature, which may either be linear or nonlinear.

The construction is typically such that the wire is wound on a form (in a coil) on notched mica cross frame to achieve small size, improving the thermal conductivity to decrease the response time and a high rate of heat transfer is obtained. In the industrial RTD's, the coil is protected by a stainless steel sheath or a protective tube.

RTDs are traditionally used for their high accuracy and precision. However, at high temperatures (above 700°C) they become very inaccurate due to degradation of the outer sheath, which contains the thermometer. Therefore, RTD usage is preferred at lower temperature ranges, where they are the most accurate.

There are two main types of RTDs, the traditional RTD and the thermistor. Traditional RTDs use metallic sensing elements that result in a linear relationship between temperature and resistance. As the temperature of the metal increases, increased random molecular movement impedes the flow of electrons.

The increased resistance is measured as a reduced current through the metal for a fixed voltage applied. The thermostat uses a semiconductor sensor, which gives a power function relationship between temperature and resistance.

RTD Structure

A schematic diagram of a typical RTD is shown in Fig: 5.10.

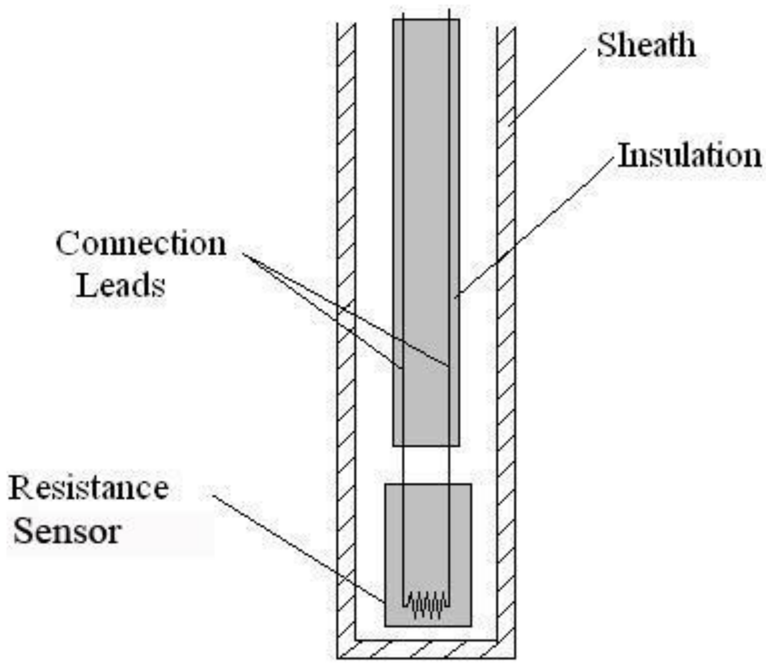


Fig: 5.10 Resistance Temperature Structure

As shown in Fig 5.10, the RTD contains an outer sheath to prevent contamination from the surrounding medium. Ideally, this sheath is composed of material that efficiently conducts heat to the resistor, but resists degradation from heat or the surrounding medium.

The resistance sensor itself is responsible for the temperature measurement, as shown in the diagram. Sensors are most commonly composed of metals, such as platinum, nickel, or copper. The material chosen for the sensor determines the range of temperatures in which the RTD could be used. For example, platinum sensors, the most common type of resistor, have a range of approximately -200°C – 800°C. (A sample of the temperature ranges and resistances for the most common resistor metals is shown in Table 1). Connected to the sensor are two insulated connection leads. These leads continue to complete the resistor circuit.

5.4 SOFTWARE DESCRIPTION

Embedded C

An embedded system is an application that contains at least one programmable computer (typically in the form of a microcontroller, a microprocessor or digital signal processor chip) and which is used by individuals who are, in the main, unaware that the system is computer-based.

Introduction

Looking around, we find ourselves to be surrounded by various types of embedded systems. Be it a digital camera or a mobile phone or a washing machine, all of them has some kind of processor functioning inside it. Associated with each processor is the embedded software. If hardware forms the body of an embedded system, embedded processor acts as the brain, and embedded software forms its soul. It is the embedded software which primarily governs the functioning of embedded systems.

During infancy years of microprocessor based systems, programs were developed using assemblers and fused into the EPROMs. There used to be no mechanism to find what the program was doing. LEDs, switches, etc. were used to check correct execution of the program. Some ‘very fortunate’ developers had In-circuit Simulators (ICEs), but they were too costly and were not quite reliable as well.

As time progressed, use of microprocessor-specific assembly-only as the programming language reduced and embedded systems moved onto C as the embedded programming language of choice. C is the most widely used programming language for embedded processors/controllers. Assembly is also used but mainly to implement those portions of the code where very high timing accuracy, code size efficiency, etc. are prime requirements.

Initially C was developed by Kernighan and Ritchie to fit into the space of 8K and to write (portable) operating systems. Originally it was implemented on UNIX operating systems. As it was intended for operating systems development, it can manipulate memory addresses. Also, it allowed programmers to write very compact codes. This has given it the reputation as the language of choice for hackers too.

As assembly language programs are specific to a processor, assembly language didn’t offer portability across systems. To overcome this disadvantage, several high level languages, including C, came up. Some other languages like PLM, Modula-2, Pascal, etc. also came but couldn’t find wide acceptance. Amongst those, C got wide acceptance for not only embedded systems, but also for desktop applications. Even though C might have lost its sheen as mainstream language for general purpose applications, it still is having a strong-hold in embedded programming. Due to the wide acceptance of C in the embedded systems, various kinds of support tools like compilers & cross-compilers, ICE, etc. came up and all this facilitated development of embedded systems using C.Subsequent sections will discuss what is Embedded C, features of C language, similarities and difference between C and embedded C, and features of embedded C programming.

EMBEDDED SYSTEMS PROGRAMMING

Embedded systems programming is different from developing applications on a desktop computers. Key characteristics of an embedded system, when compared to PCs, are as follows. Embedded devices have resource constraints(limited ROM, limited RAM, limited stack space, less processing power)Components used in embedded system and PCs are different; embedded systems typically uses smaller, less power consuming components. Embedded systems are more tied to the hardware.Two salient features of Embedded Programming are code speed and code size. Code speed is governed by the processing power, timing constraints, whereas code size is governed by available program memory and use of programming language. Goal of embedded system programming is to get maximum features in minimum space and minimum time.

Embedded systems are programmed using different type of language

- Machine Code
- Low level language, i.e., assembly
- High level language like C, C++, Java, Ada, etc.
- Application level language like Visual Basic, scripts, Access, etc.

Assembly language maps mnemonic words with the binary machine codes that the processor uses to code the instructions. Assembly language seems to be an obvious choice for programming embedded devices. However, use of assembly language is restricted to developing efficient codes in terms of size and speed. Also, assembly codes lead to higher software development costs and code portability is not there. Developing small codes are not much of a problem, but large programs/projects become increasingly difficult to manage in assembly language. Finding good assembly programmers has also become difficult nowadays. Hence high level languages are preferred for embedded systems programming.

Use of C in embedded systems is driven by following advantagesit is small and reasonably simpler to learn, understand, program and debug. C Compilers are available for almost all embedded devices in use today, and there is a large pool of experienced C programmers.

Unlike assembly, C has advantage of processor-independence and is not specific to any particular microprocessor/ microcontroller or any system. This makes it convenient for a user to develop programs that can run on most of the systems.As C combines functionality of assembly language and features of high level languages, C is treated as a 'middle-level computer language' or 'high level assembly language'. It is fairly efficient. It supports access to I/O and provides ease of management of large embedded projects.

Many of these advantages are offered by other languages also, but what sets C apart from others like Pascal, FORTRAN, etc. is the fact that it is a middle level language; it provides direct hardware control without sacrificing benefits of high level languages.Compared to other high level languages, C offers more flexibility because C is relatively small, structured language; it supports low-level bit-wise data manipulation.

Compared to assembly language, C Code written is more reliable and scalable, more portable between different platforms (with some changes). Moreover, programs developed in C are much easier to understand, maintain and debug. Also, as they can be developed more quickly, codes written in C offers better productivity. C is based on the philosophy 'programmers know what they are doing'; only the intentions are to be stated explicitly. It is easier to write good code in C & convert it to an efficient assembly code (using high quality compilers) rather than writing an efficient code in assembly itself. Benefits of assembly language programming over C are negligible when we compare the ease with which C programs are developed by programmers.

Objected oriented language, C++ is not apt for developing efficient programs in resource constrained environments like embedded devices. Virtual functions & exception handling of C++ are some specific features that are not efficient in terms of space and speed in embedded systems. Sometimes C++ is used only with very few features, very much as C.

Ada, also an object-oriented language, is different than C++. Originally designed by the U.S. DOD, it didn't gain popularity despite being accepted as an international standard twice (Ada83 and Ada95). However, Ada language has many features that would simplify embedded software development.

Java is another language used for embedded systems programming. It primarily finds usage in high-end mobile phones as it offers portability across systems and is also useful for browsing applications. Java programs require Java Virtual Machine (JVM), which consume lot of resources. Hence it is not used for smaller embedded devices.Dynamic C and B# are some proprietary languages which are also being used in embedded applications. Efficient embedded C programs must be kept small and efficient; they must be optimized for code speed and code size. Good understanding of processor architecture embedded C programming and debugging tools facilitate this.

Difference between C and embedded C

Though C and embedded C appear different and are used in different contexts, they have more similarities than the differences. Most of the constructs are same; the difference lies in their applications.

C is used for desktop computers, while embedded C is for microcontroller based applications. Accordingly, C has the luxury to use resources of a desktop PC like memory, OS, etc. While programming on desktop systems, we need not bother about memory. However, embedded C has to use with the limited resources (RAM, ROM, I/Os) on an embedded processor. Thus, program code must fit into the available program memory. If code exceeds the limit, the system is likely to crash.

Compilers for C (ANSI C) typically generate OS dependant executables. Embedded C requires compilers to create files to be downloaded to the microcontrollers/microprocessors where it needs to run. Embedded compilers give access to all resources which is not provided in compilers for desktop computer applications.Embedded systems often have the real-time constraints, which is usually not there with desktop computer applications.

Embedded systems often do not have a console, which is available in case of desktop applications.So, what basically is different while programming with embedded C is the mindset; for embedded applications, we need to optimally use the resources, make the program code efficient, and satisfy real time constraints, if any. All this is done using the basic constructs, syntaxes, and function libraries of ‘C’.

Keil C51 C Compilers

- Direct C51 to generate a listing file
- Define manifest constants on the command line

- Control the amount of information included in the object file
- Specify the level of optimization to use
- Specify the memory models

Specify the memory space for variables The Keil C51 C Compiler for the 8051 microcontroller is the most popular 8051 C compiler in the world. It provides more features than any other 8051 C compiler available today.

The C51 Compiler allows you to write 8051 microcontroller applications in C that, once compiled, have the efficiency and speed of assembly language. Language extensions in the C51 Compiler give you full access to all resources of the 8051.

The C51 Compiler translates C source files into reloadable object modules which contain full symbolic information for debugging with the µVision Debugger or an in-circuit emulator. In addition to the object file, the compiler generates a listing file which may optionally include symbol table and cross reference information.

SOFTWARE DESCRIPTION

PROTEUS

Proteus PCB design electronic circuits can computer-aided design and circuit boards are designed.

ISIS (Intelligent Schematic Input System)

The ISIS Intelligent Schematic Input System (Intelligent Switching input system), is the environment for the design and simulation of electronic circuits. The component library includes claims more than 10,000 circuit components with 6000

Prospice Simulations models. Own components can be created and added to the library.

ISIS includes a base VSM engine with support for the following functions:

- DC / AC voltmeter and ammeter, oscilloscopes, logic analyzers
- Analog signal generators, digital pattern generator
- Timer functions, protocol analyzers (including RS232, I2C, SPI)

VSM (Virtual System Modeling)

The VSM Virtual System Modeling provides a graphical SPICE circuit simulation and animation directly in the ISIS environment. The SPICE simulator is based on the Berkeley SPICE3F5 model.

It can microprocessor-based systems can be simulated. With the VSM engine can interact during the simulation directly with the circuit. Changes of buttons, switches or potentiometers are queried in real-time and LED indicators, LCD displays, "Hot / Cold" Wires displayed.

Proteus 7.0 is a Virtual System Modeling that combines circuit simulation, animated components and microprocessor models to co-simulate the complete microcontroller based designs. This is the perfect tool for engineers to test their microcontroller designs before constructing a physical prototype in real time. This program allows users to interact with the design using on-screen indicators and/or LED and LCD displays and, if attached to the PC, switches and buttons. One of the main components of Proteus 7.0 is the Circuit Simulation -- a product that uses a SPICE3f5 analogue simulator kernel combined with an event-driven digital simulator that allow users to utilize any SPICE model by any manufacturer.

Proteus VSM comes with extensive debugging features, including breakpoints, single stepping and variable display for a neat design prior to hardware prototyping.

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ADVANTAGES

- Flexibility
- Productivity
- Reduced Development Time.
- Reduced Debugging Testing Time.
- Reduced Manufacturing Delays.
- Reduced Equipment Costs.
- Reasonable Cost of Ownership.

CHAPTER 6

CONCLUSION

IOT based crop field monitoring system serves as a reliable and efficient system for monitoring agricultural parameters. The corrective action can be taken. Wireless monitoring of field not only allows user to reduce the human power, but it also allows user to see accurate changes in it. It is cheaper in cost and consumes less power. The GDP per capita in agro sector can be increased. Agriculture is a backbone of human civilization since man has started agriculture. As the generation evolved, man developed many methods of crop monitoring to provide growth to the crop. In the present scenario on conservation of water is of high importance. Present work is attempts to save the natural resources available for human kind. By continuously monitoring the status of the soil, we can control the flow of water and thereby reduce the wastage. This review is proposed to supports aggressive water management for the agricultural land. Microcontroller in the system promises about increase in systems life by reducing the power consumption resulting in lower power consumption.

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