CLOUD OF THINGS IN SMART AGRICULTURE: INTELLIGENT IRRIGATION MONITORING BY IMAGE PROCESSING

A PROJECT REPORT

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In partial fulfillment for the award of the degree of

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DECLARATION

We hereby declare that the project entitled **CLOUD OF THINGS IN SMART AGRICULTURE: INTELLIGENT IRRIGATION MONITORING BY IMAGE PROCESSING s**ubmitted by us to the School of Computing Science and Engineering, VIT Chennai, 600127 in partial fulfillment of the requirements of the award of the degree of B.Tech CSE is a bonafide record of the work carried out by us under the supervision of **Prof. ANUSOOYA G**. We further declare that the work reported in this project, has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma of this institute or of any other institute or University.

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CERTIFICATE

This is to certify that the report entitled **CLOUD OF THINGS IN SMART AGRICULTURE: INTELLIGENT IRRIGATION MONITORING BY IMAGE PROCESSING** is prepared and submitted by Revathy Suresh (Reg. No. 15BCE1183) & Hrishikesh Handique (Reg. No. 15BCE1104), to VIT Chennai, in partial fulfillment of the requirement for the award of the degree of B.Tech CSE programme is a bonafide record carried out under my guidance. The project fulfills the requirements as per the regulations of this University and in my opinion, meets the necessary standards for submission. The contents of this report have not been submitted and will not be submitted either in part or in full, for the award of any other degree or diploma and the same is certified.

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CLOUD OF THINGS IN SMART AGRICULTURE: INTELLIGENT IRRIGATION MONITORING BY IMAGE PROCESSING

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EXECUTIVE SUMMARY

Modern agriculture offers a range of benefits, including greater production and higher incomes for farmers including small producers in both developed and developing countries. Technical advances also have sharply reduced environmental impacts, enabling reduced pesticide, herbicide and fertilizer use, less tillage, and less land and water use per unit of output all decreasing pressure on fragile global ecosystems. It is clear that we have a productivity gap going forward, a gap that we must begin now to close. If we are to double agricultural output by 2050 and do so with basically the same amount of land and water as we have today while also reducing the environmental footprint then clearly we must become more productive than we have been in the past. That is the productivity gap, which is our challenge.

ABSTRACT

There has been much research and various attempts to apply new IOT technology to agricultural areas. However, IOT for agriculture should be considered differently against the same areas such as industrial, logistics. This paper presents the IOT-based agricultural production system for stabilizing supply and demand of agricultural products while developing the environment sensors and prediction system for the growth and production amount of crops by gathering its environmental information. Currently, the demand by consumption of agricultural products could be predicted quantitatively, however, the variation of harvest and production by the change of farm's cultivated area, weather change, disease, and insect damage, etc. could not be predicted, so that the supply and demand for agricultural products has not been controlled properly. To overcome it, this paper designed the IOT-based monitoring system to analyze the crop environment, and the method to improve the efficiency of decision making by analyzing harvest statistics. Therefore, this paper developed the real-time monitoring of healthiness of the crops in the agriculture field and updates the status to the cloud server and also providing necessary water to crop at the required time. Therefore, this paper developed the real-time monitoring of healthiness of the crops in the agriculture field and updates the status to the cloud server and also providing necessary water to crop at the required time.

1.Introduction

In India, where 60-70% economy depends on agriculture, Indian agriculture is developing day by day; despite its decline in country's GDP share, the advancement and development in agriculture sector could not be ignored. But with this improvement, Indian agriculture is also facing varieties of problems, some of which are natural while others are manmade. Indian soils have been used for growing crops over thousands of years without caring much for replenishing. This has led to depletion and exhaustion of soils resulting in their low productivity. The average yields of almost all the crops are among the lowest in the world. This is a serious problem which can be solved by using more manures and fertilizers.

It is estimated that 70 % of growth in agricultural production can be credited to increased fertilizer application. However there many practical problems in facilitating the use of fertilizers in Indian agriculture. Chemical fertilizers are costly and cannot be afforded by the poor peasants. Cow dung provides the best manure for the soil, but its use is limited, as much of the cow dung is used as kitchen fuel because of the shortage of fuel. Hence the fertilizer problem is acute and complex in India. Organic manures are essential for keeping the good health of the soil. At present India has a potential of producing 650 million tons of rural and 160 lakh tonnes of urban compost, but this reserve is not fully utilized. A proper waste management system will be a good option to utilize this compost. Government is providing subsidies on the chemical fertilizers, which is very helpful for poor peasants. At the time of independence, there was practically no use of chemical fertilizers, but due to the government's effort, the consumption of fertilizers increased tremendously. The quality of fertilizers is controlled by the 52 fertilizer quality control laboratories established in different parts of the country. Due to unplanned use of water the ground water level is decreasing day by day. Lack of rains and scarcity of land water also results in a decrement in the volume of water on earth. A growing population, increased demand for agriculturally-based fuel and other products changing, climate increasing water scarcity in many areas and loss of agriculturally productive lands to development will only increase pressure on natural resources in coming decades. Irrigation in India refers to the supply of water from Indian rivers, tanks, wells, canals, and other artificial projects for the purpose of cultivation and agricultural activities. In a country such as India, 64% of cultivated land is dependent on monsoons.[1] The economic significance of irrigation in India is namely, to reduce over-dependence on monsoons, advanced agricultural productivity, bringing more land under cultivation, reducing instability in output levels, the creation of job opportunities, electricity and transport facilities, control of floods and prevention of droughts. In order to secure future agricultural productivity, the nation needs both to conserve and enhance soil, water supplies, and other natural resources and to adapt to changing condition. Addressing these challenges at home also will contribute to agricultural development and resource conservation abroad through knowledge and technology transfer.

1.1 Objective

Tomorrow's challenges of doubling food supply put the sustainability of agriculture at one level with ensuring food security. The global food system needs to be resource efficient and at the same time sustainable. Efficient use of water, reduction of soil erosion and degradation to the minimum, minimization of energy input and maximization of yields under uncertain natural conditions are the goal. They pose the highest requirements on the underlying information and knowledge infrastructure and make future farming a knowledge business and a very sophisticated management task. Studies on the global and regional potentials of Earth Observation (EO) in agriculture show that EO can be pivotal. Due to its global capacity to determine information relevant for farming EO can become the global source of future, information-driven global agriculture. Assimilated into sophisticated environmental management models this EO-derived information will allow to support the whole economic and societal value chain from farmers through food industry to insurance and financial industry in producing food. At the same time, it allows supporting society in governing sustainable agriculture through verifiable rules and regulations.

1.2 Background

In the coming years, smart Agriculture is projected to create a massive impact on the agricultural economy by bridging the gap between small and large-scale businesses. The trend is not only pertinent in developed countries — but developing countries have also realized its immense importance as well. In countries such as India, China, and Japan, wide-scale deployments of smartphones and internet of things (IoT) systems have led to rapid adoption of precision agriculture solutions. The governments of several countries have also realized the need for, and the advantages of these technologies, and thus, their initiatives to promote precision farming techniques are expected to drive the growth of the market further. However, such revolutionary changes in farming practices not only come with opportunities but also certain challenges which prove to be a restraint in the growth of the market. The awareness and knowledge about newer agriculture technology are yet to spread extensively, especially in emerging countries. A change in the global aging demographic has triggered the adoption of automation in farming practices. Automation and control systems manufacturers have witnessed a definite surge in their sales due to this profound change in the farming industry. Over the past five years, agricultural robots have also been incorporated into farming operations as they treat soil and crops selectively as per their requirements and reduce the need for manual labor. UAV/drones generated the highest revenue amongst all agricultural robots utilized in smart farming. The majority of robot deployment was done for crop management.

1.3 Motivation

The farming industry will become arguably more important than ever before in the next few decades. The world will need to produce 70% more food in 2050 than it did in 2006 in order to feed the growing population of the Earth, according to the UN Food and Agriculture Organization. To meet this demand, farmers and agricultural companies are turning to the Internet of Things for analytics and greater production capabilitiesTechnological innovation in farming is nothing new. Handheld tools were the standards hundreds of years ago, and then the Industrial Revolution brought about the cotton gin. The 1800s brought about grain elevators, chemical fertilizers, and the first gas-powered tractor. Fast forward to the late 1900s, when farmers start using satellites to plan their work. The IoT is set to push the future of farming to the next level. Smart agriculture is already becoming more commonplace among farmers, and high tech farming is quickly becoming the standard thanks to agricultural drones and sensors. We've outlined IoT applications in agriculture and how "Internet of Things farming" will help farmers meet the world's food demands in the coming years.

2. Project Description And Goals

2.1 Project Description:

Our proposed system uses Arduino MEGA 2560, controller to monitor the field. In this temperature sensor and moisture sensor and rain sensor, water level sensor is connected externally so we can monitor the exact view of plants. Then the values obtained by the sensors will be displayed on LCD and using the wifi module connected the values will be automatically stored in iot cloud database server which is (http://iotclouddata.tech/616/readalltable/readalltable.php) And the main part of the system is image processing so we can monitor the plant is good condition or not. Then the image processing data's and sensor's data's move to the IoT hardware module so we can monitor all data's in unique URL address specified above. The motor will automatically on and off based on sensor value.

2.2 Goals:

The goals of our project include:

- Automatic operation of motors
- Flooding can be prevented
- Diseases can be monitored and necessary preventions can be done
- Time-saving
- More operations can be performed in a cycle of time unlike manual farming
- All the necessary data can be stored in the IoT cloud server (http://iotclouddata.tech/616/readalltable/readalltable.php)

3. Technical Specifications

3.1 Hardware Requirements:

- Arduino MEGA
- Moisture Sensor
- Temperature sensor
- Water level sensor
- Camera
- Rain Sensor
- LCD
- IOT
- Pump Motor

3.1.1 Arduino Mega 2560

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), 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 an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.

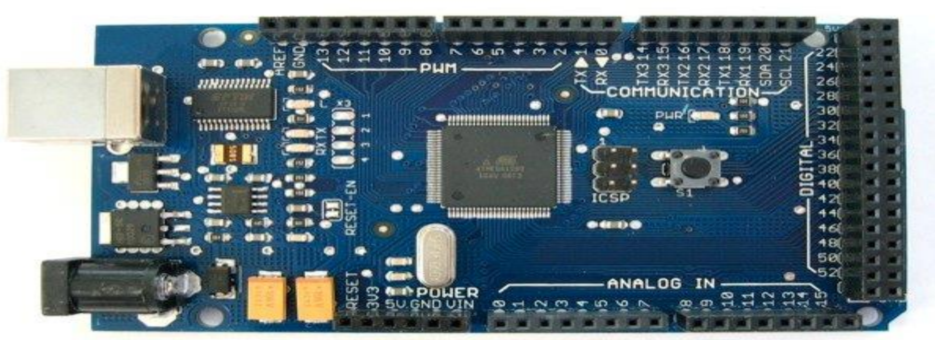


Fig 3.1.1.1 Arduino Mega 2560

Programming:

The Mega 2560 board can be programmed with the Arduino Software (IDE). For details, see the reference and tutorials.

The ATmega2560 on the Mega 2560 comes preprogrammed with a bootloader 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).

We can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar; see these instructions for details. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository. The ATmega16U2/8U2 is loaded with a DFU bootloader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.
- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode. 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 bootloader). See this user-contributed tutorial for more information.

Warnings

The Mega 2560 has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. 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.

Power

The Mega 2560 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 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

Power pins are as follow:

1.Vin. The input voltage to the board when it's using an external power source (as opposed to 5 volts from the USB connection or another regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.

1.3V3. A 3.3 volt supply generated by the onboard regulator. Maximum current draw is 50 mA.

2.GND. Ground pins.

3.IOREF. This pin on the board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

Memory

The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

Input And Output

See the mapping between Arduino pins and Atmega2560 ports

PIN MAPPING
Atmega2560

Fig 3.1.1.2 Mapping

Each of the 54 digital pins on the Mega 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 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50 k ohm. A maximum of 40mA is the value that must not be exceeded to avoid permanent damage to the microcontroller

- Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega16U2 USB-to-TTL Serial chip.
- External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low level, a rising or falling edge, or a change in level. See the attach Interrupt() function for details.
- PWM: 2 to 13 and 44 to 46. Provide 8-bit PWM output with the analog Write() function.
- SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication using the SPI library. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Arduino /Genuine Uno and the old Duemilanove and Diecimila Arduino boards.
- 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.
- TWI: 20 (SDA) and 21 (SCL). Support TWI communication using the Wire library. Note that these pins are not in the same location as the TWI pins on the old Duemilanove or Diecimila Arduino boards.

See also the mapping Arduino Mega 2560 PIN diagram.

The Mega 2560 has 16 analog inputs, each of which provides 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 analogReference() function.
>AREF. The 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.

Communication

The Mega 2560 board has a number of facilities for communicating with a computer, another board, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega16U2 (ATmega 8U2 on the revision 1 and revision 2 boards) on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2/ATmega16U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Mega 2560's digital pins.

Mega 2560 also supports TWI and SPI communication. The Arduino Software (IDE) includes a Wire library to simplify the use of the TWI bus; see the documentation for details. For SPI communication, use the SPI library.

Physical Characteristics and Shield Compatibility
The maximum length and width of the Mega 2560 PCB are 4 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three 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.

The Mega 2560 is designed to be compatible with most shields designed for the Uno and the older Diecimila or Duemilanove Arduino boards. Digital pins 0 to 13 (and the adjacent AREF and GND pins), analog inputs 0 to 5, the power header, and ICSP header are all in equivalent locations. Furthermore, the main UART (serial port) is located on the same pins (0 and 1), as are external interrupts 0 and 1 (pins 2 and 3 respectively). SPI is available through the ICSP header on both the Mega 2560 and Duemilanove / Diecimila boards. Please note that I2C is not located on the same pins on the Mega 2560 board (20 and 21) as the Duemilanove / Diecimila boards (analog inputs 4 and 5).

3.1.2 Temperature Sensor - The Lm35

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ºC)

The LM35 - An Integrated Circuit Temperature Sensor

Why use lm35s to measure temperature?

1.You can measure temperature more accurately than using a thermistor.

2The sensor circuitry is sealed and not subject to oxidation, etc.

3.The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage is amplified.

What does an lm35 look like?

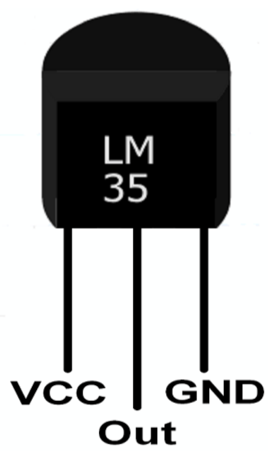


Fig 3.2.1.1 LM35

What does an lm35 do? How does it work?

1.It has an output voltage that is proportional to the Celsius temperature.

2.The scale factor is .01V/OC

3.The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 ºC at room temperature and +/- 0.8 ºf over a range of 0 ºC to +100 ºC.

4.Another important characteristic of the LM35DZ is that it draws only 60 microamps from its supply and possesses a low self-heating capability. The sensor self-heating causes less than 0.1 ºC temperature rise in still air.

The Lm35 Comes In Many Different Packages, Including The Following.

1.TO-92 plastic transistor-like package,

2.T0-46 metal can transistor-like package

3.8-lead surface mount SO-8 small outline package

4.TO-202 package. (Shown in the picture above)

How do you use an lm35? (electrical connections)

1.Here is a commonly used circuit. For connections refer to the picture above.

2.In this circuit, parameter values commonly used are:

-V_c = 4 to 30v

-5v or 12 v are typical values used.

-$R_a = V_c / 10^{-6}$

-Actually, it can range from 80 K□ to 600 K□, but most just use 80 K□.

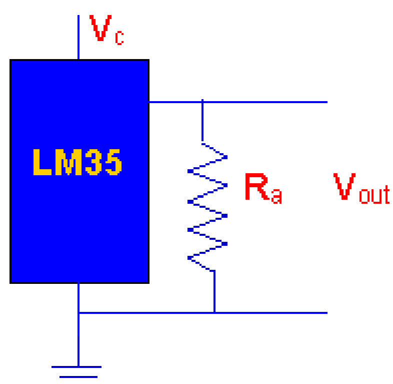


Fig 3.1.2.2 Connection

3.Here is a photo of the LM 35 wired on a circuit board.

-The white wire in the photo goes to the power supply.

-Both the resistor and the black wire go to ground.

-The output voltage is measured from the middle pin to ground.l

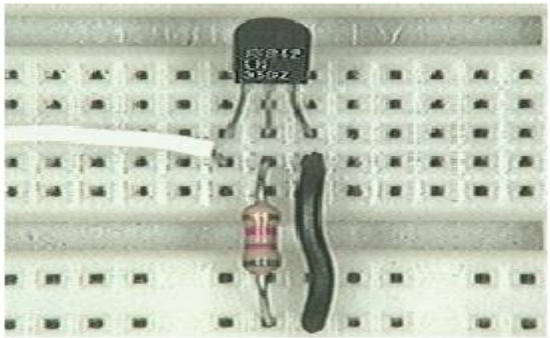


Fig 3.1.2.3 Pin Connection

What can you expect when you use an lm35?

-You will need to use a voltmeter to sense Vout.

-The output voltage is converted to temperature by a simple conversion factor.

-The sensor has a sensitivity of 10mV / ºC.

-Use a conversion factor that is reciprocal, that is 100 ºf/V.

-The general equation used to convert the output voltage to temperature is:

1.Temperature (ºC) = Vout * (100 ºC/V)

2.So if Vout is 1V, then, Temperature = 100 ºC

3.The output voltage varies linearly with temperature.

3.1.3 Liquid Crystal Displays

The LCD standard requires 3 control lines and 8 I/O lines for the data bus.

8-data pins D7: D0
-Bi-directional data/command pins.
Alphanumeric characters are sent in ASCII format.

RS: Register Select
-RS = 0 -> Command Register is selected
RS = 1 -> Data Register is selected

R/W: Read or Write
-0 -> Write, 1 -> Read
E: Enable (Latch data)
-The 8 data lines are connected to PORT 1 of 8051 microcontroller. The three control lines(RS,RW and EN) are connected to PORT 3.5,3.6 and 3.7 respectively.

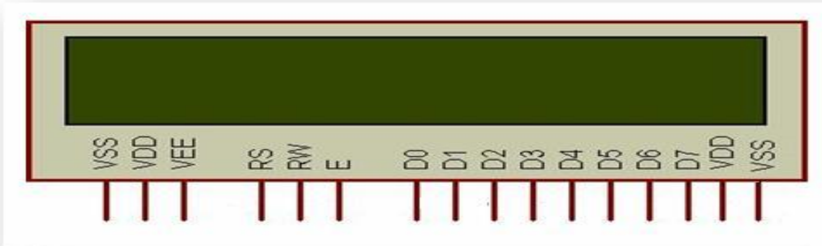


Fig 3.1.3.1 Pin Diagram of LCD

LCD (Liquid Crystal Display) screen is an electronic display module and finds a wide range of applications. A 16x2 LCD display is the very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi-segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. 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 the 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 the internal structure of an LCD.

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		DB0
8	8-bit data pins	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 1:Pin Description Of LCD

Introduction

The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580. In this tutorial, we will discuss character-based LCDs, their interfacing with various microcontrollers, various interfaces (8-bit/4-bit), programming, special stuff and tricks you can do with these simple looking LCDs which can give a new look to your Application.

Pin Description

The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters, whereas LCDs supporting more than 80 characters make use of 2 HD44780 controllers.

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections). Pin description is shown in the table below.

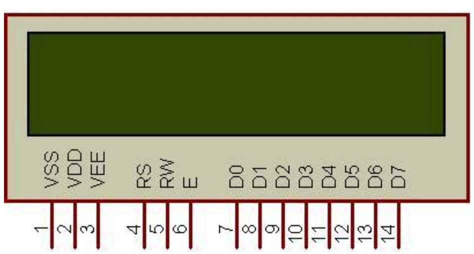


Figure3.1.3.2:Character LCD type HD44780 Pin diagram

Pin No.	Name	Description
Pin no. 1	**D7**	Data bus line 7 (MSB)
Pin no. 2	**D6**	Data bus line 6
Pin no. 3	**D5**	Data bus line 5
Pin no. 4	**D4**	Data bus line 4
Pin no. 5	**D3**	Data bus line 3
Pin no. 6	**D2**	Data bus line 2
Pin no. 7	**D1**	Data bus line 1
Pin no. 8	**D0**	Data bus line 0 (LSB)
Pin no. 9	**EN1**	Enable signal for row 0 and 1 (1^{st}controller)
Pin no. 10	**R/W**	0 = Write to the LCD module 1 = Read from LCD module
Pin no. 11	**RS**	0 = Instruction input 1 = Data input
Pin no. 12	**VEE**	Contrast adjust
Pin no. 13	**VSS**	Power supply (GND)
Pin no. 14	**VCC**	Power supply (+5V)
Pin no. 15	**EN2**	Enable signal for row 2 and 3 (2^{nd}controller)
Pin no. 16	**NC**	Not Connected

Table 2: Character LCD pins with 2 Controller

Usually these days you will find single controller LCD modules are used more in the market. So in the tutorial, we will discuss more the single controller LCD, the operation and everything else is the same for the double controller too. Let's take a look at the basic information which is there in every LCD.

Bf - busy flag:

Busy Flag is a status indicator flag for LCD. When we send a command or data to the LCD for processing, this flag is set (i.e BF =1) and as soon as the instruction is executed successfully this flag is cleared (BF = 0). This is helpful in producing an the exact amount of delay for the LCD processing. To read Busy Flag, the condition RS = 0 and R/W = 1 must be met and The MSB of the LCD data bus (D7) act as a busy flag. When BF = 1 means LCD is busy and will not accept the next command or data and BF = 0 means LCD is ready for the next command or data to process.

Instruction Register (Ir) And Data Register (Dr)

There are two 8-bit registers in HD44780 controller Instruction and Data register. Instruction register corresponds to the register where you send commands to LCD e.g LCD shift command, LCD clear, LCD address, etc. and Data register is used for storing data which is to be displayed on LCD. when send the enable signal of the LCD is asserted, the data on the pins is latched into the data register and data is then moved automatically to the DDRAM and hence is displayed on the LCD. Data Register is not only used for sending data to DDRAM but also for CGRAM, the address where you want to send the data, is decided by the instruction you send to LCD. We will discuss more on the LCD instruction set further in this tutorial.

Commands And Instruction Set

Only the instruction register (IR) and the data register (DR) of the LCD can be controlled by the MCU. Before starting the internal operation of the LCD, control information is temporarily stored into these registers to allow interfacing with various MCUs, which operate at different speeds, or various peripheral control devices. The internal operation of the LCD is determined by signals sent from the MCU. These signals, which include register selection signal (RS), read/write signal (R/W), and the data bus (DB0 to DB7), make up the LCD instructions (Table There are four categories of instructions:

-Designate LCD functions, such as display format, data length, etc.

-Set internal RAM addresses

-Perform data transfer with internal RAM

-Perform miscellaneous functions

Although looking at the table you can make your own commands and test them. Below is a brief list of useful commands which are used frequently while working on the LCD.

NOTE:

* DDRAM address given in LCD basics section see Figure 2,3,4
** CGRAM address from 0x00 to 0x3F, 0x00 to 0x07 for char1 and so on.

No.	Instruction	Hex	Decimal
1	Function Set: 8-bit, 1 Line, 5x7 Dots	0x30	48
2	Function Set: 8-bit, 2 Line, 5x7 Dots	0x38	56
3	Function Set: 4-bit, 1 Line, 5x7 Dots	0x20	32
4	Function Set: 4-bit, 2 Line, 5x7 Dots	0x28	40
5	Entry Mode	0x06	6
6	Display off Cursor off (clearing display without clearing DDRAM content)	0x08	8
7	The display on Cursor on	0x0E	14
8	The display on Cursor off	0x0C	12
9	The display on Cursor blinking	0x0F	15
10	Shift entire display left	0x18	24
12	Shift entire display right	0x1C	30
13	Move cursor left by one character	0x10	16
14	Move cursor right by one character	0x14	20
15	Clear Display (also clear DDRAM content)	0x01	1
16	Set DDRAM address or cursor position on the display	0x80+add*	128+add*
17	Set CGRAM address or set the pointer to CGRAM location	0x40+add**	64+add**

Table 3.1.3 Frequently used commands and instructions for LCD

3.1.4 Soil Moisture Sensor

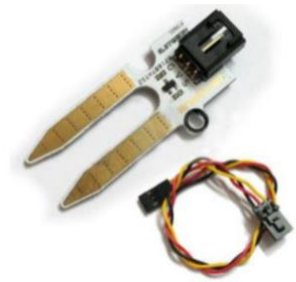


Fig.3.1.4.1 soil moisture sensor

Soil moisture sensors measure the water content in the soil. A soil moisture probe is made up of multiple soil moisture sensors. Since the analytical measurement of free soil moisture requires removing a sample and drying it to extract moisture, soil moisture sensors measure some other property, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on soil type. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments are used by farmers or gardeners.

Octopus Soil Moisture Sensor Brick can read the amount of moisture present in the soil surrounding it. Ideal for monitoring an urban garden, or your pet plant's water level. This is a must-have tool for a connected garden! This sensor uses the two probes to pass current through the soil, and then it reads that resistance to get the moisture level. More water makes the soil conduct electricity more easily (less resistance), while dry soil conducts electricity poorly (more resistance). This sensor isn't hardened against contamination or exposure of the control circuitry to water and may be prone to electrolytic corrosion across the probes (Also it can be switched on, take the reading and switched off to minimize electrolytic corrosion), so it isn't well suited to being left in place or used outdoors.

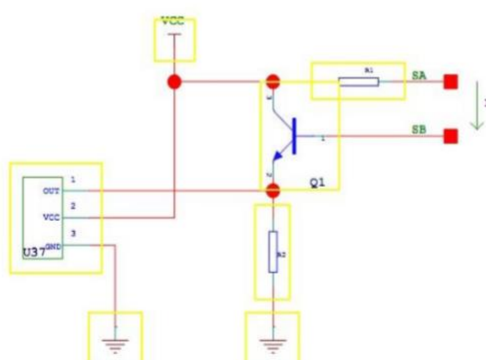


Fig 3.1.4.2 Internal Schematic

In agriculture measuring, soil moisture is important in agriculture to help farmers manage their irrigation systems more efficiently. Not only are farmers able to generally use less water to grow a crop, but they are also able to increase yields and the quality of the crop by better management of soil moisture during critical plant growth stages. Besides agriculture, there are many other disciplines using soil moisture sensors. Golf courses are now using sensors to increase the efficiencies of their irrigation systems to prevent over watering and leaching of fertilizers and other chemicals offsite.

Item	Condition	Min	Typical	Max	Unit
Voltage	-	3.3	/	5	V
Current	-	0	/	35	mA
Output Voltage	Supply Voltage 5 V	0	~	4.2	V
Output Value	Sensor in dry soil	0	~	300	/
	Sensor in humidity soil	300	~	700	/
	Sensor in water	700	~	950	/

Table 3: Voltage Current Soil moisture sensor

Features:

-Sensitivity adjustable.

-Has a fixed bolt hole, convenient installation.

-The threshold level can be configured.

-Module triple output mode, the digital output is simple, analog output more accurate, serial output with exact readings.

Applications:

-Agriculture

-Landscape irrigation

Specifications:

-Operating Voltage: +5v dc regulated

-Soil moisture: Digital value is indicated by out pin

Pin details:

1 out Active high output

- 2 +5v Power supply

- 3 and Power supply gnd
- 4 Rx receiver
- 5 tx transmitter
- 6 gnd Power supply gnd

Using The Sensor:

- Connect +5v to pin 2 and ground to pin 5 and 6.
- Pin 4 and 5 should be connected to a particular transmitter and receiver pin of the controller.
- Output pin may be connected to any port pins and can be used to any application

Hygrometer:

Hygrometers are instruments used for measuring *relative* humidity. A simple form of a hygrometer is specifically known as a **psychrometer** and consists of two thermometers, one of which includes a dry bulb and the other of which includes a bulb that is kept wet to measure *wet-bulb temperature*. Hair curvature is another old method of measuring humidity. Modern electronic devices use temperature of condensation, changes in electrical resistance, and changes in electrical capacitance to measure humidity changes.

Psychrometers

In a psychrometer, there are two thermometers, one with a dry bulb and the other with a wet bulb. Evaporation from the wet bulb lowers the temperature so that the wet-bulb thermometer usually shows a lower temperature than that of the dry-bulb thermometer, which measures *dry-bulb temperature*. When the air temperature is below freezing, however, the wet bulb is covered with a thin coating of ice and yet may be warmer than the dry bulb. Relative humidity is computed from the ambient temperature as shown by the dry-bulb thermometer and the difference in temperatures as shown by the wet-bulb and dry-bulb thermometers. Relative humidity can also be determined by locating the intersection of the wet- and dry-bulb temperatures on a psychrometric chart. One device that uses the wet/dry bulb method is the **sling psychrometer**, where the thermometers are attached to a handle or length of rope and spun around in the air for a few minutes.

Hair Tension Hygrometers

Other types of hygrometers are also commonly used to determine the ambient humidity. Such devices frequently use human or animal hair under tension. The traditional folk art device is known as a "weather house" works on this principle. In order to see changes that occur over time, several hygrometers record the value of humidity on a piece of graduated paper so that the values can be read off the chart. This can be done by placing on a surface and an instant reading will be given.

Electronic Hygrometers

Fig 3.1.4.2 electronic hygrometer

Dewpoint is the temperature at which a sample of moist air (or any other water vapor) at constant pressure reaches water vapor saturation. At this saturation temperature, further cooling results in condensation of water. "Cooled mirror dewpoint hygrometers" are the most precise instruments available. They use a chilled mirror and optoelectronic mechanism to detect condensation on the mirror surface. The temperature of the mirror is controlled by electronic feedback to maintain a dynamic equilibrium between evaporation and condensation on the mirror, thus closely measuring the dewpoint temperature. Modern instruments use electronic means of recording the information. The two most common electronic sensors are capacitive or resistive. The capacitive sensors sense water by applying an AC signal between two plates and measuring the change in capacitance caused by the amount of water present. The resistive sensors use a polymer membrane which changes conductivity according to absorbed water. Recently, an unbalanced AC Bridge approach was adapted for low power/energy operation and has shown to provide better measurement performance over a wide operating range. To further increase accuracy in this same device, which combines a sensor in data logging instrument, a calibration method utilizing a large memory array was developed to maximize performance. In most instruments, resistive sensors can be read by common meters or data acquisition boards. The temperature must also be measured, as it affects the calibration of all these sensors. Applications

Besides greenhouses and industrial spaces, hygrometers are also used in some saunas, humidors, and museums. In residential settings, hygrometers are used to aid humidity control (too low humidity damages human skin and body, while too high humidity favors the growth of mildew and dust mite). The sling or motorized psychrometer is used in meteorology, and in the HVAC industry for proper refrigerant charging of residential and commercial air conditioning systems.

3.1.5 Current Sensor

Fig 3.1.5 Current Sensor

This board is a simple carrier of Allegro's ±30A ACS714 Hall effect-based linear current sensor, which offers a low-resistance (~1.2 mΩ) current path and electrical isolation up to 2.1 kV RMS. This version accepts a bidirectional current input with a magnitude up to 30 A and outputs a proportional analog voltage (133 mV/A) centered at 2.5 V with a typical error of ±1.5%. It operates from 4.5 V to 5.5 V and is intended for use in 5 V systems.

• Designed for bidirectional input current from -30 A to 30 A (though the robust sensor IC can survive up to five times the overcurrent condition).

• Conductive path internal resistance is typically 1.2 mΩ, and the PCB is made with 2oz copper, so very little power is lost in the board.

• Use of a Hall effect sensor means the IC is able to electrically isolate the current path from the sensor's electronics (up to 2.1 kV RMS), which allows the sensor to be inserted anywhere along the current path and to be used in applications that require electrical isolation.

• 80 KHz bandwidth that can optionally be decreased by adding a capacitor across the board pins marked "filter".

• High accuracy and reliability: typical total output error of ±1.5% at r

3.1.6 Crystal Oscillator

Fig 3.1.6 Crystal Oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits**.**

3.1.6 Relay

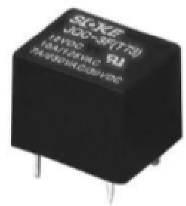


Fig 3.1.7 Relay

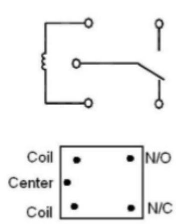
A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation 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 as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. 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 contractor. Solid-state relays control power circuits with no moving parts, instead of 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".

Normally-open (NO): contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a "Form A" contractor "makes" contact. NO contacts may also be distinguished as "early-make" or "NOEM", which means that the contacts close before the button or switch is fully engaged.

Normally-closed (NC): contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also called a "Form B" contact or "break" contact. NC contacts may also be distinguished as "late-break" or "NCLB", which means that the contacts stay closed until the button or switch is fully disengaged.

Connection diagram: the pictures in circuit diagram shows the bottom view of relay.



3.1.8 BC548 Transistor

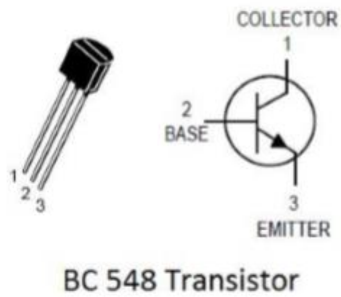


Fig 3.1.8 BC 548 Transistor

The BC548 is a general purpose epitaxial silicon NPN bipolar junction transistor found commonly in European electronic equipment. It is part of a historically significant series of transistors that began in 1966 when Philips introduced the metal-cased BC108 family of transistors that included the high-voltage BC107 and low noise BC109 variants. The BC546, BC547, BC548, BC549, and BC550 have broadly similar characteristics. In particular, they have the same maximum collector current and power dissipation Absolute Maximum Ratings, but their collector breakdown voltage ratings VCEO and VCBO vary. The BC548 has a 30 VCBO, while the BC547 50 V and the BC546 80 V. The BC549 and BC550 are low-noise versions with VCEOs of 30V and 45V respectively

Transistor As A Switch

When used as an AC signal amplifier, the transistors Base biasing voltage is applied in such a way that it always operates within its "active" region, that is the linear part of the output characteristics curves are used. However, both the NPN & PNP type bipolar transistors can be made to operate as "ON/OFF" type solid-state switches by biasing the base of the transistor differently to that of a signal amplifier.

Solid state switches are one of the main applications for the use of transistors, and transistor switches can be used for controlling high power devices such as motors, solenoids or lamps, but they can also use in digital electronics and logic gate circuits. If the circuit uses the Bipolar Transistor as a Switch, then the biasing of the transistor, either NPN or PNP is arranged to operate the transistor at both sides of the “I-V” characteristics curves the areas of operation for a Transistor Switch are known as the Saturation Region and the Cut-off Region. This means then that we can ignore the operating Q-point biasing and voltage divider circuitries required for amplification, and use the transistor as a switch by driving it back and forth between its “fully-OFF” (cut-off) and “fully-ON” (saturation) regions.

Design Steps :

VB = VBE + IBRB

VB = 5V

VBE = 0.7V

IB = 10mA

Therefore, RB = 4.3/ (10 x 10-3) = 430 Ω = 390Ω approx.

VCC - VCE (sat) – ICRC – IE R (Relay) = 0

VCC = 5V ,

VCE(sat) = 0

When ON state; IC = IE

R (Relay) = 70Ω

IC = VCC/R (Relay) = 71mA = 100mA approx.

Therefore, RC = 20 Ω = 22 Ω approx.

3.1.9 Pumping Motor

Fig 3.1.9 Pumping Motor

The best domestic water supply. Water is pumped to and flows back from, a large tank uphill from the 12v water pump everything 12v water pump for garden pond pumps, solar and travel pumps. It's the 12v water pump, that wonderful little gadget that can pump water, 12v water pumps for safe low voltage water pumping applications such as garden ponds, wastewater and tank water drainage solar-powered water pump for solar heating a solar powered water pump is usually but not always found as a component in solar heating systems. Solar powered this is a high quality made, mini submersible water pump. It's built by a brushless motor providing smooth and quiet operation than a non-brushless water pump.

The ebp25 kit is a ‘brushless' 12 volt, high flow, magnetically driven water pump with a flow rate of 25 liters per minute. The EBP motor has no brushes to ever wear out and the pump is magnetically driven by the motor, which means that no shaft sealing is required. The many EBP applications include booster for car heater and LPG systems, solar pump.

TECHNICAL SPECIFICATIONS	
Operating Voltage	9VDC to 15VDC
Maximum Current	3.5A
Flow Rate	25L/min (6.6 US gal/min) @10kpa
Operating Temperature	-40° to 120°C (-40 to 248 F)
Pump Design	Recirculating centrifugal
Motor Life	15,000 hours at 80°C (176F) continuous
Pump Weight	995 grams
Pump Material	Nylon 6/6, 33% glass filled
Burst Pressure	250kpa (36psi) minimum

Table 3.1.9 Technical Specifications

3.1.10 Rain Sensors

Fig 3.1.10 Rain Sensor

A rain sensor module is an easy tool for rain detection. It can be used as a switch when a raindrop falls through the raining board and also for measuring rainfall intensity. The module features, a rain board and the control board that is separate for more convenience, power indicator LED and an adjustable sensitivity through a potentiometer. The analog output is used in the detection of drops in the amount of rainfall. Connected to the 5V power supply, the LED will turn on when the induction board has no raindrop, and the DO output is high. When dropping a little amount of water, DO output is low, the switch indicator will turn on. Brush off the water droplets, and when restored to the initial state, outputs high level.

Specifications

- Adopts high quality of RF-04 double-sided material.
- Area: 5cm x 4cm nickel plate on side,
- Anti-oxidation, anti-conductivity, with long use time
- Comparator output signal clean waveform is good, driving ability, over 15Ma
- Potentiometer adjust the sensitivity
- Working voltage 5V
- Output format: Digital switching output (0 and 1) and analog voltage output AO
- With bolt holes for easy installation

➢ Small board PCB size: 3.2cm x 1.4cm
➢ Uses a wide voltage LM393 comparator

Pin Configuration

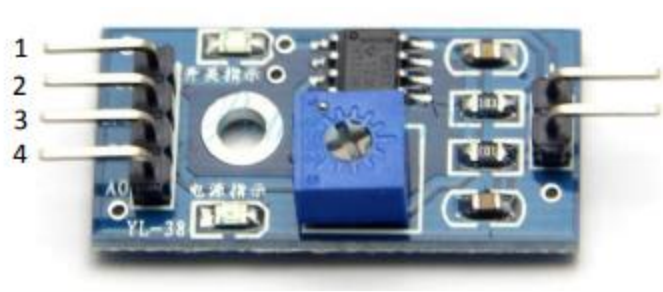


Fig 3.1.10-1 Pin Diagram

1. VCC: 5V DC

2. GND: ground

3. DO: high/low output

4. AO: analog output

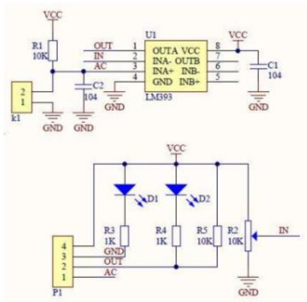


Fig 3.1.10-2 Schematic Diagram

3.1.11 Water Level Depth Sensor

Fig 3.1.11 Water level depth sensor

The Water Level Depth Detection Sensor for Arduino has Operating voltage DC3-5V and Operating current less than 20mA. The Sensor is the Analog type which produces analog output signals according to the water pressure with its Detection Area of 40x16mm.

The Water Level Sensor is an easy-to-use and cost-effective with high level/drop recognition sensor by having a series of parallel wires exposed traces measure droplets/water volume in order to determine the water level.

Easy to complete water to analog signal conversion and output analog values can be directly read Arduino development board to achieve the level alarm effect.

Specification

1. Operating voltage: DC3-5V
2. Operating current: less than 20mA
3. Sensor Type: Analog
4. Detection Area: 40mmx16mm
5. Operating temperature: 10℃-30℃
6. Humidity: 10% -90% non-condensing

3.1.12 Iot Wifi Module

The **internet of things** (**IoT**) is the network of physical devices, vehicles, buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on the Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems and resulting in improved efficiency, accuracy and economic benefit. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation, and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

Internet of Things (IoT) is an environment in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. IoT board featured with SIM900 GPRS modem to activate internet connection also equipped with a controller to process all input UART data to GPRS based online data. Data may be updated to a specific site or a social network by which the user can able to access the data.

Infrastructure:

The Internet of Things will become part of the fabric of everyday life. It will become part of our overall infrastructure just like water, electricity, telephone, TV and most recently the Internet. Whereas the current Internet typically connects full-scale computers, the Internet of Things (as part of the Future Internet) will connect everyday objects with a strong integration into the physical world.

1. Plug and Play Integration

If we look at IoT-related technology available today, there is a huge heterogeneity. It is typically deployed for very specific purposes and the configuration requires significant technical knowledge and may be cumbersome. To achieve true Internet of Things we need to move away from such small-scale, vertical application silos, towards a horizontal infrastructure on which a variety of applications can run simultaneously.

2. Infrastructure Functionality

The infrastructure needs to support applications in finding the things required. An application may run anywhere, including on the things themselves. Finding things is not limited to the start-up time of an application. Automatic adaptation needed whenever relevant new things become available, things become unavailable or the status of things changes. The infrastructure has to support the monitoring of such changes and the adaptation that is required as a result of the changes.

3. Physical Location and Position

As the Internet of Things is strongly rooted in the physical world, the notion of physical location and position are very important, especially for finding things, but also for deriving knowledge. Therefore, the infrastructure has to support finding things according to location (e.g. geo-location based discovery). Taking mobility into account, localization technologies will play an important role in the Internet of Things and may become embedded into the infrastructure of the Internet of Things.

4. Security and Privacy

In addition, an infrastructure needs to provide support for security and privacy functions including identification, confidentiality, integrity, non-repudiation authentication and authorization. Here the heterogeneity and the need for interoperability among different ICT systems deployed in the infrastructure and the resource limitations of IoT devices (e.g., Nanosensors) have to be taken into account.

Data Management

Data management is a crucial aspect of the Internet of Things. When considering a world of objects interconnected and constantly exchanging all types of information, the volume of the generated data and the processes involved in the handling of those data become critical. A long-term opportunity for wireless communications chip makers is the rise of Machine-to-Machine (M2M) computing, which one of the enabling technologies for the Internet of Things. This technology spans abroad range of applications. While there is a consensus that M2M is a promising pocket of growth, analyst estimates on the size of the opportunity diverge by a factor of four [1]. Conservative estimates assume roughly 80 million to 90 million M2M units will be sold in 2014, whereas more optimistic projections forecast sales of 300 million units. Based on historical analyses of adoption curves for similar disruptive technologies, such as portable MP3 players and antilock braking systems for cars, it is believed that unit sales in M2M could rise by as much as a factor of ten over the next five years, see Figure 2.29 [5]. There are many technologies and factors involved in the "data management" within the IoT context. Some of the most relevant concepts which enable us to understand the challenges and opportunities of data management are:

• Data Collection and Analysis
• Big Data
• Semantic Sensor Networking
• Virtual Sensors
• Complex Event Processing.

Application areas:

In the last few years, the evolution of markets and applications, and therefore their economic potential and their impact in addressing societal trends and challenges for the next decades has changed dramatically. Societal trends are grouped as health and wellness, transport and mobility, security and safety, energy and environment, communication and e-society, as presented in Figure 2.15. These trends create significant opportunities in the markets of consumer electronics, automotive electronics, medical applications, communication, etc. The applications in these areas benefit directly by the More-Moore and More-than-Moore semiconductor technologies, communications, networks, and software developments.

a) **Cities**

- **Smart Parking:** Monitoring of parking spaces available in the city.
- **Structural health:** Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.
- **Noise Urban Maps:** Sound monitoring in bar areas and centric zones in real
- time.
- **Traffic Congestion:** Monitoring of vehicles and pedestrian levels to optimize
- driving and walking routes.
- **Smart Lightning:** Intelligent and whether adaptive lighting in street lights.
- **Waste Management:** Detection of rubbish levels in containers to optimize
- the trash collection routes.
- **Intelligent Transportation Systems:** Smart Roads and Intelligent Highways
- with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

b) Environment

Forest Fire Detection: Monitoring of combustion gases and preemptive fire conditions to define alert zones.
Air Pollution: Control of CO_2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.
Landslide and Avalanche Prevention: Monitoring of soil moisture, vibrations and earth density to detect dangerous patterns in land conditions.
Earthquake Early Detection: Distributed control in specific places of tremors.

c) Water

Water Quality: Study of water suitability in rivers and the sea for fauna and Eligibility for drinkable use.
Water Leakages: Detection of liquid presence outside tanks and pressure variations along pipes.
River Floods: Monitoring of water level variations in rivers, dams, and reservoirs.

d) Energy Smart Grid, Smart Metering

Smart Grid: Energy consumption monitoring and management.
Tank level: Monitoring of water, oil and gas levels in storage tanks and cisterns.
Photovoltaic Installations: Monitoring and optimization of performance in solar energy plants.
Water Flow: Measurement of water pressure in water transportation systems.
Silos Stock Calculation: Measurement of emptiness level and weight of the goods.

e) Security & Emergencies

Perimeter Access Control: Access control to restricted areas and detection of people in non-authorized areas.
Liquid Presence: Liquid detection in data centers, warehouses and sensitive building grounds to prevent break downs and corrosion.
Radiation Levels: Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.

Explosive and Hazardous Gases: Detection of gas levels and leakages in industrial environments, surroundings of chemical factories and inside mines.

f) Industrial Control

M2M Applications: Machine auto-diagnosis and assets control.

Indoor Air Quality: Monitoring of toxic gas and oxygen levels inside chemical plants to ensure workers and goods safety.

Temperature Monitoring: Control of temperature inside industrial and medical fridges with sensitive merchandise.

Ozone Presence: Monitoring of ozone levels during the drying meat process in food factories.

Indoor Location: Asset indoor location by using active (ZigBee, UWB) and passive tags (RFID/NFC).

Vehicle Auto-diagnosis: Information collection from CAN Bus to send real-time alarms to emergencies or provide advice to drivers.

G.)Agriculture

inequality Enhancing: Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.

Green Houses: Control micro-climate conditions to maximize the production of fruits and vegetables and its quality.

Golf Courses: Selective irrigation in dry zones to reduce the water resources required in the green.

Meteorological Station Network: Study of weather conditions in fields to forecast ice formation, rain, drought, snow or wind changes.

Compost: Control of humidity and temperature levels in alfalfa, hay, straw, etc. to prevent fungus and other microbial contaminants.

H.)Domestic & Home Automation

Energy and Water Use: Energy and water supply consumption monitoring to obtain advice on how to save cost and resources.

Remote Control Appliances: Switching on and off remotely appliances to avoid accidents and save energy.

Intrusion Detection Systems: Detection of window and door openings and violations to prevent intruders.

Art and Goods Preservation: Monitoring of conditions inside museums and art warehouses.

g) eHealth

Fall Detection: Assistance for elderly or disabled people living independently.

Medical Fridges: Control of conditions inside freezers storing vaccines, medicines and organic elements.

Sportsmen Care: Vital signs monitoring in high-performance centers and fields.

Patients Surveillance: Monitoring of conditions of patients inside hospitals and in old people’s home.

Ultraviolet Radiation: Measurement of UV sun rays to warn people not to be exposed in certain hours.

ESP-12E BASEDNODEMCU

The ESP8266 is the name of a microcontroller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from the existing microcontroller to Wi-Fi and is also capable of running self-contained applications. This module comes with a built-in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCUdevkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboarded friendly.

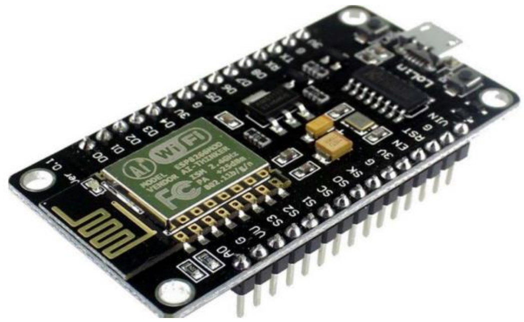


Fig 3.1.12**ESP-12E BASED NODE MCU**

ESP-12E Wi-Fi module is developed by Ai-thinker Team. core processor ESP8266 in smaller sizes of the module encapsulates Tensilica L106 integrates industry-leading ultra-low power 32-bit MCU micro, with the 16-bit short mode, Clock speed support 80 MHz, 160 MHz, supports the RTOS, integrated Wi-Fi MAC/BB/RF/PA/LNA, onboard antenna. The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking or building a separate network controller. ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems or to function as a standalone application, with the lowest cost, and minimal space requirement.

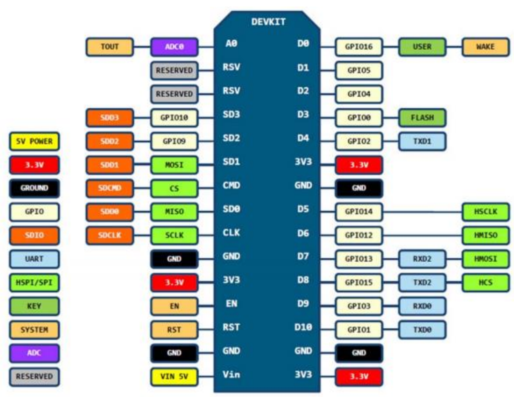
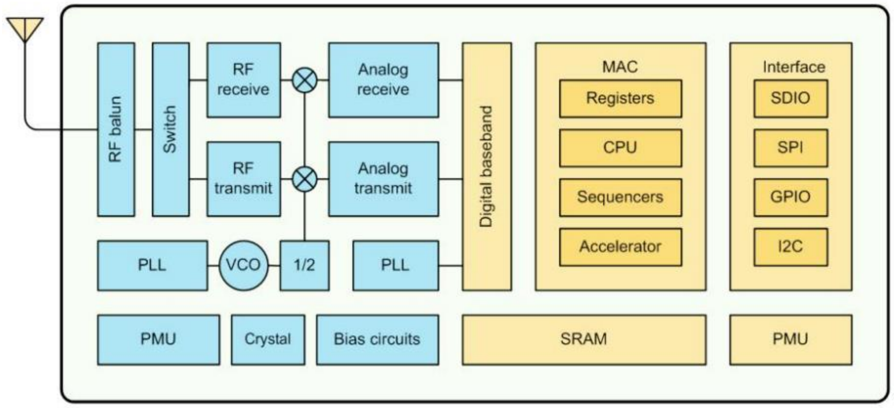


fig 3.1.12-nodemcu pin configuration

ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor. When ESP8266EX hosts the application, it boots up directly from an external flash. It has an integrated cache to improve the performance of the system in such applications. Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any microcontroller based design with simple connectivity (SPI/SDIO or I2C/UART interface). ESP8266EX is among the most integrated Wi-Fi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB are



3.1.12.3 Esp-12e Architecture

ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor, with on-chip SRAM, besides the Wi-Fi functionalities. ESP8266EX is often integrated with external sensors and other application specific devices through its GPIOs; codes for such applications are provided in examples in the SDK. Espressif Systems' Smart Connectivity Platform (ESCP) demonstrates sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing. For low-power operation, advanced signal processing, and spur cancellation and radio co-existence feature for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

Features:

- 802.11 b/g/n
- Integrated low power 32-bit MCU
- Integrated 10-bit ADC
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and power management units
- Supports antenna diversity
- Wi-Fi 2.4 GHz, support WPA/WPA2
- Support STA/AP/STA+AP operation modes
- Support Smart Link Function for both Android and iOS devices
- Support Smart Link Function for both Android and iOS devices
- SDIO 2.0, (H) SPI, UART, I2C, I2S, IRDA, PWM, GPIO
- STBC, 1x1 MIMO, 2x1 MIMO
- A-MPDU & A-MSDU aggregation and 0.4s guard interval
- Deep sleep power < 5uA
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)
- +20dBm output power in 802.11b mode
- Operating temperature range -40C ~ 125C

fig 3.1.12.4 esp-12e pin configuration

Pin description:

NO.	Pin Name	Function
1	RST	Reset the module
2	ADC	A/D Conversion result.Input voltage range 0-1v,scope:0-1024
3	EN	Chip enable pin.Active high
4	IO16	GPIO16; can be used to wake up the chipset from deep sleep mode.
5	IO14	GPIO14; HSPI_CLK
6	IO12	GPIO12; HSPI_MISO
7	IO13	GPIO13; HSPI_MOSI; UART0_CTS
8	VCC	3.3V power supply (VDD)
9	CS0	Chip selection
10	MISO	Salve output Main input

Table 3.1.12 Pin Description of Esp 12-E(I)

11	IO9	GPIO9
12	IO10	GBIO10
13	MOSI	Main output slave input
14	SCLK	Clock
15	GND	GND
16	IO15	GPIO15; MTDO; HSPICS; UART0_RTS
17	IO2	GPIO2; UART1_TXD
18	IO0	GPIO0
19	IO4	GPIO4
20	IO5	GPIO5
21	RXD	UART0_RXD; GPIO3
22	TXD	UART0_TXD; GPIO1

Table 3.1.12 Pin Description of Esp 12-E(II)

Pin Mode:

Mode	GPIO15	GPIO0	GPIO2
UART	Low	Low	High
Flash Boot	Low	High	High

Table 3.1.12.2 Pin mode of Esp 12-E

Receiver sensitivity:

Parameters	Min	Typical	Max	Unit
Input frequency	2412		2484	MHz
Input impedance		50		Ω
Input reflection			-10	dB
Output power of PA for 72.2Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b mode	19.5	20.5	21.5	dBm
Sensitivity				
DSSS, 1Mbps		-98		dBm
CCK, 11Mbps		-91		dBm
6Mbps (1/2 BPSK)		-93		dBm
54Mbps (3/4 64-QAM)		-75		dBm
HT20, MCS7 (65Mbps, 72.2Mbps)		-72		dBm
Adjacent Channel Rejection				
OFDM, 6Mbps		37		dB
OFDM, 54Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

Table 3.1.12.3 Pin Description of Esp 12-E(I)

Schematic :

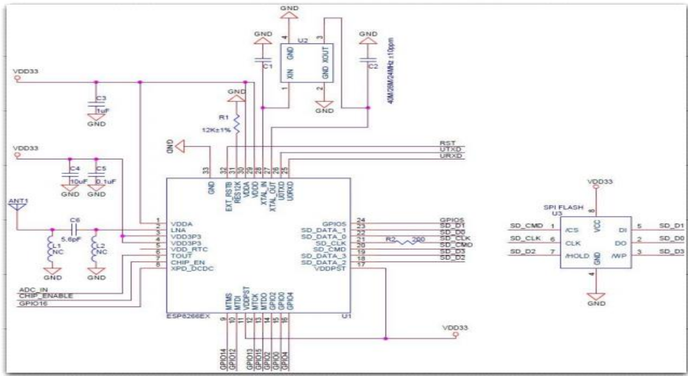


Fig 3.1.12.5 Schematic of Esp 12-E Iot Wifi module

Functional descriptions:

1.Mcu

ESP8266EX is embedded with Tensilica L106 32-bit microcontroller (MCU), which features extra low power consumption and 16-bit RSIC. The CPU clock speed is 80MHz. It can also reach a maximum value of 160MHz. ESP8266EX is often integrated with external sensors and other specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

2.Memory Organization

-Internal Sram And Rom

ESP8266EX Wi-Fi SoC is embedded with a memory controller, including SRAM and ROM. MCU can visit the memory units through iBus, dBus, and AHB interfaces. All memory units can be visited upon request, while a memory arbiter will decide the running sequence according to the time when these requests are received by the processor. According to our current version of SDK provided, SRAM space that is available to users is assigned as below:

▪RAM size < 36kB, that is to say, when ESP8266EX is working under the station mode and is connected to the router, programmable space accessible to the user in heap and data section is around 36kB.)

▪ There is no programmable ROM in the SoC, therefore, the user program must be stored in an external SPI flash.

-External Spi Flash

This module is mounted with a 4 MB external SPI flash to store user programs. If larger definable storage space is required, an SPI flash with larger memory size is preferred. Theoretically speaking, up to 16 MB memory capacity can be supported. Suggested SPI Flash memory capacity:

▪OTA is disabled: the minimum flash memory that can be supported is 512 kB;

▪OTA is enabled: the minimum flash memory that can be supported is 1 MB. Several SPI modes can be supported, including Standard SPI, Dual SPI, and Quad SPI.

-Crystal

Currently, the frequency of crystal oscillators supported includes 40MHz, 26MHz, and 24MHz. The accuracy of crystal oscillators applied should be ±10PPM, and the operating temperature range should be between -20°C and 85°C. When using the downloading tools, please remember to select the right crystal oscillator type. In circuit design, capacitors C1 and C2, which are connected to the earth, are added to the input and output terminals of the crystal oscillator respectively. The values of the two capacitors can be flexible, ranging from 6pF to 22pF, however, the specific capacitive values of C1 and C2 depend on further testing and adjustment on the overall performance of the whole circuit. Normally, the capacitive values of C1 and C2 are within 10pF if the crystal oscillator frequency is 26MHz, while the values of C1 and C2 are 10pF

Interfaces:

Interface	Pin Name	Description
HSPI	IO12(MISO) IO13(MOSI) IO14(CLK) IO15(CS)	SPI Flash 2, display screen, and MCU can be connected using HSPI interface.
PWM	IO12(R) IO15(G) IO13(B)	Currently the PWM interface has four channels, but users can extend the channels according to their own needs. PWM interface can be used to control LED lights, buzzers, relays, electronic machines, and so on.
IR Remote Control	IO14(IR_T) IO5(IR_R)	The functionality of Infrared remote control interface can be implemented via software programming. NEC coding, modulation, and demodulation are used by this interface. The frequency of modulated carrier signal is 38KHz.
ADC	TOUT	ESP8266EX integrates a 10-bit analog ADC. It can be used to test the power-supply voltage of VDD3P3 (Pin3 and Pin4) and the input power voltage of TOUT (Pin 6). However, these two functions cannot be used simultaneously. This interface is typically used in sensor products.
I2C	IO14(SCL) IO2(SDA)	I2C interface can be used to connect external sensor products and display screens, etc.

Interface	Pin Name	Description
UART	**UART0:** TXD (U0TXD) RXD (U0RXD) IO15 (RTS) IO13 (CTS) **UART1:** IO2(TXD)	Devices with UART interfaces can be connected with the module. Downloading: U0TXD+U0RXD or GPIO2+U0RXD Communicating: UART0: U0TXD, U0RXD, MTDO (U0RTS), MTCK (U0CTS) Debugging: UART1_TXD (GPIO2) can be used to print debugging information. By default, UART0 will output some printed information when the device is powered on and is booting up. If this issue exerts influence on some specific applications, users can exchange the inner pins of UART when initializing, that is to say, exchange U0TXD, U0RXD with U0RTS, U0CTS.
I2S	**I2S Input:** IO12 (I2SI_DATA) ; IO13 (I2SI_BCK); IO14 (I2SI_WS); **I2S Output:** IO15 (I2SO_BCK); IO3 (I2SO_DATA); IO2 (I2SO_WS).	I2S interface is mainly used for collecting, processing, and transmission of audio data.

Node Mcu Gpio For Lua

The GPIO(General Purpose Input/Output) allows us to access to pins of ESP8266 , all the pins of ESP8266 accessed using the command GPIO, all the access is based on the I/O index number on the NoddMCUdev kits, not the internal GPIO pin, for example, the pin ‘D7' on the NodeMCUdev kit is mapped to the internal GPIO pin 13, if you want to turn ‘High' or ‘Low' that particular pin you need to call the pin number ‘7', not the internal GPIO of the pin. When you are programming with generic ESP8266 this confusion will arise which pin needs to be called during programming, if you are using NodeMCUdevkit, it has come prepared for working with Lua interpreter which can easily program by looking the pin names associated on the Lua board. If you are using generic ESP8266 device or any other vendor boards please refer to the table below to know which IO index is associated with the internal GPIO of ESP8266.

Nodemcu dev kit	ESP8266 Pin	Nodemcu dev kit	ESP8266 Pin
D0	GPIO16	D7	GPIO13
D1	GPIO5	D8	GPIO15
D2	GPIO4	D9	GPIO3
D3	GPIO0	D10	GPIO1
D4	GPIO2	D11	GPIO9
D5	GPIO14	D12	GPIO10
D6	GPIO12		

Table 3.12.4 Pin description Of esp8266

D0 or GPIO16 can be used only as a read and write pin, no other options like PWM/I2C are supported by this pin. In our example in chapter 5 on blinking the blue LED, the blue LED in connected to GPIO2, it is defined as Pin4 (D4) in Lua script.

Single-chip usb-to-uart bridge:

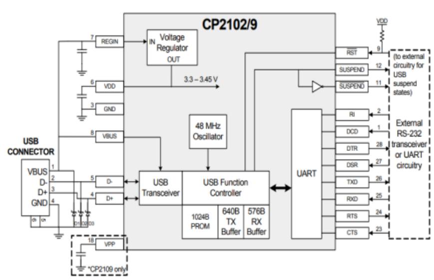


fig 3.1.12.5 single-chip usb-to-uart bridge

The CP2102/9 is a highly-integrated USB-to-UART Bridge Controller providing a simple solution for updating RS232 designs to USB using a minimum of components and PCB space. The CP2102/9 includes a USB 2.0 full speed function controller, USB transceiver, oscillator, EEPROM or EPROM, and asynchronous serial data bus (UART) with full modem control signals in a compact 5 x 5 mm QFN-28 package. No other external USB components are required. The on-chip programmable ROM may be used to customize the USB Vendor ID, Product ID, Product Description String, Power Descriptor, Device Release Number, and Device Serial Number as desired for OEM applications. The programmable ROM is programmed onboard via the USB, allowing the programming step to be easily integrated into the product manufacturing and testing process. Royalty-free Virtual COM Port (VCP) device drivers provided by Silicon Laboratories allow a CP2102/9-based product to appear as a COM port to PC applications. The CP2102/9 UART interface implements all RS-232 signals, including control and handshaking signals, so existing system firmware does not need to be modified. In many existing RS-232 designs, all that is required to update the design from RS-232 to USB is to replace the RS232 level-translator with the CP2102/9. Direct access driver support is available through the Silicon Laboratories USBXpress driver set.

3.2 Software Requirements

- Proteus Virtual System Modelling
- Arduino IDE
- MATLAB
- Embedded C

3.2.1 Proteus Virtual System Modeling (Vsm)

PROTEUS combines advanced schematic capture, mixed mode SPICE simulation, PCB layout, and auto routing to make a complete electronic design system. The PROTEUS product range also includes our revolutionary VSM technology, which allows you to simulate the microcontroller-based design, complete with all the surrounding electronics.

Product Features

• ISIS Schematic Capture an easy to use yet and extremely powerful tool for entering your design

• PROSPICE Mixed mode SPICE Simulation industry standard SPICE3F5 simulator upgradeable to our unique virtual system modeling technology

• ARES PCB Layout

• Modern Graphical User Interface standardized across all modules

• Runs on Windows 98/ME/2000/XP or Later

• Technical Support direct from the author

• Rated best overall products

Intelligent Schematic Input System (ISIS) ISIS lies right at the heart of the PROTEUS system and is far more than just another schematic package. It has a powerful environment to control most aspects of the drawing appearance. whether your requirement is the rapid entry of complex design for simulation & PCB layout Or the creation of attractive Schematic for publication ISIS is the right tool for the job Product Features

• Produces publication quality schematic

• Style templates allow customization of supplied library

• Mouse driven context-sensitive user interface

• Automatic wire routing and junction dot placement

• Full support for buses including sub- circuit ports and bus pins

• Large and growing component library of over 8000 parts

Vsm (Virtual System Modeling)

Proteus VSM is an extension of the PROSPICE simulator that facilities co-simulation of microprocessor-based design including all the associated electronics. Furthermore, you can interact with the microcontroller software through the use of animated keypads, switches, buttons, LEDs, lamps and even LCD displays.

Features

• CPU models available for many popular microcontrollers including PIC, AVR, HC11 and 8051

• Interactive device models include LED and LCD displays, RS232 terminal, universal keypad plus a range of switches, buttons, pots, LEDs, 7 seg displays and more.

• Extensive debugging facilities including register and memory contents, breakpoints and single step modes.

• Source level debugging for selected development tools including IAR C-SPY and Keil uVision

3.2.2 Arduino IDE

The Arduino/Genuine Uno can be programmed with the (Arduino Software (IDE)). Select "Arduino/Genuino 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/Genuino Uno comes preprogrammed with a bootloader 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 bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar; see these instructions for details.

The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository. The ATmega16U2/8U2 is loaded with a DFU bootloader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resing the 8U2.
- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

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 bootloader). See this user-contributed tutorial for more information

Warnings

The Arduino/Genuino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. 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.

Differences with other boards:

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.

3.2.3 Embedded C

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations.

In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as fixed-point arithmetic, named address spaces, and basic I/O hardware addressing.

Embedded C uses most of the syntax and semantics of standard C, e.g., main() function, variable definition, datatype declaration, conditional statements (if, switch case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, etc.

A Technical Report was published in 2004 and the second revision in 2006.

Advantages

-It is small and simpler to learn, understand, program and debug.

-Compared to assembly language, C code written is more reliable and scalable, more portable between different platforms.

=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 the 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 the 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.

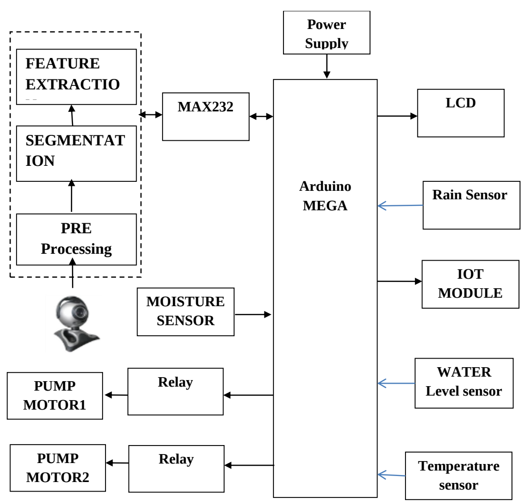
-Java is also used in many embedded systems but Java programs require the Java Virtual Machine (JVM), which consumes a lot of resources. Hence it is not used for smaller embedded devices.

-In Embedded applications there is a need to read/write data on a given address, and in C it is easy to access and modify addresses, because of the pointers which are a language feature.

Other High-level programming languages like Pascal, FORTRAN also provide some of the advantages.

4.Design Approach And Details

4.1 Design



The transformers step down the supply voltage and supply the power to the sensors, pumps as well as ATmega328. The 12V motor is automatically ON during the time when the plant requires water, fertilizer or during pest attack. The water moisture sensor, PH sensor is fixed in the soil, and PIR sensor is placed in the corner of the plant. When the sensor senses the water content, fertility and peat attack simultaneously and output is given to the control unit, whether it senses the below the saturate value the control unit activates the motor automatically.

Whenever input gets low, the output of the chip is high and relay (12V, 70 ohms) driving circuit i.e. transistor (BC548) is used to drive the relay. This chip runs on 5v supply, therefore, we use 7805 for the 5v regulator. The diode is connected in the pump as a freewheeling diode. Whenever water content in the soil got lower, the sensor will sense it, the motor will start through the relay. When soil got enough water the motor will stop working, similarly for PIR sensor and also PH sensor.

4.2 Codes

Embedded c:

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(2,3,4,5,6,7);
void iot(String stringdata);
int moisture = A2;
int temp = A0;
int water = A9;
int rain = A11;
int mpin1 = 52;
int mpin2 = 50;
int mpin3 = 46;
int mpin4 = 44;
char s;
void setup()
{
  //pinMode(water,INPUT);
  Serial.begin(9600);
  Serial1.begin(9600);
  Serial2.begin(9600);
  pinMode(moisture, INPUT);
  pinMode(temp, INPUT);
  pinMode(mpin1,OUTPUT);
  pinMode(mpin2,OUTPUT);
  pinMode(mpin3,OUTPUT);
  pinMode(mpin4,OUTPUT);
lcd.begin(16, 2);
```

```
  lcd.setCursor(0, 0);
  lcd.print("SMART");
  lcd.setCursor(4,1);
  lcd.print("AGRICULTURE");
  delay(2000);
  lcd.clear();
}
void loop()
{
  while ( Serial.available() > 0)
  {
    char s = (char) Serial.read();
   // Serial.print(state);
    lcd.print(s);
    if (s == 'A')
    {
      lcd.setCursor(0, 0);
      lcd.print("CITRUS CONKER");
      delay(1000);
      iot("*CITRUS CONKER#");
      delay(1000);
      lcd.clear();
      s = ' ';
    }
    else if (s == 'B')
    {
      lcd.setCursor(0, 0);
      lcd.print("CITRUS WHITEFLY");
      delay(1000);
      iot("*CITRUS WHITEFLY#");
```

```
    delay(1000);
   lcd.clear();
    s = ' ';
  }
  else if (s == 'C')
  {
   lcd.setCursor(0, 0);
   lcd.print("CITRUS GREENING");
   delay(1000);

   iot("*CITRUS GREENING#");
   delay(1000);
   lcd.clear();
    s = ' ';
  }
  else if (s == 'D')
  {
   lcd.setCursor(0, 0);
   lcd.print("CITRUS SOOTYMOLD");
   delay(1000);
   iot("*CITRUS SOOTYMOLD#");
   delay(1000);
   lcd.clear();
    s = ' ';
  }
}
int moisturelevel = analogRead(moisture);
delay(100);
//Serial.println(moisturelevel);
lcd.setCursor(0,0);
```

```
lcd.print("MOIS LEVEL; ");
lcd.print(moisturelevel);
delay(1000);
lcd.clear();
 if (moisturelevel>800)
{
   digitalWrite(mpin1,HIGH);
  digitalWrite(mpin2,LOW);
  lcd.setCursor(0, 0);
  lcd.print("MOISTURE LEVEL");
  lcd.setCursor(0, 1);
  lcd.print("LOW");
  delay(1000);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("PUMP MOTOR ON");
  iot("*MOISTURE LEVEL LOW#");
      lcd.clear();
}
if(moisturelevel<600)
{
  lcd.setCursor(0, 0);
  lcd.print("MOISTURE LEVEL");
  lcd.setCursor(0, 1);
  lcd.print("NORMAL");
digitalWrite(mpin1,LOW);
  digitalWrite(mpin2,LOW);
  iot("*MOISTURE LEVEL NORMAL#");
  lcd.clear();
}
```

```
 int waterlevel = analogRead(water);
 //Serial.print(waterlevel);
 lcd.setCursor(0,0);
 lcd.print("water level; ");
 lcd.print(waterlevel);
 delay(1000);
 lcd.clear();
 if(waterlevel<416)
 {
   digitalWrite(mpin3, HIGH);
   digitalWrite(mpin4, LOW);
   lcd.setCursor(0,0);
   lcd.print("TANK EMPTY");
   delay(1000);
   lcd.clear();
   lcd.setCursor(0,0);
   lcd.print("PUMP MOTOR ON");
   iot("*TANK EMPTY#");
   lcd.clear();
 }
if(waterlevel>600 && waterlevel<710)
 {
   digitalWrite(mpin3, LOW);
   digitalWrite(mpin4, LOW);
   lcd.setCursor(0,0);
   lcd.print("TANK LEVEL");
   lcd.setCursor(4,1);
   lcd.print("NORMAL");
   iot("*TANK LEVEL NORMAL#");
   lcd.clear();
```

```
}
 if(waterlevel>720 && waterlevel<900)
{
 digitalWrite(mpin3, LOW);
  digitalWrite(mpin4, LOW);
  lcd.setCursor(0,0);
  lcd.print("TANK LEVEL");
  lcd.setCursor(4,1);
  lcd.print("FULL");
  iot("*TANK LEVEL FULL#");
  lcd.clear();
  }
int tempvalue = analogRead(temp);
//Serial.println(tempvalue);
delay(100);
lcd.setCursor(0, 0);
lcd.print("TEMPLEVEL:");
lcd.setCursor(11, 0);
lcd.print(tempvalue/2);
delay(1000);
lcd.clear();
if ((tempvalue/2)>45)
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("TEMPERATURE");
  lcd.setCursor(0, 1);
  lcd.print("LEVEL HIGH");
  delay(1000);
  iot("*TEMPERATURE LEVEL HIGH#");
```

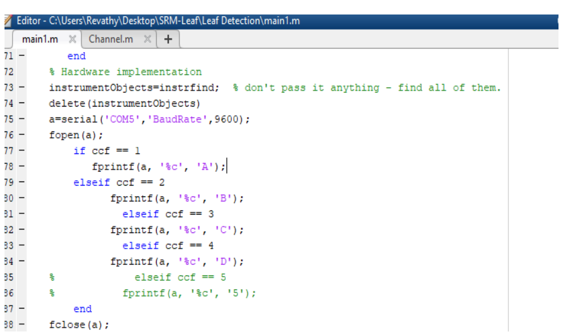
```
    lcd.clear();
   }
   else
   {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("TEMPERATURE");
    lcd.setCursor(0, 1);
    lcd.print("LEVEL NORMAL");
    delay(1000);
    iot("*TEMPERATURE LEVEL NORMAL#");
    lcd.clear();
   }
   int rainlevel=analogRead(rain);
   //Serial.println(rainlevel);
   lcd.setCursor(0,0);
   lcd.print("RAINLEVEL:");
   lcd.setCursor(11,0);
   lcd.print(rainlevel);
   lcd.clear();
   if (rainlevel<330)
   {
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("RAIN LEVEL");
    lcd.setCursor(0,1);
    lcd.print("HIGH");
    iot("*RAIN LEVEL HIGH#");
lcd.clear();
   }
```

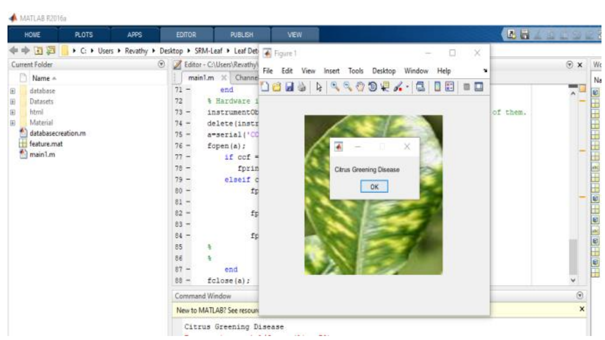
```
  if(rainlevel>600)
  {
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("NO RAIN");
    delay(1000);
    iot("*NO RAIN#");
    delay(1000);
    lcd.clear();
  }
  if((rainlevel>350)&&(rainlevel<600))
  {
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("RAIN LEVEL");
    lcd.setCursor(0,1);
    lcd.print("NORMAL");
    iot("*RAIN LEVEL NORMAL#");
    lcd.clear();
  }
}
void iot(String stringdata)
{
  for (int i = 0; i < stringdata.length(); i++)
  {
    Serial1.write(stringdata[i]);
  }
  delay(4000);
}
```

Matlab code:

```
% % % % % Leaf Detection
clc;
clear all;
close all;
warning('off','all');
[filename,pathname] = uigetfile('*.jpg');
im = imread([pathname,filename]);
im = imresize(im,[256 256]);
figure
imshow(im);
% % % % % Feature Extraction
% aa = dir('database\*.jpg');
% feature = [];
% for i2 = 1:length(aa)
%     aa1 = aa(i2).name;
%     im = imread(fullfile('database\',aa1));
%     im = imresize(im,[256,256]);
% figure,imshow(im);title('Input image');
% % % % % database creation
% cam = webcam('USB2.0 PC CAMERA');
% preview(cam);
% for i=1
%     pause(10);
%     a = snapshot(cam);
% im = imresize(a,[256 256]);
% imwrite(im,'database\18.jpg');
% end
% figure,imshow(im),title('resized image')
% end
[r c d] = size(im);
if d == 3
   gray = im2double(rgb2gray(im));
else
   gray = im2double(im);
end
% figure,imshow(gray);
% %
points11 = detectSURFFeatures(gray);
figure,
imshow(im);
hold on;
plot(selectStrongest(points11,100))
 % Extract the features.
[f1,vpts1] = extractFeatures(gray,points11);
f2 = mean(f1);
% feature = [feature;f2];
% end
% save('feature','feature')
```

```
load feature.mat;
% % classification
lab = [1,3,3,3,4,4,4,4,1,1,1,2,2,2,2,3];
mdl = fitcknn(feature,lab);
yfit = predict(mdl,f2);
% % Decision Making
if yfit == 1
    ccf = 1;
    msgbox('Citrus Cancer');
    disp('Citrus Cancer');
 elseif yfit == 2
    ccf = 2;
    msgbox('Citrus Greening Disease');
    disp('Citrus Greening Disease');
     elseif yfit == 3
    ccf = 3;
    msgbox('Citrus Whitefly');
    disp('Citrus Whitefly');
     elseif yfit == 4
    ccf = 4;
    msgbox('Scooty Mold');
    disp('Scooty Mold');
   end
% Hardware implementation
instrumentObjects=instrfind;  % don't pass it anything - find all of them.
delete(instrumentObjects)
a=serial('COM5','BaudRate',9600);
fopen(a);
    if ccf == 1
        fprintf(a, '%c', 'A');
    elseif ccf == 2
            fprintf(a, '%c', 'B');
              elseif ccf == 3
            fprintf(a, '%c', 'C');
              elseif ccf == 4
            fprintf(a, '%c', 'D');
%               elseif ccf == 5
%             fprintf(a, '%c', '5');
    end
fclose(a);
```





4.3 Constraints

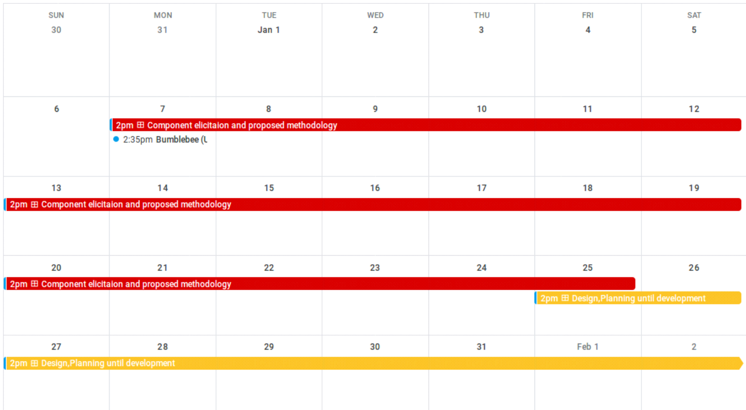
-Agriculture being a natural phenomenon relies mostly on nature, and man can never predict or control nature let it be rain, drought, sunlight availability, pests control, etc. So even implementation IoT system we cannot implement SMART agriculture.

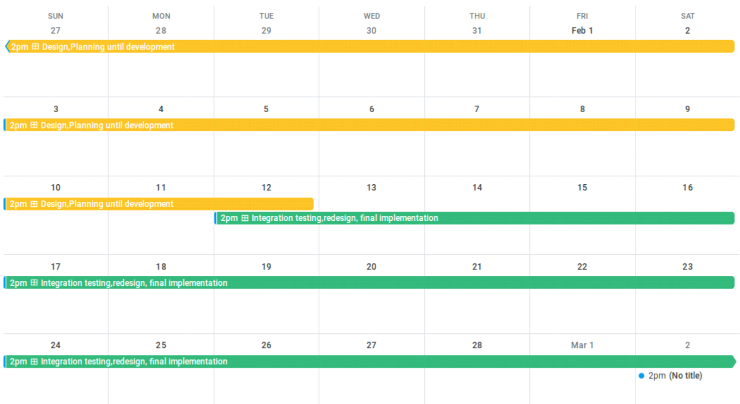
-Faulty sensors or data processing engines can cause faulty decisions which may lead to overuse of water, fertilizers and other wastage of resources.

-The current IoT systems are not scalable or reliable and the initial costs are high which the farmers cannot afford.

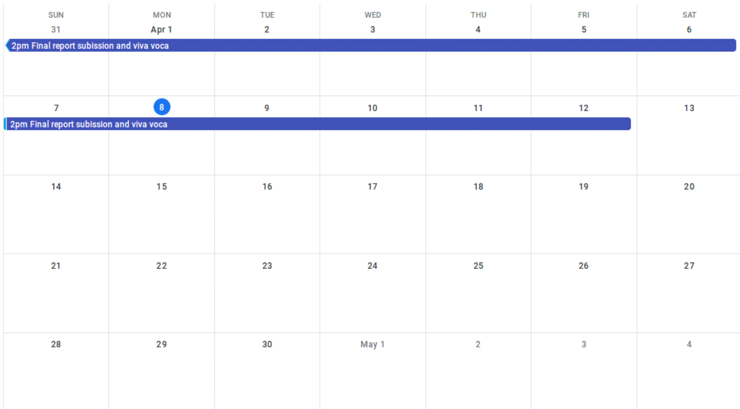
5. Schedule, Task, And Milestones

5.1 Schedule And Tasks


SUN MON TUE WED THU FRI SAT
30 31 Jan 1 2 3 4 5
6 7 8 9 10 11 12
2pm Component elicitaion and proposed methodology
2:35pm Bumblebee (L
13 14 15 16 17 18 19
2pm Component elicitaion and proposed methodology
20 21 22 23 24 25 26
2pm Component elicitaion and proposed methodology
2pm Design,Planning until development
27 28 29 30 31 Feb 1 2
2pm Design,Planning until development


SUN MON TUE WED THU FRI SAT
27 28 29 30 31 Feb 1 2
2pm Design,Planning until development
3 4 5 6 7 8 9
2pm Design,Planning until development
10 11 12 13 14 15 16
2pm Design,Planning until development
2pm Integration testing,redesign, final implementation
17 18 19 20 21 22 23
2pm Integration testing,redesign, final implementation
24 25 26 27 28 Mar 1 2
2pm Integration testing,redesign, final implementation
2pm (No title)


SUN MON TUE WED THU FRI SAT
24 25 26 27 28 Mar 1 2
2pm Integration testing,redesign, final implementation
2pm (No title)
3 4 5 6 7 8 9
2pm Integration testing,redesign, final implementation
10 11 12 13 14 15 16
2pm Integration testing,redesign, final implementation
17 18 19 20 21 22 23
2pm Integration testing,redesign, final implementation
24 25 26 27 28 29 30
2pm Integration testing,redesign, final implementation
2pm Final report subission and viva voca
31 Apr 1 2 3 4 5 6
2pm Final report subission and viva voca

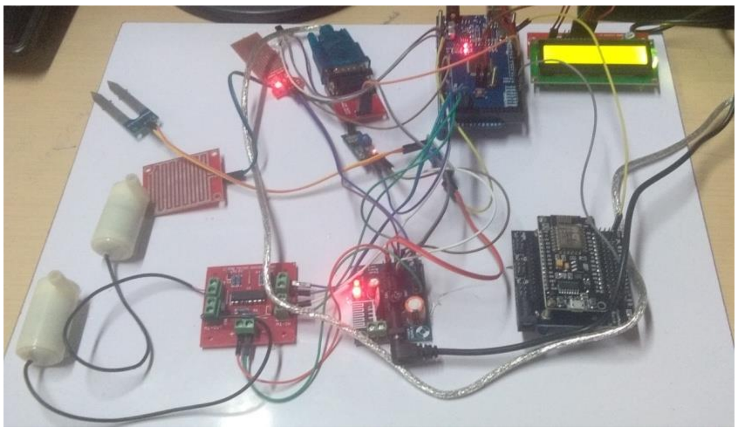


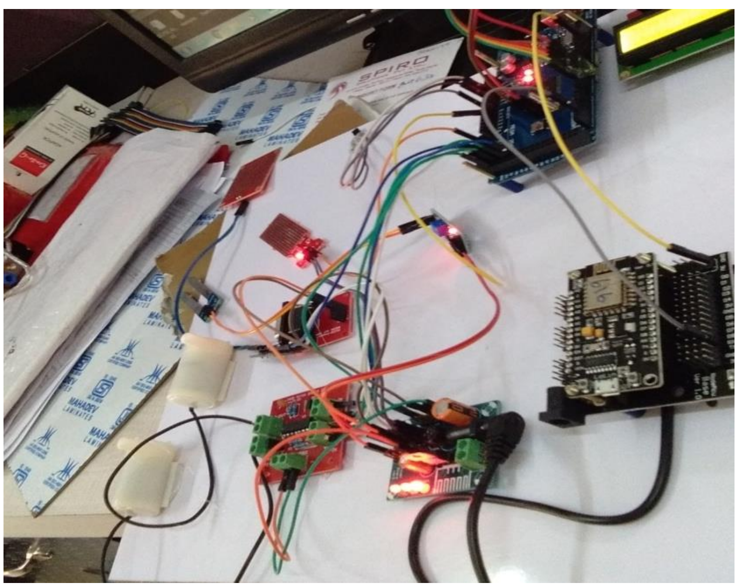
5.2 Milestones

- There are many major milestones as well as sever smaller tasks that must be achieved in order to reach the milestones. The milestones are:
- Checking the temperature if it's too hot or cold and adjusting the water in the plants according to it.
- Analysing which disease by image processing and finding the right pesticide.
- Checking the moisture level of the soil for the right fertility of the crops.
- Providing all the informations to the cloud so that all the work can be maintained remotely
- Tasks will be split up among group members according to each member's level of expertise or comfort.
- Each task will have a leader who is responsible for completion of that task. However, the other group members are expected to provide assistance if needed. This way, an engineer can concentrate on a task but still get help if needed. Also, each tasks` respective leader is held accountable if the task fails.

6. Project Demonstration

To primary project demonstration will pit the Arduino MEGA, controller to monitor the sample soil and water provided in a cup. In this temperature sensor and moisture sensor and rain sensor water level sensor is connected externally so we can monitor the exact view of plants. Which is done by connecting the Arduino mega and not module to the computer with the arduino software running the codes for the hardware to start operating giving the vital messages about the information of the uses of the sensor modules when provided or given into different environment. And the main part of the system is image processing so we can monitor the plant is good condition or not. Then the image processing data's and sensor's data's move to the IoT hardware module so we can monitor the all data's in unique URL address. Motor will automatically on and off based on sensor value.





7.Cost Analysis

MOISTURE SENSOR	Rs. 80
WATER LEVEL SENSOR	RS. 90
TEMPERATURE SENSOR	RS. 110
RAIN SENSOR	Rs. 110
LCD	R. 125
RELAY X2	Rs. 52
PUMP MOTOR X2	Rs. 420
IOT MODULE ESP8266	Rs. 3234
ARDUINO MEGA 2526	Rs. 749
CAMERA	Rs. 999
CURRENT SENSOR	Rs. 745
CRYSTAL OSCILLATOR	Rs. 119
BC548 TRANSISTOR	Rs. 3
ADAPTER	Rs. 290
A TO B CABLE	Rs. 143
Total	**Rs.7260**

8.Summary

- It is small and simpler to learn, understand, program and debug.
- Compared to assembly language, C code written is more reliable and scalable, more portable between different platforms.
- 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.
- Java is also used in many embedded systems but Java programs require the Java Virtual Machine (JVM), which consumes a lot of resources. Hence it is not used for smaller embedded devices.
- In Embedded applications there is a need to read/write data on a given address, and in C it is easy to access and modify addresses, because of the pointers which are a language feature.

Other High-level programming languages like Pascal, FORTRAN also provide some of the advantages.

9 .Future Scope

The sensor network technology can help the farmers in different ways: Simulation models of crops, pests, diseases and farming operations are important tools for required information. It helps in calculating the water needs of the crops during growing period. The environment monitoring data provided over time and space by sensors can be used to validate and calibrate existing models. Farmers can monitor in real time the field conditions. This all can help them to take better decisions on crops, moisture conditions, climatic changes, water conditions, etc. The engineers and researchers can help the illiterate farmers by using maps and graphs drawn from the collected data which could help them in taking better decisions regarding their fields. Sensor Technology: Different sensors are employed for sensing various parameters like soil moisture, water levels, climate change, pest detection, humidity to various other things in the fields. For sensing these parameters, the sensors are deployed in the field. They are spread in such a way that they cover the whole field. Now these sensors can be used in many different ways. The a sic technology employed in the sensors is the same. Only the way they are spread out differs. But this different arrangement plays an important role as when used efficiently these sensors save time, save the required power and also may decrease the channel congestion, thus increasing the overall efficiency of the whole network.

Advantages

- Nutrient management
- To maintain the productivity, vermin compost and
- Bio fertilizers are added in the soil at the time of pudding.
- We can also use neem compost and neem leaves because they
- Work as pesticides and growth promoter. Water management

The main requirement of paddy is wet soil for its growth and sufficient water management according to need. Flooding is unnecessary if the weeds can be removed manually but if not then the fields are flooded to suppress weed growth and maintain nutrients such as phosphorus, potassium, and silica and calcium iron. Water is needed only at three critical stages, at the initial seedling period (10 days), flowering and panicle initiation stage. After the transplantation till the seedlings grow it needs standing water at a depth of 2-5 cm. Then till the dough stage of the crop, 5cm of water should be maintained. Then at last, water should be drained out from the field 7-15 days before the harvest. The amount of water required for a given crop depends on state of development of soil, quantity and type of fertilizer given, quality of water used [4]. The paddy needs a lot of water. Another big concern here is that the water should not be in excess nor it should be less than the required amount. Both are very harmful for the cultivation of paddy. Therefore, we need a method by which the amount of water in the field can be monitored regularly and the water level can be controlled.

10. Conclusion

10.1 How Our Project Supports The Present Solution

Presently the smart agriculture system is only limited to sensing the data and working on it manually. What our system does is it not only senses the environmental factors but also reads and analyse the data and accordingly does what it is supposed to do. Like if the soil is too dry (i.e less humid) then sprinkle some water automatically. Likewise vice versa. It also drains excessive water by using the water sensor. So the farmers don't have to worry about irrigation anymore and what's best is all the datas that are provided by the sensors can be read remotely.

10.2 How Working Is Better And Application In The Remote Areas

Modern agriculture offers a range of benefits, including greater production and higher incomes for farmers including small producers in both developed and developing countries. Technical advances also have sharply reduced environmental impacts, enabling reduced pesticide, herbicide and fertilizer use, less tillage, and less land and water use per unit of output all decreasing pressure on fragile global ecosystems[10]. It is clear that we have a productivity gap going forward, a gap that we must begin now to close. If we are to double agricultural output by 2050 and do so with basically the same amount of land

and water as we have today while also reducing the environmental footprint then clearly we must become more productive than we have been in the past. That is the productivity gap, which is our challenge [3, 4].

Recently, potentiometric sensors have appeared that take profit of the electric field generated by the membrane potential caused by presence of specific ions; the electric field modulates current in a field effect transistor, in this way these sensors are known as Ion Selective Field Effect Transistors (ISFETs). ISFET sensors have a great future in continuous monitoring, given that they are able to determine ions at very low concentrations and they can be massively produced using VLSI technology. In agricultural farms where operation and environmental conditions are quite aggressive the robust and cheap ionic sensors that provide real-time information of the ionic composition of the nutrient solution are very useful, although accuracy is not excessively high [1, 4].

The technique is also suitable for expensive crops like strawberry and mushrooms in closed soilless systems. The closed soilless systems is a techniques implemented in modern horticulture in order to improve the efficiency in the use of water and fertilizers and to preserve the environment. In few words, in this technique, plants grow on artificial substrates which substitute natural soil [5, 3]. A fertilizer supply unit provides nutrients and the solution not used by the plants is collected and regenerated to be reused several cycles. The addition of new fertilizer ions (ammonium, potassium, nitrate, phosphate) and tap water is controlled by the value of electrical conductivity (EC) and pH signals. However, this protocol can only give a qualitative control over these species given ion's uptake by the plants may vary [2]. In the closed soilless systems non-essential ions such as sodium and chloride accumulate in nutrient solution causing an increase in the overall EC and consequently a decrease of the concentration of the nutrient ions if the conductivity is maintained at a fixed value [5].Therefore, the measurement of the concentration of each individual ion in the nutrient solution in continuous mode, and in real-time can be a clear improvement to normal use in this area, and can lead to fine control of fertilizer dosage adapted to each plant stage [1,3].

In agriculture and forestry it is well-known the existence of different microorganisms and insects that can cause production losses. Their monitoring and control are very important. In [3] a pest insect trap equipped with low-power image sensor technology is designed to perform remote automatic pest motorization. Traps form a Wireless Sensor Network (WSN) and the images are sent via wireless one-hop broadcast communications to a host control station. In [4] is reported a system to detect the tobacco mosaic virus in the soil adopting the real-time quantitative polymerase chain reaction (RT-qPCR) by means of a specific device. A new technology for detecting root colonization in potatoes by microorganisms by exciting the material to produce fluorescence and capturing the images through a confocal laser scanning microscope is described in [3,5]. In [3,6] is outlined the design and realization of a bioacoustic sensor, equipped with a probe for acquisition of sounds, in order to perform the early detection of real palm we evil for pest control.

11. References

1.Smart Farming System Using Sensors for Agricultural Task Automation, Chetan Dwarkani M, Ganesh Ram R, IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development (TIAR 2015), 2015.

2. Providing Smart Agricultural Solutions to Farmers for better yielding using IoT, M.K.Gayatri, J.Jayasakthi. IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development (TIAR 2015), 2015.

3.Internet of Things Application for Implementation of Smart Agriculture System, K.Lokesh Krishna, International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC 2017)

4.AgriSys: A Smart and Ubiquitous Controlled- Environment Agriculture System, Aalaa Abdullah, Shahad Al Enazi and Issam Damaj, 3rd MEC International Conference on Big Data and Smart City, 2016.

5.Smart Farming—A Prototype for Field Monitoring and Automation in Agriculture, K. Sreeram, IEEE WiSPNET,2017.