

ARDUINO BASED CROP SUGGESTION AND MONITORING SYSTEM IN AGRICULTURE

A PROJECT REPORT

Submitted by

DHARANI P

(715515105011)

GAYATHRI K

(715515105013)

In partial fulfillment for the award of the degree

Of

BACHELOR OF ENGINEERING

IN

ELECTRICAL AND ELECTRONICS ENGINEERING



PSG INSTITUTE OF TECHNOLOGY AND APPLIED RESEARCH

COIMBATORE

ANNA UNIVERSITY: CHENNAI 600 025

APRIL 2019

ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report “**ARDUINO BASED CROP SUGGESTION AND MONITORING SYSTEM IN AGRICULTURE**” is the bonafide work of “**DHARANI P. and GAYATHRI K.**” who carried out the project work under my supervision.

HEAD OF THE DEPARTMENT

Dr. C. L. Vasu

Department of Electrical and
Electronics Engineering
PSG Institute of Technology
and Applied Research

SUPERVISOR

Ms. C. V. Pavithra

Assistant Professor (Sr.Gr.)
Department of Electrical and
Electronics Engineering
PSG Institute of Technology
and Applied Research

Certified that the candidate was examined in the viva voce examination held on 01/04/2019

Internal Examiner

External Examiner

ACKNOWLEDGEMENT

It is our proud privilege to express our deep sense of gratitude towards all those who supported us in completing this thesis.

We express our profound sense of gratitude and regards to our Principal **Dr. P. V. MOHANRAM** and Vice - Principal **Dr. G. CHANDRAMOHAN** for giving all facilities to carry out the project successfully.

We are deeply indebted to **Dr. C. L. VASU**, Professor and Head of the Department, Electrical and Electronics Engineering, for his valuable suggestions.

We would like to express our deep sense of respectful gratitude to our guide, **Ms. C. V. Pavithra**, Assistant Professor (Sr. Gr), Department of Electrical and Electronics Engineering for her persistent encouragement and assistance for successful completion of this project.

We thank all the staff members of the Department of Electrical and Electronics Engineering for their help during the project work.

Finally we express our deep sense of gratitude to our parents, friends and all others for their thoughtful discussions, sharing of knowledge and their persistent support and cooperation.

The technical information derived from various research papers is gratefully acknowledged.

ABSTRACT

In agriculture, the growth of the crops largely depends on the soil type and its properties. Just as air and water, soil - which is a mixture of organic matter, minerals, gases, liquids, and organisms - serves as important natural resource to support the growth of variety of plant species. The knowledge of the soil type and planting the crops corresponding to the soil nutrients, moisture content, humidity, and luminescence are very prominent for good yield of the crops.

With this objective in mind, this project aims at developing a system that would benefit farmers, small scale to large scale. In this project, the system developed will suggest appropriate seed to be sown in the given soil, based on the soil type, nutrient and alkalinity.

The controlling factors for the plant growth are continuously monitored by the various sensors installed in the field. The Arduino controller employed controls the parameter for the plant growth. Further the field sensor data are sent to the ThingSpeak cloud through ESP8266 (Wi-Fi module), which may be used for future references.

Thus, the proposed method for smart farming can also provide great benefits in terms of environment issues like effective management and optimized use of water and also provide a new platform to other common or growing trends in agriculture.

TABLE OF CONTENTS

Chapter No.	Title	Page No.
	ABSTRACT	iv
	LIST OF FIGURES	xi
	LIST OF TABLES	xiii
	LIST OF ABBREVIATIONS	xiv
1.	INTRODUCTION	1
	1.1 Overview	1
	1.1.1 Crops grown in India	3
	1.1.2 Challenges faced by Indian agricultural sector	3
	1.2 Conventional system	4
	1.3 Proposed system	5
	1.4 Project organization	6
2.	LITERATURE REVIEW	7

3.	SYSTEM DESCRIPTION	10
	3.1 Block diagram	10
	3.1.1 Crop suggestion system	11
	3.1.1.1 Need for crop suggestion system	11
	3.1.1.2 Implementation of crop suggestion system	11
	3.1.1.3 Data for crop suggestion	12
	3.1.2 Field monitoring and control system	15
	3.1.2.1 Need for field monitoring and control system	15
	3.1.2.2 Implementation of field monitoring and control system	16
	3.1.2.2.1 Measuring pH of soil	17
	3.1.2.2.2 Moisture content	18
	3.1.2.2.3 Effect of soil temperature	19

3.2 Working procedure	19
4. HARDWARE AND SOFTWARE	
REQUIREMENTS	21
4.1 Hardware description	21
4.1.1 pH sensor	21
4.1.2 Moisture sensor	21
4.1.3 Temperature sensor	22
4.1.3.1 DS18B20	22
4.1.3.2 LM 35	23
4.1.4 ESP 8266	23
4.1.5 Submersible pump	26
4.1.6 Incandescent lamp	26
4.1.7 DC Cooling fan	27
4.1.8 Relay	27
4.1.9 Arduino board	28

4.1.10 LDR	32
4.2 Interfacing process for crop suggestion system	33
4.2.1 Interfacing of pH sensor with Arduino Uno board	33
4.2.2 Interfacing of one wire temperature sensor with Arduino Uno board	34
4.2.3 Interfacing of LM 35 with Arduino Uno board	34
4.3 Interfacing process for growth enhancing factor control	35
4.3.1 Interfacing of moisture sensor module with Arduino Uno board	36
4.3.2 Interfacing LDR with Arduino Uno board	36
4.3.3 Interfacing relay with Arduino Uno board	36

4.3.4	Interfacing of ESP 8266-01 with Arduino	
	Uno board	37
4.4	Power supply circuit design	37
4.4.1	Heat sink	38
4.5	Software implementation	40
4.5.1	Arduino programming	40
4.5.2	ThingSpeak	41
4.5.2.1	Creation of new ThingSpeak	
	channel	42
5.	RESULT AND DISCUSSION	44
5.1	Summary of result	44
5.1.1	Output of crop suggestion	44
5.1.2	Monitoring growth enhancement factor	45
5.1.2.1	Maintaining moisture content	45

	5.1.2.2 Maintaining atmospheric	
	temperature	46
	5.1.3 Graphical format of data stored in the cloud	47
6.	CONCLUSION	49
	6.1 Future work	49
	APPENDIX I	50
	APPENDIX II	60
	APPENDIX III	65
	REFERENCES	68

LIST OF FIGURES

Figure No.	Title	Page No.
1.1	Agricultural land availability in India over year	2
3.1	Overall block diagram of the model	10
3.2	Block diagram for crop suggestion system	12
3.3	Mean rainfall for monsoon season during 2004	13
3.4	The proposed controlling system	16
4.1	pH sensor	21
4.2	Moisture sensor	22
4.3	DS18B20 Soil temperature probe	22
4.4	LM 35 Temperature sensor	23
4.5	ESP8266-01 module	24
4.6	Submersible pump	26
4.7	DC cooling fan	27
4.8	Relay	27

4.9	Arduino UNO board	29
4.10	LDR module and its characteristics	32
4.11	Interfacing for crop suggestion system	35
4.12	Relay pin diagram	37
4.13	Power supply circuit	38
4.14	New channel creation in ThingSpeak	42
5.1	Serial monitor output of crop suggestion system	44
5.2	LCD display of suitable crop	45
5.3	Serial monitor output of moisture control	46
5.4	Serial monitor output of temperature control	47
5.5	Serial monitor output of transmitted data	48
5.6	Data stored in ThingSpeak cloud	48

LIST OF TABLES

Table No.	Title	Page No.
3.1	Crop data collected for high rainfall region	14
3.2	Crop data collected for medium rainfall region	14
3.3	Crop data collected for low rainfall region	15
3.4	Standard buffer vs. pH sensor board	17

ABBREVIATIONS

AC	Alternate Current
API	Application Program Interface
DC	Direct Current
GND	Ground
GPIO	General Purpose Input Output
HTTP	Hypertext Transfer Protocol
IoT	Internet of Things
IDE	Integrated Development Environment
KB	Kilo Bytes
LCD	Liquid Crystal Display
LDR	Light Dependent Resistor
LED	Light Emitting Diode
MHz	Mega Hertz
PWM	Pulse Width Modulation

RST	Reset
RX	Receiver
TX	Transmitter
UART	Universal Asynchronous Reception Transmission
USB	Universal Serial Bus
V_{cc}	Power Supply
Wi-Fi	Wireless Fidelity
WSN	Wireless Sensor Network

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The population of the world is increasing day by day at an alarming rate and it is becoming a huge concern for the world. Currently, on an average about one billion people are added every 12 – 13 years. Population has already crossed 8 billion in the world. Due to population explosion, the availability of resources becomes lesser and therefore the effective use of the available resource is very important.

India occupies 2.4% of the world's land area and supports over 17.5% of the world's population. Our population is expected to cross 150 crore of population before the year of 2030. As our population grows, the needs of the population become bigger.

Agriculture is the backbone of Indian economy. According to “The Economic Survey 2017-2018”, agriculture sector employs more than 50% of the total workforce in India and contribute around 17-18% to the country's GDP. Thus agriculture is unquestionably the largest livelihood provider in India which feeds half of the population.

The 4th National Conference on Krishi Vigyan Kendras has quoted that India's per capita availability of agricultural land has shrunk to 0.3 hectare per farmer compared to over 11 hectares in the developed world. At the same time population has more than doubled since 1970s to 1122 million, putting India's food security in question.

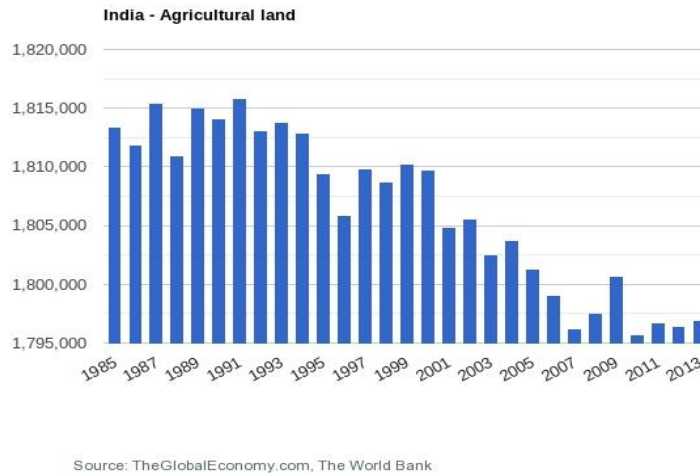


Fig. 1.1 Agricultural land availability in India over year

Fig. 1.1 shows the graphical representation of availability of agricultural land in India over 1985 to 2013 shows the decline in land over the period. In traditional method of agriculture, the unplanned uses of natural resource are considered to be the wasted resources. Hence, in order to meet the future requirement of expanding population and for optimized use of resources, an alternative method of farming has to be adopted.

Instead of changing the existing soil condition by adding excess manure after sowing crops, the soil condition can be pre-examined and accordingly the seeds can be planted. The need of resources like water, temperature, and luminescence can be supplied to the plant in an automated manner which will ensure the correct utilization of depleting resources. The data which were collected during the growth of plant can be stored in the cloud. This data may be likely used in future harvesting to train the system based on the conditions prevailed during the growth of the crop. This will replace the traditional mundane way of agriculture that ensure optimal utilization of resources and better crop yield.

Thus the significance of agriculture is not only to provide food for living, but also serve as many sources of income that decide the economical growth of the nation. Hence higher-end technological advancement may be done to benefit the farmers to augment the productivity.

1.1.1 CROPS GROWN IN INDIA

India is a subtropical land, which is characterized by warm to hot summer and cold to mild winters. This climate allows plant to flourish. India ranks second worldwide in farm output. Crops in India are broadly divided into three major categories, viz.

- Kharif crops: The crops that are sown in the rainy season are called kharif crops. Its season starts from July and ends in October, e.g. Maize, Sugarcane, Cotton, Jawar, Bajra soyabean, turmeric, paddy, moong, ground nuts, red chillies.
- Rabi crops: The crops that are sown in the winter season are called rabi crops. Its season is during October to March, e.g. Wheat, oil seed, pulses, rubber beans.
- Zaid crops: Crops grown between March and June are known as Zaid e.g. muskmelon, watermelon and vegetables like guard, pumpkin etc.

1.1.2 CHALLENGES FACED BY INDIAN AGRICULTURAL SECTOR

- The main reason for low production of crop cultivation is mainly due to improper irrigation and lack of proper irrigational facilities.
- Indian agriculture is mainly dependent on monsoon, if monsoon fails in one year, then the farmers will face a huge loss.
- Many a time improper utilization of water lessens the productivity.

- Most of the agricultural operations in larger parts are carried on by human hand using simple and conventional tools. It results in low yields per capital investment.
- Storage facilities in the rural areas are either totally absent or grossly inadequate. Under such conditions the farmers are compelled to sell their produce immediately after the harvest at the prevailing market prices which are bound to be low.

1.2 CONVENTIONAL SYSTEM

The conventional system of agriculture uses the traditional knowledge of the farmer to decide the crop which is to be sown. The planted crops will be then monitored manually. The control action such as turning on and off the pump, to maintain sufficient moisture will be carried out manually. In this conventional farming the problem of over irrigation, under irrigation, top soil erosion are not considered as a major issues. If a particular area of the farm needs water, the entire area will be supplied with water rather than supplying for the necessary area. Hence, the traditional agriculture practice results in unwanted usage of natural resources.

The plant growth enhancing factors such as temperature, moisture, humidity and luminescence will not play any role in this type of agriculture practice. But they have a huge impact on the plant development. A large portion of farming and agricultural activities are based on the farmer predictions. Because of rapid change in environmental conditions nowadays, the predictions may fail which will impose a huge loss over the farmers.

1.3 PROPOSED SYSTEM

The soil pH has its own effect on the plants. For example rice can grow well in alkaline soil than in acidic soil. The soil pH is already defined for a soil. By selecting a crop which will grow with the ease in particular soil, the growth of that crop can be promoted in that soil without need of any other process to change the pH. The prevailing atmospheric condition such as soil temperature, humidity and luminescence will have its direct impact on the plant growth. So they have to be observed before selecting the crop for the field to be planted. Our proposed system will suggest the suitable crop based on the datum from the field study.

After planting the crop, the growth enhancing factors such as soil temperature, soil moisture, atmospheric humidity and luminescence are monitored and controlled through a controller which decides the control action based on the violated threshold value. For instance when the threshold value of moisture falls below the necessary value, the controller will actuates the pump. Similarly other control action will be taken likewise.

Through this way of monitoring, the error which may occur due to human incompetency will be eliminated and can ensure that the resources are used efficiently. Easily the favorable condition for the plant growth can be maintained throughout the period of cultivation. This ensures better productivity of the crop.

The information of the prevailing condition during the plant growth and after harvesting can be stored in the cloud. The data stored in the cloud can be used to train the system in future which will predict the yield of harvest season based on the condition preserved during the plant growth.

1.4 PROJECT ORGANIZATION

CHAPTER 1: A brief introduction on the state of agriculture in India and conventional method of farming practices and the challenges faced by the farmers are discussed.

CHAPTER 2: A thorough literature survey of the existing methodologies of the farming and the drawbacks in the system are discussed.

CHAPTER 3: A brief description about the project.

CHAPTER 4: provides information on the hardware and software requirement.

CHAPTER 5: provides the result of the project outcome in form of tables, graphs, visualization and pictures.

CHAPTER 6: provides the concluding report which summarizes the project's objective and future scope.

CHAPTER 2

LITERATURE REVIEW

Research on crop suggestion and smart farming using IoT started few years ago and got increased with the technologies. Increased awareness about the necessity to plant the correct crop and to monitor its growth during the process also paved a way to focus on better crop yield. Many researches and theories are being stated by many people. Here are some of the researches that are made at international level from last few years.

- Dr. Shaik Nassera (2017) presented a paper on “Smart Agriculture Using IoT” published in IRJAET. The proposed system which monitors the moisture content of the soil using sensor and process the collected data using Raspberry pi. And also when a person entered the farm field that does not belong to him, it is sensed by PIR sensor and an SMS is sent to the farmer of that field through mobile applications with help of GSM Module so that farmer’s land gets protected.
- Lakshmisudha K et al (2011) presented a paper on “Smart Precision Based Agriculture Using Sensors” published in IJCA. She proposed a system in which soil parameters information are collected from different sensors and they are sent to computer which is located remote from the field position through the Zigbee network. The remote computer will process the data collected from the sensors and capable of controlling the motor pump for irrigation when soil is dry and controlling humidity fan when the temperature goes high. The motor pump and humidity fan are located in cultivating farm.

- Vinoth kumar V et al (2017) presented a paper on “Implementation of IoT in Smart Irrigation System Using Arduino Processor” which is published in IJCIET. The proposed irrigation system for agricultural purpose monitors the Soil moisture, temperature of the field and collects data through the respective sensors and transmits the collected data to the user (farmer) through the Wi-Fi module and IoT server ThingSpeak cloud. If there is any deviation from the reference threshold value, then the user can send the required command through the IoT server to maintain the set point value of field parameter for a proper irrigation and proposed IoT based irrigation system is better than the recently proposed other irrigation systems.
- Gautam A Bhoge et al (2017) presented a paper on “Wireless Agriculture Monitoring Using Raspberry PI” published in IJERT. The proposed control system would provide feedback, which will control all the activities regarding irrigation system of farms efficiently. This irrigation system will allow the farmers to cultivate crops in places where water scarcity problem arises, so that there is improvement in sustainability. By using this system, the farmer can save man power, providing water to improve the production rate and ultimately increase the profit.
- Himanshu Gupta et al (2017) presented a paper on “Automated Precision Farming Using IoT” which is published in IJARCET. The proposed precision farming system is an integrated system to help the farmers to automate the process to get a better yield. The system helps farmer to reduce the labor task by eliminating the need to check the soil parameters manually. The whole control of the system is with farmers, from setting the threshold

values to getting the messages from the system to farmer's mobile phone about which action is performed.

- Sandip Rukhmode (2017) presented a paper on “IoT Based Agriculture Monitoring System Using WEMOS” published in ICEMESM journal. The proposed system realizes the precision agriculture monitoring system based on wireless sensor network (WSN). The system monitors the real - time environmental factors like soil temperature, humidity and soil moisture. By controlling the parameters using the collected real time data through WSN in order to improve the operation efficiency of the agricultural crops and also to get the better yield.

CHAPTER 3

SYSTEM DESCRIPTION

3.1 BLOCK DIAGRAM

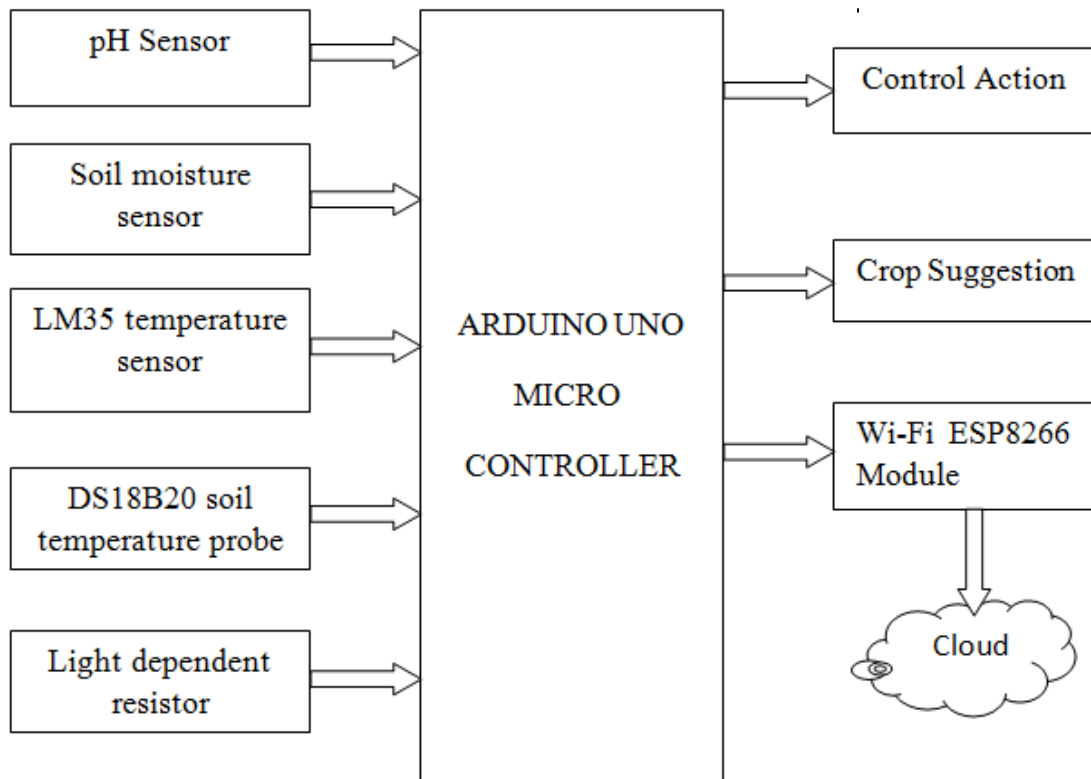


Fig. 3.1 Overall block diagram of the model

Fig. 3.1 shows the overall block diagram of the proposed crop suggestion and monitoring system. The objective of our project is to recommend cultivation of a crop which is suitable for the soil and monitor the parameters through sensors. Hence, manpower is reduced and accuracy is also increased. The overall block diagram depicts the working procedure of our project.

The proposed system consists of two parts to attain the final integrated agricultural monitoring and crop suggestion system. They are:

- A) Crop suggestion system
- B) Field monitoring and controlling system

3.1.1 CROP SUGGESTION SYSTEM

The best crop which suits the environment is suggested through this part of the project.

3.1.1.1 NEED FOR CROP SUGGESTION SYSTEM

Nutrient content of the soil is directly related with the pH of soil. Hence choosing the crop which can grow easily on that soil will be an enhancing factor for the crop growth. Along with the soil pH, factors such as atmospheric temperature and soil temperature also affect the growth of the plant to a larger extent. Therefore choosing the crop based on these factors will enhance the crop growth naturally without any human intervention.

3.1.1.2 IMPLEMENTATION OF CROP SUGGESTION SYSTEM

It is clear that choosing the correct crop for cultivation ensures better productivity of the crop. The pH plays a vital role in the cultivating the crop. If we cultivate crop which is not suitable for that soil then we have to provide the necessary nutrient through manure and fertilizer. Hence it is better to ensure the plant growth in the soil of appropriate pH, so that the need for artificial fertilizer to promote plant growth can be reduced. The fertility of such soil is preserved even after harvest, which ensures the growth of any other crop in that land, with the same pH requirement. Hence, pH of the soil is the important parameter for growing crops. The soil pH is collected through a pH sensor which is in contact with the soil, and the data is transferred to the serial monitor.

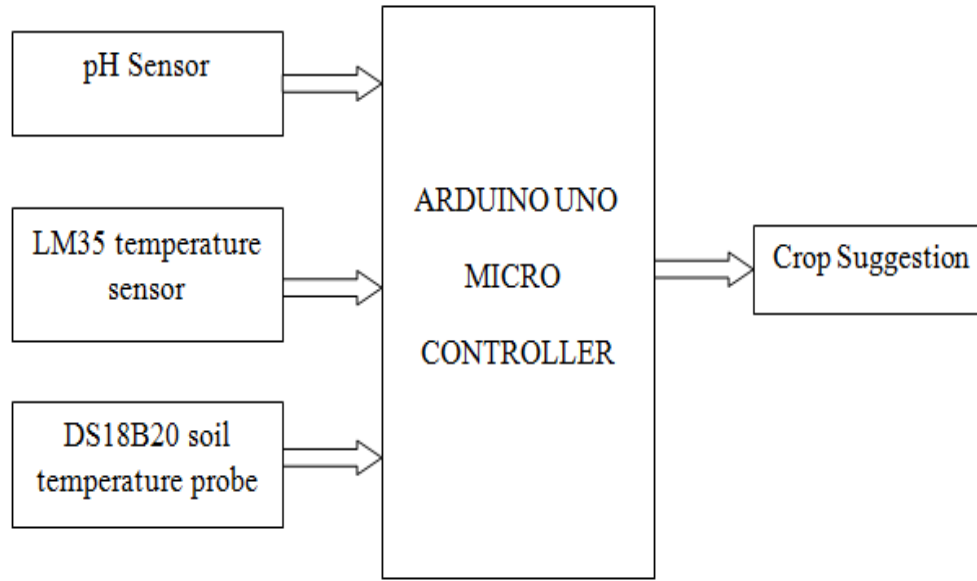


Fig. 3.2: Block diagram for crop suggestion system

Fig 3.2 shows the block diagram for implementing the crop suggestion system. The soil temperature is monitored through a soil probe placed in the soil which will provide us with the temperature data and, the other temperature sensor placed in the field will give the atmospheric temperature. These data are also continuously fed to the micro controller.

3.1.1.3 DATA FOR CROP SUGGESTION

With the necessary data already stored in the controller, the controller on request will search for the crop which can well suit the condition of the field. As a part of proposed work, the system is designed to suggest the crops which are majorly grown in the area of north western part of Tamilnadu.

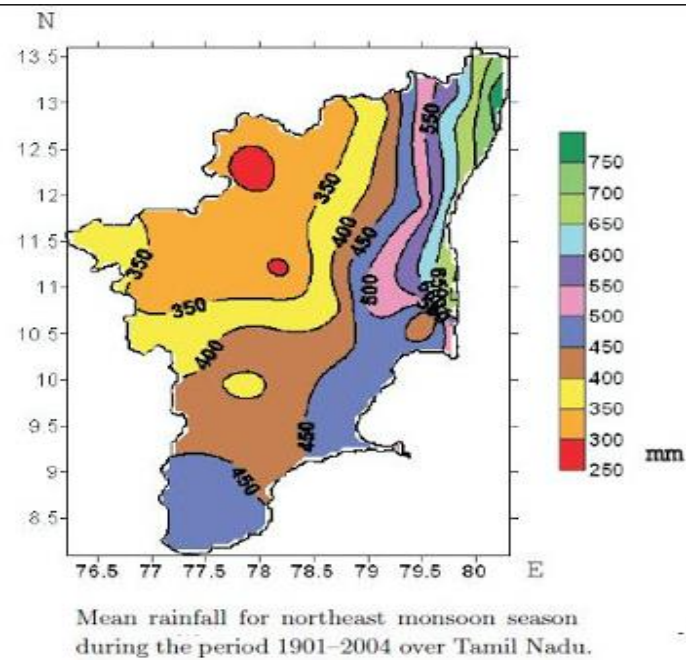


Fig. 3.3 Mean rainfall for monsoon season during 2004

Fig. 3.3 shows the mean rainfall for monsoon season during the year 2004 which clearly depicts the varying range of rainfall in Tamil Nadu. Hence, for better crop suggestion the range of rainfall is a key feature.

The area is classified as

- a) High rainfall region (125 cm to 300 cm rainfall)
- b) Medium rainfall region (75 cm to 125 cm rainfall)
- c) Low rainfall region (40 cm to 75 cm rainfall)

Table 3.1 to 3.3 show the data which was collected to suggest the best crop based on the rainfall in that region.

Table 3.1 Crop data collected for high rainfall region

CROP	SOIL pH	SOIL TEMPERATURE (°C)	ATMOSPHERIC TEMPERATURE (°C)
RICE	5.0 to 6.5	22 to 32	20 to 27
TEA	4.5 to 5.5	20 to 27	10 to 15
COFFEE	4.0 to 7.0	15 to 24	18 to 21
TURMERIC	6.0 to 6.5	20 to 30	20 to 35

Table 3.2 Crop data collected for medium rainfall region

CROP	SOIL pH	SOIL TEMPERATURE (°C)	ATMOSPHERIC TEMPERATURE (°C)
MAIZE	5.8 to 6.8	18 to 27	25 to 38
COTTON	7.5 to 8.5	21 to 30	21 to 37
GROUNDNUT	6.0 to 6.5	27 to 33	27 to 33
SUGARCANE	5.0 to 6.5	21 to 27	19 to 23

Table 3.3 Crop data collected for low rainfall region

CROP	SOIL pH	SOIL TEMPERATURE (°C)	ATMOSPHERIC TEMPERATURE (°C)
SORGHUM	6.0 to 7.5	27 to 35	30 to 35
SESAME	5.5 to 8.0	24 to 32	25 to 29
GRAMS	8.5 to 9.5	25 to 35	28 to 30

For example, When the rainfall region is in high rainfall range and the soil pH is in 5.5 then soil temperature is 25 and atmospheric temperature is 20, then the best crop for that type of condition is coffee, that will be displayed on LCD board connected to the micro controller.

3.1.2 FIELD MONITORING AND CONTROL SYSTEM

The best crop which is planted in the field will be monitored through the entire process of harvesting.

3.1.2.1 NEED FOR FIELD MONITORING AND CONTROL SYSTEM

Better production of crop is not only dependent on selecting the correct crop but also it depends on maintaining the growth enhancing factors like atmospheric temperature, soil moisture and luminescence during the crop growth.

3.1.2.2 IMPLEMENTATION OF FIELD MONITORING AND CONTROL SYSTEM

After selecting the suitable crop as suggested by the controller, the seed is sown in the soil. The fertile, crop production enhancing parameters are kept in the favorable condition. By maintaining these parameters in favorable limit, the crop growth will be enhanced than in traditional method of monitoring the field manually.

The growth enhancing factors will be monitored through the micro controller Arduino Uno which receives data from various sensors. The data from the various field sensors like soil moisture sensor, LM35 sensor, light dependent resistor and soil temperature probe are compared with the already available data and the controller takes necessary actions accordingly.

The real - time collected data is also sent to the ThingSpeak cloud. So that collected data is displayed in the web page channel which has been created and the data will be updated every one hour.

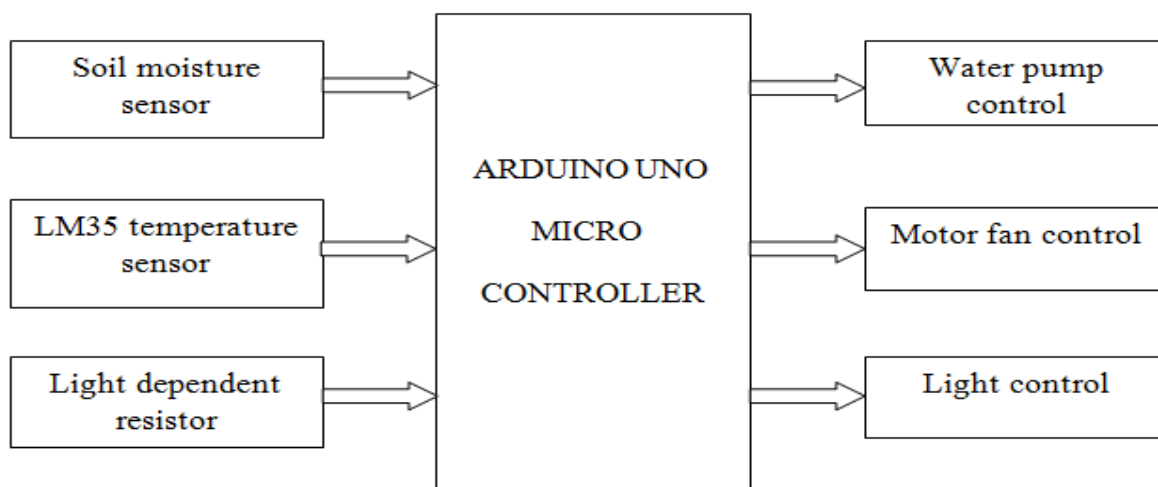


Fig. 3.3 The proposed controlling system

Fig. 3.3 shows the block diagram of the proposed controlling system implemented. The functioning of the system is as follows. If the real - time soil moisture value goes less than the set point, the relay will actuate the water pump to irrigate soil. If the sensed atmospheric temperature reaches the threshold means, the motor fan action will be performed to reduce the temperature of the surrounding. If the monitored solar intensity decreases below the certain range, the light control action takes place to supply the light intensity required by the plant.

Thus the system controls the action on the equipment which is in the field to improve the crop production and plant growth by using the soil and the environmental factors.

3.1.2.2.1 Measuring pH of soil

To measure soil pH, 3 in 1 pH sensor board is used. This pH board is designed using ATMEGA8 IC. While connected to the Arduino Uno, the serial monitor displays the value of soil pH along with the ambient temperature and the intensity of light in the surrounding.

The sensor board has to be calibrated against the solution which has standard pH value. The calibration is done using the standard buffer solution of pH 4 and pH 9.2.

Table 3.4 Standard buffer vs. pH sensor board.

Standard buffer solution value noted in glass electrode	pH sensor board reading
4.1	6.31
9.2	11.22

Let X and Y be the correction factor to obtain correct pH from sensor board

$$4.1 = 6.31X - Y \quad (3.1)$$

$$9.2 = 11.22X - Y \quad (3.2)$$

Solving the equation 3.1 and 3.2 the correction factor is obtained as

$$X = 1.03 \text{ and } Y = 2.4.$$

The value obtained from the sensor board is corrected using the correction factor and that value is used along with the ambient temperature and soil temperature is used to determine the best crop for that soil in that condition.

3.1.2.2.2 MOISTURE CONTENT

Too much water in the field will cause the roots to rot along with that the plant cannot get enough oxygen from soil. This case is not favorable for the profitable plant growth and it does not help in utilizing the available resources in a proper manner. Similarly too little water will result in the not proper absorption of nutrient. Each crop will have its own favorable moisture content to promote its growth. Without proper balance of water, the plants not only become malnourished, but also weak which cannot even support its own weight. In general the plant cannot grow in a healthy manner when the root of the plant is not healthy, so the proper balance of water is the key for growing plants

This emphasizes the need of maintaining the moisture level in the desired level to obtain profitable productivity. In order to maintain the moisture and also to use the resource effectively a moisture sensor is used.

3.1.2.2.3 EFFECT OF SOIL TEMPERATURE ON PLANT GROWTH

Soil temperature affects the germination of seed. If the temperature is too low the seed fails to germinate or the rate of germination will be slower. On other hand when the soil temperature is high, the seed may get injured. The growth of root and absorption of mineral is greatly influenced by the soil temperature. The microbial activity of soil is greatly affected by the soil temperature. Various microbial processes which are necessary for plant growth like nitrogen fixation, pesticide degradation and mineralization of nitrogen are carried out when the temperature is maintained in its optimum level.

Therefore in order to improve the health of plant, it has to be grown in the correct soil temperature.

3.2 WORKING PROCEDURE

The main aspect of the project is suggesting the suitable crop for the soil to the farmer and the continuous monitoring of the crop field by using set of sensors controlled by Arduino controller connected to the ThingSpeak cloud. The crop will be suggested based on soil pH and the temperature of the soil and the atmosphere. The field will be continuously monitored by sensors and the data will be send to cloud and controls the field using actuators like motor fan, water pump etc.,

The hardware of the project is build using the glass door setup to represent a real agricultural field. Inside this setup, the box filled with soil is for the cultivation of the seed. The water pump arrangement and light arrangement is fixed inside the glass setup. A motor fan arrangement is fixed in the one sides of glass cabin to realize cooling mechanism.

The power supply circuit is designed with a bridge rectifier along with voltage regulator to provide constant 5 V supply for Arduino, sensors and other control equipments. When the Arduino powered up the process get initiated.

The first step in our proposed system is to collect the real time data like pH from pH sensor board. The soil and atmospheric temperature are read from the soil temperature probe and LM35 temperature sensor respectively. The collected data is sent to the controller where the Arduino is already programmed with set of database regarding the crop details. The received information is compared with the database values. Based on comparison, the suitable crop for that particular field will be notified to the farmer by displaying the crop through the LCD display. So it is helpful to layman who does not even know about agriculture and soil condition and which crop need to be cultivated in that soil etc.,

The real - time collected data are continuously transmitted to the cloud called ThingSpeak which is open source cloud through Wi-Fi ESP8266 module. The farmer will be notified by the information collected from the field. The data will be updated in the webpage that has been created using the ThingSpeak cloud every one hour. The data is available as tables as well as in graphical form. The stored data will be used for any future references.

The sensor data will be given to the Arduino controller to compare the collected data with the threshold value. Based on the condition, the actuators will be switched ON/OFF to maintain the condition favorable for farming.

CHAPTER 4

HARWARE AND SOFTWARE REQUIREMENTS

4.1 HARDWARE DESCRIPTION

This section discusses the hardware used in this project and a brief specification of the sensors used.

4.1.1 pH SENSOR



Fig. 4.1 pH sensor

The pH sensor used for measuring the concentration of hydrogen ion in soil. There are two electrodes which have to be placed in the soil. The pH of the soil is then available in the transmit pin of the board which has inbuilt microcontroller. This sensor will not require a separate battery arrangement; it will be powered with the microcontroller itself. The baud rate of the sensor is 9600.

4.1.2 MOISTURE SENSOR

When the soil is wet then the soil will conduct current with very less resistance compared to the dry soil. That is resistance of the soil varies inversely with the availability of water. This principle is used in the moisture sensor.

The moisture sensor consists of two probes to measure the volumetric content of water. The probes will allow the current to pass through the soil and it gets the resistance value to measure the moisture content.

The module also has the potentiometer which will set the threshold value which is being compared against the received value in LM393 comparator, which turn on the LED based on the error signal.

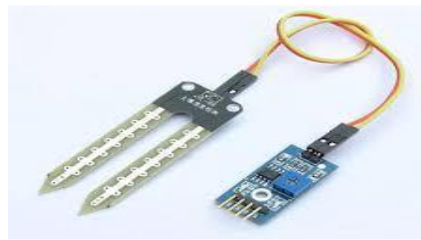


Fig. 4.2 Moisture sensor

The sensor reads the value ranging from 0.6 to 5 V DC based on the moisture level. When the moisture level drops from the normal value then the microcontroller will switch on the pump through a relay and maintain the same condition till the nominal value is reached, then it turn off the pump.

4.1.3 TEMPERATURE SENSOR

4.1.3.1 DS18B20



Fig. 4.3 DS18B20 Soil temperature probe

Fig. 4.3 shows the image of DS18B20 Soil temperature probe. It is a one wire digital temperature sensor which has the accuracy of +/- 0.5. This can measure the temperature ranging from -55 °C to 125 °C. To interface the temperature sensor with the Arduino Uno two header files are required.

- 1-wire bus
- Dallas temperature has to be installed in the software package.

When the temperature read from the sensor is above the threshold value then the pump is turned on and it helps in maintaining the temperature of soil in the required range.

4.1.3.2 LM35



Fig. 4.4 LM35 Temperature sensor

Fig. 4.4 shows the image of LM35 Temperature sensor used. It produces the output voltage proportional to the temperature. The range of the sensor is -55 to 125 in °C. The scale factor is 0.1 V/°C. When the temperature rises above accepted limit microcontroller will switch ON the cooling fan.

4.1.4 ESP8266

ESP 8266 is a low cost Wi-Fi microchip with a microcontroller and full TCO/IP stack. This low cost standalone wireless transceiver that can be used for end point IoT development. This module should be operated on 3.3 V any voltage greater than 3.3 V can damage the module. This module allows a micro controller

to connect to a Wi-Fi network. The ESP 8266 is capable of either hosting an application or offloading all Wi-Fi networking from another application processor.

The modules come with different pin availability option like,

- A) ESP-01 comes with 8 pin (2 GPIO pins), along with a PCB trace antenna.
- B) ESP-02 comes with 8 pin (3 GPIO pins), along with U-FL antenna connector.
- C) ESP-03 comes with 14 pins (7 GPIO pins), along with a ceramic antenna.
- D) ESP-04 comes with 14 pins (7 GPIO pins), and without any antenna.

The module which we are going to use in this project is shown in the Fig. 4.5

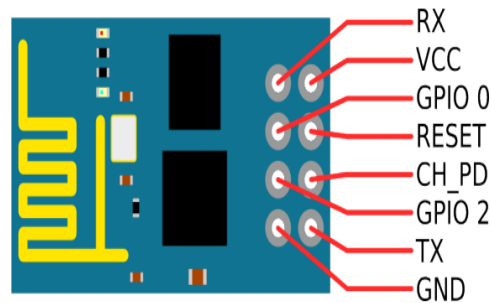


Fig. 4.5 ESP 8266-01 module

This module has a on board 80 MHz low power 32 bit processor which can be used for custom firmware. ESP 8266-01 module consists of 8 pins, 4 in the row of 2. The pins present in ESP 8266 -01 are

- RX - Serial receiver pin of UART
- V_{CC} - 3.3 V power pin
- RESET - Active low reset pin
- CH_PD - Active high enable pin

TX - Serial transmission pin of UART

GPIO0 AND GPIO2 - General purpose I/O pins

The general purpose I/O pins decide the mode (boot or normal) the module start and also decide whether the RX/TX pins are used for programming the module or for serial I/O purpose.

There are three modes of operation of ESP 8266-01

- ACCESS POINT (AP)

The Wi-Fi module acts as a Wi-Fi network, or access point. It allows other device to connect. Establish a two way communication between the ESP 8266 and the device connected to it via Wi-Fi.

- STATION (STA)

The esp-01 can connect to an access point such as the Wi-Fi network. This allows any device connected to that network to communicate with that module.

- BOTH

The Wi-Fi module acts as both an AP as well as in STA mode.

Communication with ESP 8266-01 module with any micro controller will be carried out using the set of AT commands.

Features of ESP 8266-01

- High durability due wide operating condition range.
- Compactness.
- Power saving architecture.

- Low cost, but powerful Wi-Fi module.
- Supports serial communication hence compactable with development platform like Arduino.

4.1.5 SUBMERSIBLE PUMP



Fig. 4.6 Submersible pump

Fig. 4.6 shows the image of the submersible pump used. Submersible Pump is a device which has a hermetically sealed (sealing the object airtight) motor close coupled to the pump body. The whole setup is submerged in the fluid to be pumped.

In order to maintain the moisture content in the model setup a 5 V DC submersible pump is used, which will be triggered by the value read by the moisture sensor.

4.1.6 INCANDESCENT LIGHT

Plant growth is greatly influenced by the light availability, especially the colour red, green and blue will influence the plant growth in a great extend. To ensure the proper availability of the light the incandescent lamp is used. The lamp which is used will be controlled by the LDR module connected to the micro controller.

4.1.7 DC COOLING FAN



Fig. 4.7 DC cooling fan

Fig. 4.7 shows the image of DC Cooling fan. To maintain the optimum temperature for the process of plant growth the DC fan is used. This fan is controlled by the input given to the micro controller by the temperature sensor LM 35.

4.1.8 RELAY

Relays are the primary protection as well as switching devices in most of the control processes or equipments. All the relays respond to one or more electrical quantities like voltage or current such that they open or close the contacts or circuits. As a switching device a relay works to isolate or change the state of an electric circuit from one state to another.

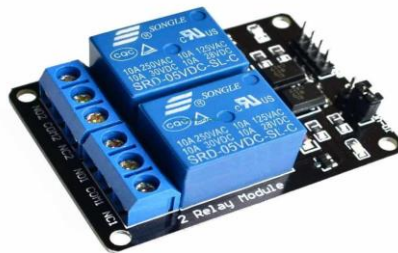


Fig. 4.8 Relay

Fig. 4.8 shows the image of the two channel 5 V relay module. In this project to start the control action such as switching ON/OFF of the DC cooling fan, submersible pump and incandescent light is done through the relay. When the micro controller senses that any enhancing factor is violated then it closes the contacts of relay and which in turn switch on the respective element to maintain the optimum condition for the process of plant growth.

4.1.9 Arduino board

“Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino board is able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online”.

Communication with Arduino board can be established through the Arduino IDE. Because of its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use, yet flexible enough depending on the user needs.

Among many boards in Arduino family, the ARDUINO UNO is the most robust board which can match our requirement. The UNO is the most used and documented board of the whole Arduino family.

Arduino Uno is a micro controller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the micro controller; it can be programmed through the IDE. It can be connected to the computer through a USB A cable. Fig. 4.9 shows the picture of Arduino Uno board used.

Voltage regulator

The Arduino Uno can be powered by USB cable (or) directly supplying 9 - 12 V from the barrel jack. The circuitry operates at 5 V DC which in case input more than that is regulated with the help of 7805 voltage regulator. The voltage regulator is used regulate the voltage supplied to the arduino board and manage it through processor and other elements.

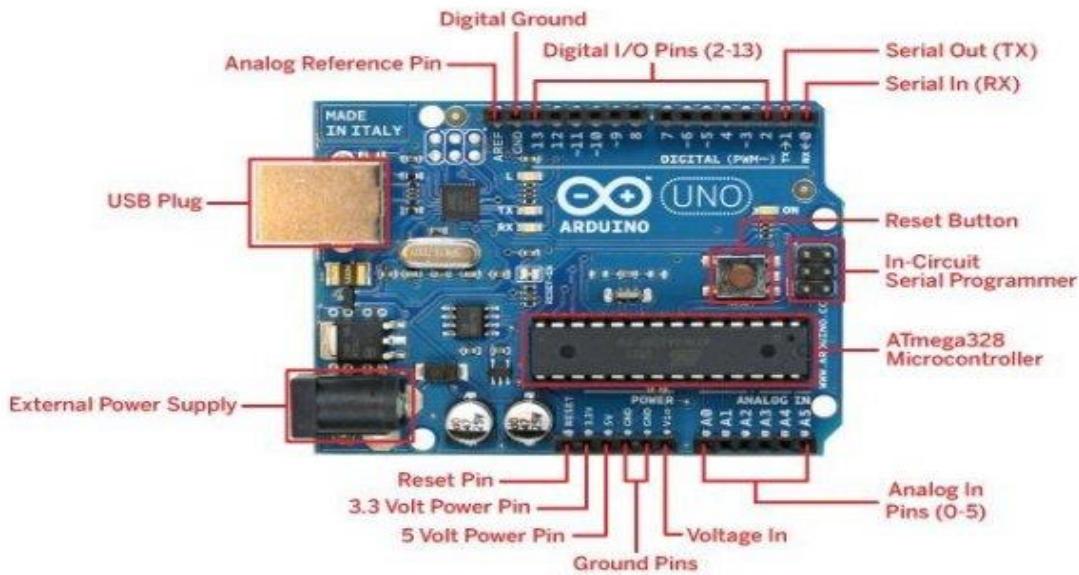


Fig. 4.9 Arduino UNO Board

Crystal Oscillator

There are certain cases when the processor has to deal with time-signal issues, in order to balance it the crystal oscillator are used. The crystal oscillator is the only way the Arduino is able to calculate the time. There is a number printed on the top of the crystal. The number indicates the frequency of the crystal, in most of them the frequency is 16 MHz or 16,000,000 Hz.

Reset Button

There is a reset button given which is used to restart the program running in the Arduino Uno. There are two ways to restart the whole program.

- The default reset button.
- Own reset button at the pin labeled as Reset.

Arduino Uno board General Voltage pins

There are following output voltage pins.

- 3.3 V output pin
- 5 V output pin
- GND (ground)

Most of the Arduino components operate at 5 V or 3.3 V. There are two ground ports which can be used to give ground to your circuit and components. There is a V_{in} pin which can be used to power the Arduino UNO from an external source. The voltage must be 5 V DC in case the Arduino board is powered using external source.

Analog I/O pins

The Arduino UNO board has 6 analog input and output pins from A0 to A5. The pins are best used in case of the analog sensors. The analog pins can read the analog signals from them like temperature, proximity, humidity etc and converts them into digital values that can be read and processed by the microcontroller.

Micro controller in Arduino UNO board

Different Arduino boards have different microcontrollers. It can be said that is the main component in the overall Arduino board. The microcontrollers used basically are of ATMEL Company.

SPI Ports

The SPI (Serial Peripheral Interface) is considered for an expansion of the output. In most of the cases the ICSP Pin as an small programming header in Arduino Uno consist of RESET, SCK, MOSI, MISO, VCC and GND.

Power Indicator LED

When the Arduino UNO board is powered up, there must be an LED light up which will indicate the board is powered up correctly. In case if the glow is not there then it indicate the presence of error in the supply given to the board.

TX and RX Pins

In the Arduino UNO board there are two LED's labeled as TX (transmitter) and RX (Receiver), same are labeled on the pin 0 and 1 respectively. These pins are used for serial communication and the corresponding LED glowing indicated the data is being sent by TX and if the data is being received by RX. The TX LED flashes at the different frequency which depends on the baud rate being used by the Arduino board to transmit.

Digital I/O pins

Arduino UNO board does have 14 digital I/O pins (input/output pins) out of which contains 6 PWM output (Pulse width modulation). The digital pins can be configured to read logic values such as 0 and 1 or can give logic (0 and 1) output for different modules such as LEDs, Relays, etc. there is a symbol “~” corresponding to the PWM pins. Additionally there is AREF which is used to set an external reference voltage as the upper limit to the analog input pins. The external reference voltage is usually in between 0 to 5 volts.

4.1.10 LDR

A photo resistor or light dependent resistor is a component that is sensitive to light. The resistance of the component changes with the amount of intensity of light which fall on the module. Values of the resistance of the LDR may change over many orders of magnitude the value of the resistance falling as the level of light increases. The value of resistance can be in range of Mega-ohm in darkness to few hundred ohms when illuminated by a source. With such a wide variation in resistance, LDRs are easy to use. Fig. 4.10 shows the LDR characteristics and LDR Module.

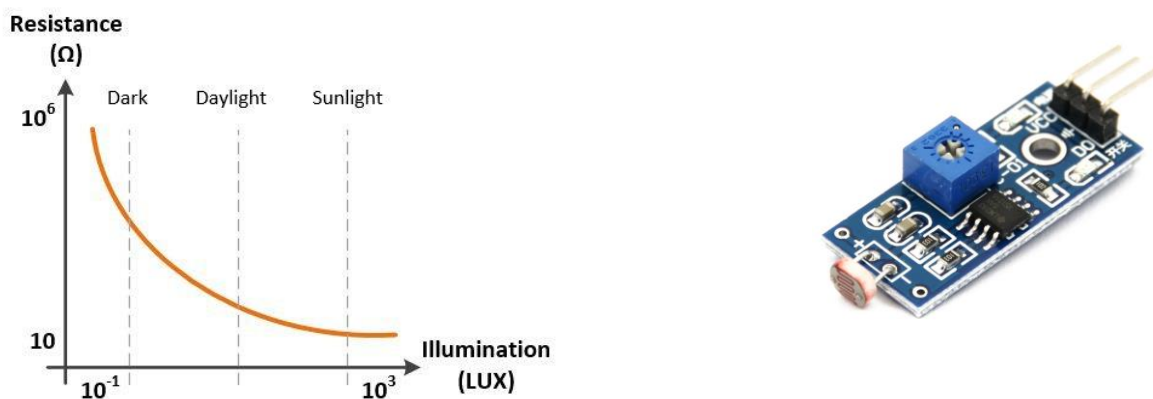


Fig. 4.10 LDR Module and its characteristics

The healthy plant growth is greatly influenced through the light availability as the process of photosynthesis is greatly influenced through the light, hence maintaining the optimum amount of illumination pave the way for better plant growth.

In order to ensure the availability of proper illumination LDR module is connected to the micro controller board, when the threshold value is violated then the micro controller will turn ON the lamp to provide better illumination.

PIN CONFIGURATION OF LDR MODULE

- Input Voltage: DC 3.3 V to 5 V
- Output: Analog and Digital
- Sensitivity adjustable

4.2 INTERFACING PROCESS FOR CROP SUGGESTION SYSTEM

This part explains about the interfacing of various sensors involved in crop suggestion.

4.2.1 INTERFACING OF pH SENSOR WITH ARDUINO UNO BOARD

For suggesting the suitable crop for the particular field, the pH value is very important factor. The pH value of the field is obtained through the pH sensor. Interfacing of pH board with Arduino microcontroller is given below,

Pins in pH sensor board	Pins in micro controller
V _{CC}	5 V pin
GND	GND
Rx	Rx
Tx	Tx

As the pH sensor board has inbuilt micro controller the Arduino will start to read its value just by simply connecting receive and transmit pin of pH sensor board to receive and transmit pin of Arduino board, along with the power supply pins.

4.2.2 INTERFACING OF ONE WIRE TEMPERATURE SENSOR WITH ARDUINO UNO BOARD

The one wire temperature sensor used to collect the soil temperature to suggest the best crop which suits the natural environment. The sensor data is read, and through a micro controller the best crop is suggested.

Pin in temperature sensor	pin in Arduino micro controller
V _{CC}	5 V
GND	GND
Data	D0 (Digital pin)

4.2.3 INTERFACING OF LM 35 WITH ARDUINO UNO BOARD

Interfacing LM 35 with Arduino board is important for suggesting the best crop for that environment, the interfacing of LM 35 to Arduino UNO is done in the following way

Pins in LM 35	Pins in micro controller
V _{CC}	5 V
GND	GND
Data	A1 (Analog pin)

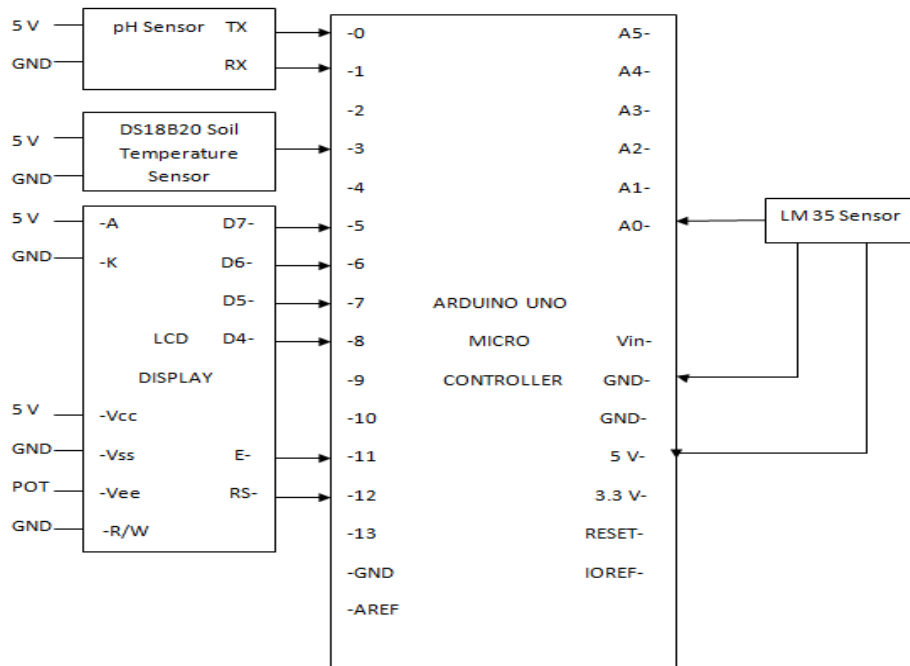


Fig. 4.11 Interfacing for crop suggestion system

Fig. 4.11 shows overall interfacing connection of the crop suggestion system using Arduino Uno.

4.3 INTERFACING PROCESS FOR GROWTH ENHANCING FACTOR CONTROL

The plant growth enhancing factors had to be monitored continuously and they should be maintained within the favorable limit, for that the sensor mounted on the field should be maintained within the acceptable limit for enhancing the plant growth. Hence interfacing the field sensor with the micro controller is important.

4.3.1 INTERFACING OF MOISTURE SENSOR MODULE WITH ARDUINO UNO BOARD

The moisture sensing probe is to be buried in the soil and the sensing module has to be connected to the Arduino board as

Pins in moisture sensor	Pins in micro controller
V _{CC}	5 V
GND	GND
AN	A0

4.3.2 INTERFACING LDR WITH ARDUINO UNO BOARD

To maintain the illumination in the appreciable limit the LDR module in the field is helpful. The interfacing of LDR with the microcontroller is done as

Pins in LDR module	Pins in micro controller
V _{CC}	5 V
GND	GND
AN	A1

4.3.3 INTERFACING RELAY WITH ARDUINO UNO BOARD

The control action involves in switching ON/OFF of pump, cooling fan and light source. For this action to be done the relay is used. The interfacing of relay with Arduino is as shown in Fig. 4.12. The pin A and B of relay is connected to micro controller whereas the pins N/O and Comm. pins are connected to actuate control action.

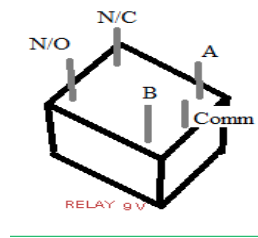


Fig. 4.12 Relay pin diagram

4.3.4 INTERFACING OF ESP 8266-01 WITH ARDUINO UNO BOARD

Interfacing ESP 8266-01 with Arduino board will allow the micro controller board to send data to the ThingSpeak cloud, interfacing will be like.

Pins in ESP 82660-01	Pins in micro controller
V _{CC}	3.3 V
GND	GND
CH_PD	3.3 V
GPIO0	GND
TX	TX
RX	RX

4.4 POWER SUPPLY CIRCUIT DESIGN:

Regulated power supply is an electronic circuit that is designed to provide a constant dc voltage of predetermined value across load terminals irrespective of ac mains fluctuations or load variations. All low power system can be run with a battery. But, for a long time operating devices, batteries could prove to be costly

and complicated. The best method used is in the form of an unregulated power supply – a combination of a transformer, rectifier and a filter.

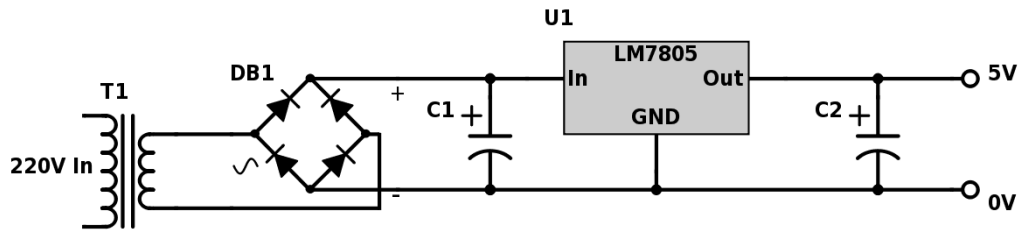


Fig. 4.13 Power supply circuit

As shown in the Fig. 4.13, a small step down transformer is used to reduce the voltage level to the devices needs. In India, a 1 - \emptyset supply is available at 230 volts. The output of the transformer is a sinusoidal AC voltage, which is converted to pulsating DC with the help of a rectifier. This output is given to a filter circuit which reduces the AC ripples, and passes the DC components.

4.4.1 HEAT SINK:

A heat sink is a piece of metal engineered to dissipate the maximum thermal energy into the ambient surroundings. It assists a component to remain below its maximum operating junction temperature by drawing this energy away, thereby preventing damage through excessive temperatures.

All electronic components dissipate heat, and usually their package (body) is sufficient to dissipate it into the surroundings, however voltage regulators such as a 7805, 7812, LM317T, require assistance if they are to operate to their extreme limits.

HEAT SINK CALCULATION:

CALCULATING POWER DISSIPATION:

The power dissipation of the regulator is very simple to calculate using the standard formula for current multiplied by voltage.

$$P_D = (V_{in} - V_{out}) * I_{out}$$

CALCULATING Θ_{JA} (TOTAL):

Θ_{JA} (TOTAL) = Total junction-to-ambient thermal resistance

T_J = Junction Temperature

T_A = Ambient Temperature

P_D = Power Dissipation

CALCULATING HEAT SINK SIZE:

The heat sink-to-ambient thermal resistance is θ_{SA} , which the following formula calculates, and since we have all the pertinent values, we can plug them in. This is the value you need when selecting a heat sink. In our case, we are in need of 5 V constant DC supply, hence,

Power dissipation, $P_D = (V_{in} - V_{out}) * I_{out}$

$$= (12 - 5) * 1$$

$$= 7 \text{ W}$$

$$\Theta_{JA}(\text{TOTAL}) = (T_j - T_a) / P_D$$

$$= (125 - 27) / 7 = 14 \text{ }^\circ\text{C/W}$$

Hence, 14 °C/W heat sink is sufficient to control the temperature heat loss.

4.5 SOFTWARE IMPLEMENTATION

The software part which is used in our project is discussed as follows:

4.5.1 ARDUINO PROGRAMMING

Arduino software is open source software, which can be easily downloaded in the Arduino website. Programming is done in the high level language which makes it easy to understand.

The following are some special functions used in our project,

- `lcd.setCursor()` - Position the LCD cursor, which set the location at which subsequent text written to the LCD will be displayed.
- `lcd.print()` - Position the LCD cursor, which set the location at which subsequent text written to the LCD will be displayed.
- `sensors.requestTemperature()` - Will request the sensor to start the measurement. The measurement does not happen instantly, it may take up to 750ms to get the result.
- `sensors.getTempCByIndex()` - Calculate temperatures in Celsius. The sensor actually is calibrated to work in Celsius. The function returns float values, which may be readily used in other program logic.
- `Serial.parseFloat()` - Returns the first valid floating point number from the Serial buffer.

To interface one wire temperature sensor, ESP 8266, and LCD display some extra header files are needed. They are,

- SoftwareSerial.h
- ThingSpeak.h
- OneWire.h
- DallasTemperature.h
- ESP8266WiFi.h
- LiquidCrystal.h

4.5.2 ThingSpeak

“ThingSpeak is an IoT analytics platform service that allows user to aggregate, visualize, and analyze live data streams in the cloud. User can send data to ThingSpeak from your devices, create instant visualizations of live data, and send alerts using web services. With MATLAB analytics inside ThingSpeak”. It has the ability to collect, analyze and trigger.

Collect – Can send sensor data privately to the cloud

Analyze – Can visualize your data with MATLAB

Act – Can trigger a reaction based on user need

ThingSpeak offers free data storage and analysis of time-stamped numeric or alphanumeric data. Users can access ThingSpeak by creating a ThingSpeak user account. ThingSpeak will not consider the type of micro controller if the controller is networked; this gives flexibility to choose any kind of micro controller based on the user need. Reading and writing in a ThingSpeak channel is done through the sequence of unique alphanumeric character generated after the channel creation. There is a separate API keys for reading and writing the data.

4.5.2.1 CREATION A NEW ThingSpeak CHANNEL

Creation of a channel is necessary for working in ThingSpeak. While creating a new channel the channels name along with its description is to be given in the web page. Each channel can contain about eight field data which can be used for monitoring, while creating a channel extra information such as the location of the field can also be included. After creating a channel a new window with the following tabs will appear on the screen. Fig. 4.14 shows how to create a new channel in ThingSpeak

- **Private View:** This tab displays information about a channel that only created user can see.
- **Public View:** This tab displays the information which are available in public viewing
- **Channel Settings:** This tab shows all the channel options which was set at creation.

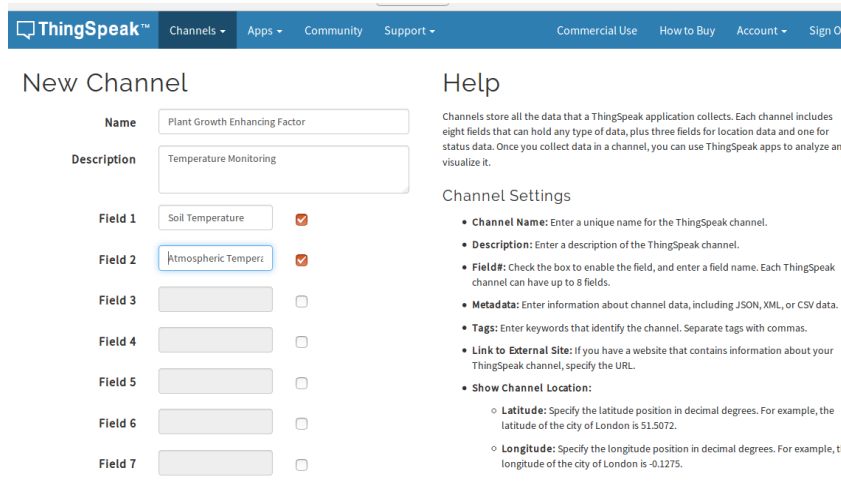


Fig. 4.14 New channel creation in ThingSpeak

- **Sharing:** This tab shows channel sharing options. A channel can be set as private, shared with everyone (public), or shared with specific users.
- **API Keys:** This tab displays channel API keys. We need the keys to read from and write to your channel.
- **Data Import/Export:** This tab enables to import and export channel data.

CHAPTER 5

RESULT AND DISCUSSION

5.1 SUMMARY OF RESULT

This section provides the results of the crop suggestion and its growth monitoring in graphical form.

5.1.1 OUTPUT OF CROP SUGGESTION

The suitable crop is suggested through the pH sensor, soil temperature probe and temperature sensor which are interfaced with the Arduino. The programming of Arduino Uno is done through the Arduino IDE. The output obtained by interfacing these sensors with Arduino will suggest a suitable crop for that soil.

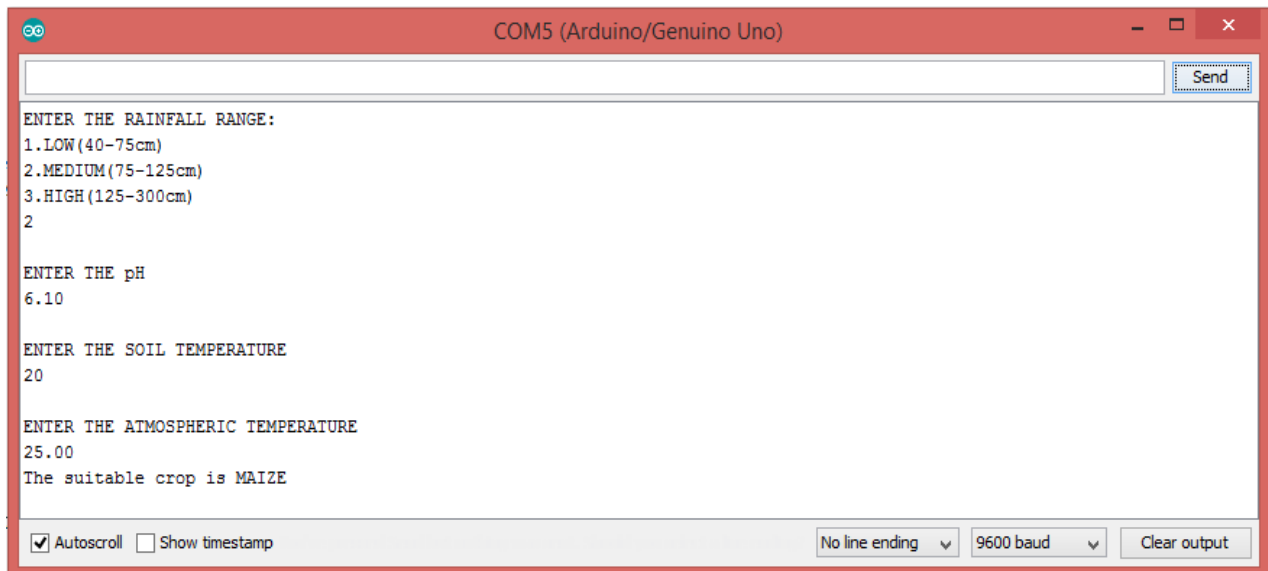


Fig. 5.1 Serial monitor output of crop suggestion system

Fig 5.1 shows the serial monitor output when sensors are interfaced for the purpose of crop suggestion.

The prevailing condition in the setup is

- pH of the soil sample taken 6.1
- Soil temperature monitored 20
- Atmospheric temperature monitored 25

For the condition prevailing in the hardware setup, the best crop which suits is displayed through the LCD display as shown in Fig. 5.2.



Fig. 5.2 LCD display of suitable crop

5.1.2 MONITORING GROWTH ENHANCEMENT FACTOR

This part discusses about the process of monitoring the plant growth enhancement factor and makes them to present in the favorable condition.

5.1.2.1 MAINTAINING MOISTURE CONTENT

For the best crop suggested here the favorable moisture content is 40%, so that condition is maintained.

The conditions to turn ON and OFF the pump are:

- Moisture value $> 40\%$, Turn OFF the pump.
- Moisture value $< 40\%$, Turn ON the pump.

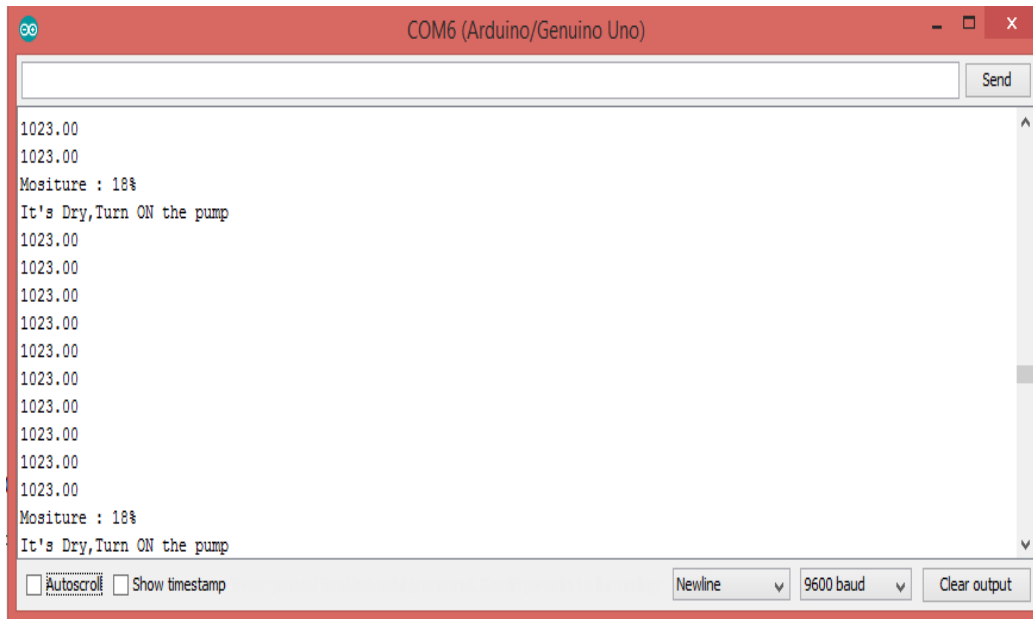


Fig. 5.3 Serial monitor output for moisture control

Fig. 5.3 shows the serial monitor output when interfaced with moisture sensor and relay. The water pump control will be provided to irrigate the soil whenever it dries and automatically turn OFF when it reaches its threshold value, so that the field will be remains wet favorable for field to get good yield.

5.1.2.2 MAINTAINING ATMOSPHERIC TEMPERATURE

The favorable condition of atmospheric temperature to promote maize growth is 27 °C, so that condition is maintained through the process.

The conditions to turn ON/OFF the fan are:

- Temperature > 27 °C, Turn ON the fan.
- Temperature < 27 °C, Turn OFF the fan.

The dc motor fan control is there to regulate the temperature within the range to maintain the environment normal to grow the crops. The fan will automatically switch OFF when it reaches below the set point.

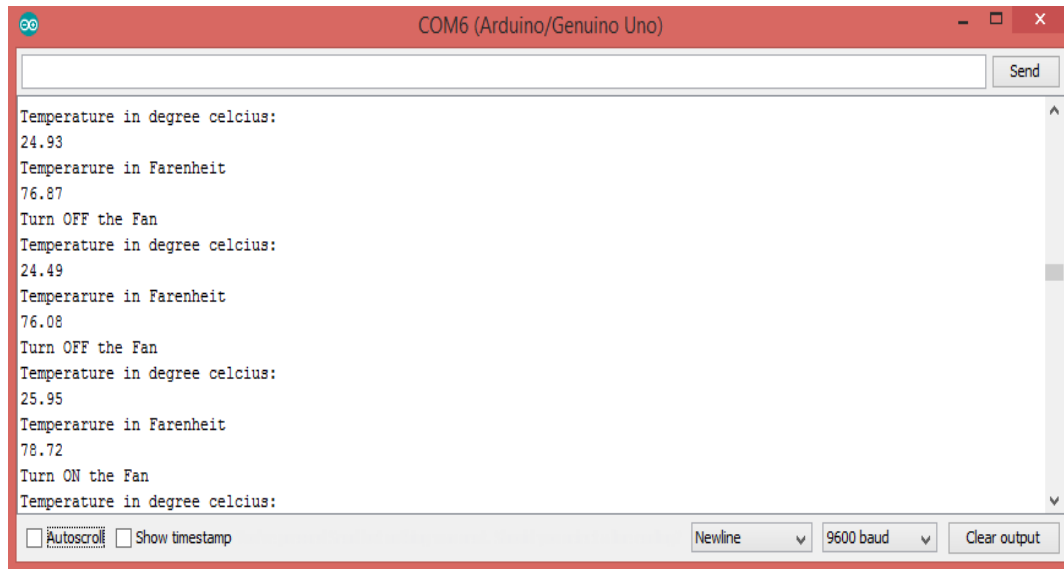


Fig. 5.4 Serial monitor output for temperature control

Fig. 5.4 shows the output of serial monitor when interfaced with temperature sensor and relay to maintain the optimum atmospheric temperature..

5.1.3 GRAPHICAL FORM OF DATA STORED IN THE CLOUD

The serial monitor output while connecting a Wi-Fi module to the Arduino board is shown in Fig. 5.5.

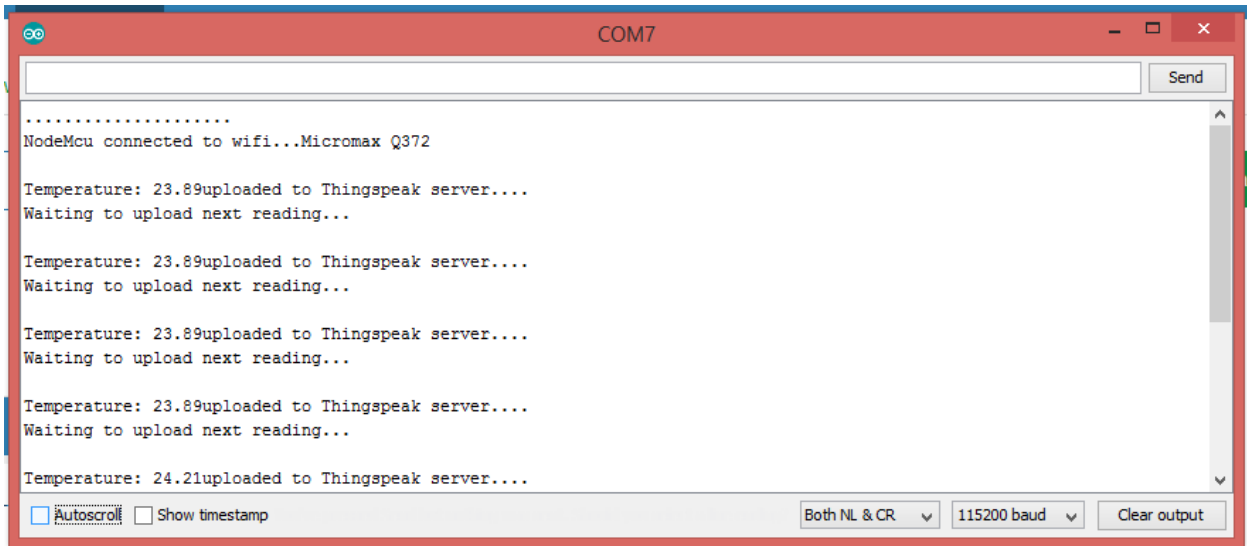


Fig. 5.5 Serial monitor output of transmitted data

The environmental condition prevailing during the entire process of plant growth is send to ThingSpeak cloud, the data which send to the cloud is shown in the graphical format. Fig. 5.6 shows the graphical representation of temperature data in ThingSpeak cloud.

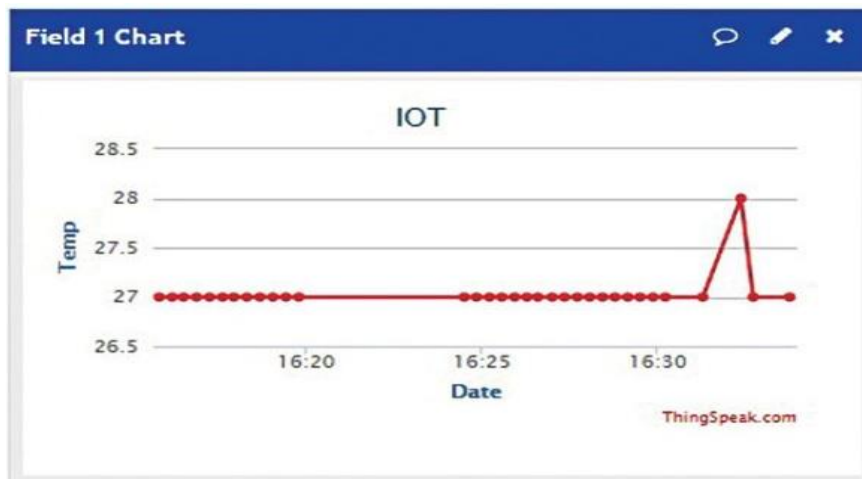


Fig. 5.6 Data stored in ThingSpeak cloud

CHAPTER 6

CONCLUSION

One of major challenges faced today is to ensure the production of agricultural crop, which suits the natural environment and uses the minimal resources and to guarantee the maximum yield with the available resources. In traditional agricultural method, the depleting natural resources are not utilized properly. The need for proper utilization of resources is due to exponential growth of population and reduction in availability of agricultural land.

Hence this project's outcome is the design and development of a system that suggest the best crop which suit the prevailing environment condition. Also the crop growth is enhanced by maintaining the optimum condition in the land through continuous monitoring. The data collected over the period of crop growth is sent to the ThingSpeak cloud, which can be used in future for training the machine.

6.1 FUTURE WORK

This project can be further extended by incorporating the various sensors at various part of the field for accurate control. The data stored in the cloud can be used to train the system which will predict the total harvest before the end of the harvest season, using the condition prevailing during the plant growth.

APPENDIX I

PROGRAM FOR CROP SUGGESTION SYSTEM

```
// CROP SUGGESTION SYSTEM
```

```
#include <LiquidCrystal.h>
```

```
#include <OneWire.h>
```

```
#include <DallasTemperature.h>
```

```
#define ONE_WIRE_BUS 5
```

```
OneWire oneWire(ONE_WIRE_BUS);
```

```
DallasTemperature sensors(&oneWire);
```

```
// Soil Probe Parameters
```

```
float Celcius=0;
```

```
// LM35 Sensor Parameters
```

```
const int sensor = A1;
```

```
const int ledPin1 = 9;
```

```
float tempc;
```

```
float v_out;
```

```
// Crop Suggesting Parameters
```

```
int rainfall, soilTemperature, atmTemperature;
```

```

float pH;
String Crop;

const int rs=12,en=11,d4=5,d5=4,d6=3,d7=2;
LiquidCrystal lcd(rs,en,d4,d5,d6,d7);

void setup(void)
{
Serial.begin(9600);
sensors.begin();
pinMode(sensor, INPUT);
delay(500);
Serial.print("ENTER THE RAINFALL RANGE:");
Serial.print("\n1.LOW(40-75cm)\n2.MEDIUM(75-125cm)\n3.HIGH(125-
300cm)");
while(Serial.available()<=0)
{
}
rainfall = Serial.parseInt();
Serial.print("\nENTER THE pH");
while(Serial.available()<=0)
{
}
pH = Serial.parseFloat();
Serial.println(pH);

```

```

// Soil Probe Temperature
Serial.print("\nENTER THE SOIL TEMPERATURE");
sensors.requestTemperatures();
Celcius = sensors.getTempCByIndex(0);
Fahrenheit = sensors.toFahrenheit(Celcius);
Serial.print("Soil Temperature in celcius: ");
Serial.print(Celcius);

// LM35 Temperature
Serial.print("\nENTER THE ATMOSPHERIC TEMPERATURE");
Serial.println("Atm. Temperature in celcius: ");
v_out = analogRead(sensor);
v_out = tempc * 0.48828125;
tempc = v_out;
Serial.println(tempc);
// Delay for 1 second
delay(1000);

// LCD Initialization
lcd.begin(16,2);
// Region Detection
if (rainfall == 1)
{
    lowRainfall();
}

```

```

}
else if (rainfall == 2)
{
    mediumRainfall();
}
else if (rainfall == 3)
{
    highRainfall();
}
lcd.setCursor(0,1);
lcd.print("Best Crop:");
lcd.println(Crop);                // Printing Suitable Crop on LCD
delay(500);
}
void loop()
{
}
// Low Rainfall Region Crops
void lowRainfall()
{
    int count1 = 0;
    if (pH>=6 && pH<=7.5)
    {
        if (soilTemperature>=27 && soilTemperature<=32)
        {

```

```

if (atmTemperature>=30 && atmTemperature<=35)
{
    Crop = "SORGHUM";
    count1 = 1;
}
}
}
else if (pH>=8.5 && pH<=9.5)
{
    if (soilTemperature>=25 && soilTemperature<=35)
    {
        if (atmTemperature>=28 && atmTemperature<=30)
        {
            Crop = "GREENGRAM";
            count1 = 1;
        }
    }
}
else if (pH>=5.5 && pH<=8)
{
    if (soilTemperature>=24 && soilTemperature<=32)
    {
        if (atmTemperature>=25 && atmTemperature<=29)
        {
            Crop = "SESAME";

```

```

        count1 = 1;
    }
}
}
If (count1 ==0)
{
    Crop = "CASTOR";
}
}
// Medium Rainfall Region Crops
void mediumRainfall()
{
    int count2 = 0;
    if (pH>=6 && pH<=6.8)
    {
        if (soilTemperature>=21 && soilTemperature<=26)
        {
            if (atmTemperature>=21 && atmTemperature<=24)
            {
                Crop = "WHEAT";
                count2 =1;
            }
        }
    }
    else if (pH>=5 && pH<=6.5)

```

```

{
  if (soilTemperature>=21 && soilTemperature<=27)
  {
    if (atmTemperature>=19 && atmTemperature<=23)
    {
      Crop = "SUGARCANE";
      count2 = 1;
    }
  }
}
else if (pH>=7.5 && pH<=8.5)
{
  if (soilTemperature>=21 && soilTemperature<=30)
  {
    if (atmTemperature>=21 && atmTemperature<=37)
    {
      Crop = "COTTON";
      count2 = 1;
    }
  }
}
else if (pH>=6 && pH<=6.5)
{
  if (soilTemperature>=27 && soilTemperature<=33)
  {

```

```

if (atmTemperature>=27 && atmTemperature<=33)
{
    Crop = "GROUND NUT";
    count2 = 1;
}
}
}
else if (pH>=5.8 && pH<=6.8)
{
    if (soilTemperature>=18 && soilTemperature<=27)
    {
        if (atmTemperature>=25 && atmTemperature<=38)
        {
            Crop = "MAIZE";
            count2 = 1;
        }
    }
}
if (count2 == 0)
{
    Crop = "PEAS";
}
}
// High Rainfall Region Crops
void highRainfall()

```



```

{
int count3 = 0;
if (pH>=5 && pH<=5.5)
{
if (soilTemperature>=22 && soilTemperature<=32)
{
if (atmTemperature>=20 && atmTemperature<=22)
{
Crop = "RICE";
count3 = 1;
}
}
}
else if (pH>=4.5 && pH<=5.5)
{
if (soilTemperature>=20 && soilTemperature<=27)
{
if (atmTemperature>=10 && atmTemperature<=15)
{
Crop = "TEA";
count3 = 1;
}
}
}
else if (pH>=4 && pH<=7)

```

```

{
  if (soilTemperature>=15 && soilTemperature<=24)
  {
    if (atmTemperature>=18 && atmTemperature<=21)
    {
      Crop = "COFFEE";
      count3 = 1;
    }
  }
}
else if (pH>=6 && pH<=6.5)
{
  if (soilTemperature>=20 && soilTemperature<=30)
  {
    if (atmTemperature>=20 && atmTemperature<=35)
    {
      Crop = "TURMERIC";
      count3 = 1;
    }
  }
}
if (count3 == 0)
{
  Crop = "BANANA";
}}

```

APPENDIX II

PROGRAM FOR CROP MONITORING SYSTEM USING ARDUINO

```
// CROP MONITORING SYSTEM
```

```
// Moisture Control Parameters
```

```
int moistureInputpin = A0;
```

```
int moistureOutput;
```

```
int minMoisture = 10, maxMoisture = 60;
```

```
int pump = 8, pumpSpeed;
```

```
float avgMoisture, bufM[10];
```

```
// Temperature Control Parameters
```

```
const int sensor = A1;
```

```
const int ledPin1 = 9;
```

```
float tempc;
```

```
float tempf;
```

```
int tempmin = 30, tempmax = 70;
```

```
float v_out;
```

```
// LDR Control Parameters
```

```
const int ldrPin = A2;
```

```
const int ledpin2 = 10;
```

```

void setup()
{
  Serial.begin(9600);
  delay(500);
  pinMode(ldrPin, INPUT);
  pinMode(ledPin1, OUTPUT);
  pinMode(sensor, INPUT);
  pinMode(ledpin2, OUTPUT);
}

void loop()
{
  moistureRelay();
  ldrRelay();
  temperature_relay();
  delay(3000);
}

// Relay Control of Moisture Sensor
void moistureRelay()
{
  moistureCalibration();
  if(moistureOutput <= minMoisture)
  {
    digitalWrite(pump,HIGH);
    delay(6000);
  }
}

```

```

}
else if((moistureOutput >= minMoisture) && (moistureOutput <= maxMoisture))
{
    digitalWrite(pump,LOW);
}
delay(3000);
}
// Calibration of Moisture Sensor
void moistureCalibration()
{
    for(int i = 0; i < 10; i++)
    {
        bufM[i] = analogRead(moistureInputpin);
        Serial.println(bufM[i]);
        avgMoisture = 0;
        avgMoisture = avgMoisture + bufM[i];
    }
    avgMoisture = avgMoisture/10;
    moistureOutput = map(avgMoisture,125,0,0,100);
    Serial.print("Moisture : ");
    Serial.print(moistureOutput);
    Serial.println("%");
    delay(1000);
}
// Relay Control for Temperature Sensor

```

```

void temperature_relay()
{
  temperature_calibration();
  if(tempc < tempmin)
  {
    digitalWrite(ledpin2,LOW);
  }
  if((tempc >= tempmin) && (tempc <= tempmax))
  {
    fanspeed = map(tempc,tempmin,tempmax,0,100);
    Serial.println("Fan speed:");
    Serial.println(fanspeed);
    digitalWrite(ledpin2,HIGH);
  }
  delay(3000);
}

// Calibration of Temperature Sensor
void temperature_calibration()
{
  Serial.println("Temperature:");
  v_out = analogRead(sensor);
  v_out = tempc * 0.48828125;
  tempc = v_out;
  Serial.println(tempc);
  tempf = (v_out*1.8)+32;

```

```

Serial.println(tempf);
}
// Relay Control of LDR
void ldrRelay()
{
ldr_calibration();
if (ldrStatus <= 500)
{
digitalWrite(ledPin1, LOW);
Serial.print("Its DARK, Turn on the LED : ");
Serial.println(ldrStatus);
}
else
{
digitalWrite(ledPin1, HIGH);
Serial.print("Its BRIGHT, Turn off the LED : ");
Serial.println(ldrStatus);
}
delay(3000);
}
// Calibration of LDR
void ldr_calibration()
{
int ldrStatus = analogRead(ldrPin);}

```

APPENDIX III

PROGRAM FOR TEMPERATURE SENSING USING ESP8266 MODULE

```
#include <ESP8266WiFi.h>

String apiWritekey = "JT7CGBOJ9BLV4S1U"; // Write your API Key
const char* ssid = "xxxxxxxxxx"; // Write your Wi-Fi Name
const char* password = "xxxxxxxxxx" ; // Write your Wi-Fi Password
const char* server = "api.thingspeak.com";
float resolution=3.3/1023;
WiFiClient client;

void setup() {
  Serial.begin(115200);
  WiFi.disconnect();
  delay(10);
  WiFi.begin(ssid, password);
  Serial.println();
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print("."); }
}
```



```

Serial.println("");
Serial.print("NodeMcu connected to wifi...");
Serial.println(ssid);
Serial.println();
}

void loop() {
  float temp = ((analogRead(A0) * resolution) * 100)+23.89;
  if (client.connect(server,80)) {
    String tsData = apiWritekey;
    tsData += "&field1=";
    tsData += String(temp);
    tsData += "\r\n\r\n";

    // Updating Temperature value to ThingSpeak Cloud
    client.print("POST /update HTTP/1.1\n");
    client.print("Host: api.thingspeak.com\n");
    client.print("Connection: close\n");
    client.print("X-THINGSPEAKAPIKEY: "+apiWritekey+"\n");
    client.print("Content-Type: application/x-www-form-urlencoded\n");
    client.print("Content-Length: ");
    client.print(tsData.length());
    client.print("\n\n");
    client.print(tsData);
  }
}

```

```
// Printing Temperature Value in Serial Monitor
Serial.print("Temperature: ");
Serial.print(temp);
Serial.println("uploaded to Thingspeak server....");
}
client.stop();
Serial.println("Waiting to upload next reading...");
Serial.println();
delay(15000); // Delay of 15 seconds
}
```

REFERENCES

- [1] K. Lakshmisudha, Swathi Hegde, Neha Kale, Shruti Iyer, “Smart Precision based Agriculture using Sensors”, International Journal of Computer Applications (IJCA), July 2016
- [2] V. Vinoth Kumar, R. Ramasamy, S. Janarthanan, M. VasimBabu, “Implementation of IoT in Smart Irrigation System using Arduino Processor”, International Journal of Civil Engineering and Technology (IJCET), October 2017
- [3] Gautam A. Bhoge, Swapnil A. Afre, Yogesh S. Gatkal, “Wireless Agriculture Monitoring using Raspberry Pi” International Journal of Engineering Research and Technology (IJERT), May 2017
- [4] Himanshu Gupta, Vinita Pareek, Richman Mishra, Lavanya K, “Automated Precision Farming using IoT” International Journal of Advanced Research in Computer Engineering and Technology (IJARCET), May 2017
- [5] Sandip Rukhmode, Gayatri Vyavhare, Sharda Banot, “IoT Based Agriculture Monitoring System using WEMOS”, International Conference on Emanations in Modern Engineering Science and Management (ICEMESM), 2017
- [6] Abhinayalalitha K, Ramadoss P, “Arduino based Agriculture Monitoring System using Mobile Applications”, International Research Journal of Engineering and Technology (IRJET), May 2017
- [7] Dr. Shaik Nasser, “Smart Agriculture using IoT”, International Research Journal in Advanced Engineering and Technology (IRJAET), 2017
- [8] <http://www.arduino.org/products/boards/arduino-uno/>
- [9] http://www.thingspeak.com/pages/how_to#act
- [10] http://rancidbacon.com/files/kiwicon8/ESP8266_WiFi_Module_Quick_Start_Guide_v_1.0.4