1. INTRODUCTION

1.1 OVERVIEW

AGRICULTURAL SOIL MONITORING is a process and effort to overcome the problem faced by farmers. The propose system is to make soil testing easer for famers by making a portable setup which can be used anywhere by not going to visit labs and could be affordable.

A soil test is important for several reasons: to optimize crop production, to protect the environment from contamination by runoff and leaching of excess fertilizers, to aid in the diagnosis of plant culture problems, to improve the nutritional balance of the growing media and to save money and conserve energy by applying only the amount of fertilizer needed. Pre- plant media analyses provide an indication of potential nutrient deficiencies, pH imbalance or excess soluble salts. This is particularly important for growers who mix their own media. Media testing during the growing season is an important tool for managing crop nutrition and soluble salts levels.

NEED FOR IMPROVEMENT IN ARDUINO

India is an agricultural country. India ranks second worldwide in farm output. At present, farmers have to get to soil testing labs to get their soil tested for macro-nutrients which are Nitrogen, Phosphorus and Potassium. For which they have to travel to other districts as in Telangana there are only 5 government laboratory's which perform soil testing. And the existing system which could perform such test is expensive so by this proposed system we are trying to saving the time and money which cost farmers to travel laboratory or to by the buy the expensive equipment.

1.2 FEATURES OF AGRICULTURAL SOIL MONITORING

- To overcome the problem to "Soil test for macro-nutrients".
- Get the results instantly.
- Cost efficient.

1.3 ADVANTAGES OF AGRICULTURAL SOIL MONITORING

- The aim of this project is to reduce the time take to travel to laboratory's.
- Easy to operate and instant results
- Highly portable

1.3.1 ARDUINO MEGA BOARD

Arduino is a software company, project, and user community that designs and manufactures computer open-source hardware ,open-source software, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices .

The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can interface to various expansion boards (termed *shields*) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment(IDE) based on a programming language named *Processing*, which also supports the languages C and C++.

The first Arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

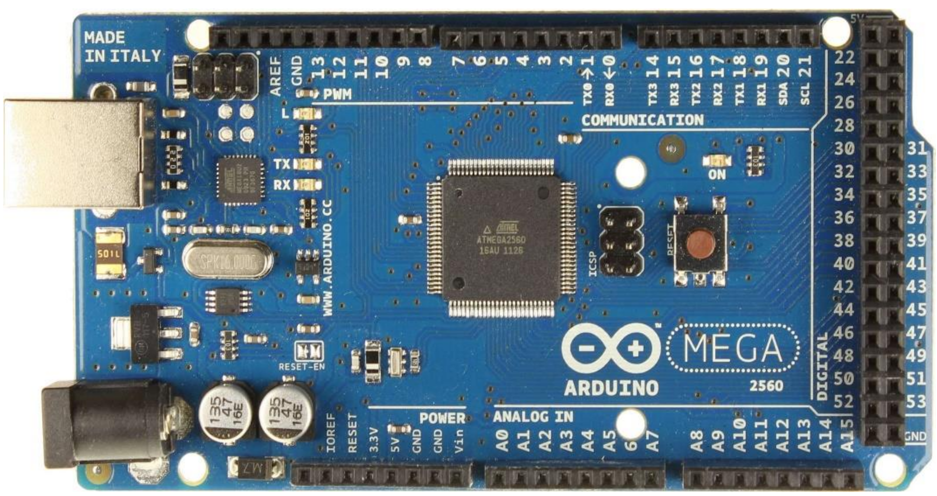

FIG 1.3.1 ARDUINO MEGA BOARD

SOFTWARE OF ARDUINO

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism to compile and load programs to an Arduino board[3]. A program written with the IDE for Arduino is called a "sketch".

The Arduino IDE supports the languages C and C++ using special rules to organize cod These systems provide sets of digital and analog I/O pins that can interface to various expansion boards (termed *shields*) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment(IDE) based on a programming language named *Processing*, which also supports the languages C and C++.

The first Arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators .

1.3.2 JUMP WIRES

Jump wires (also called jumper wires) for solderless breadboarding can be obtained in ready-to-use jump wire sets or can be manually manufactured. The latter can become tedious work for larger circuits. Ready-to-use jump wires come in different qualities, some even with tiny plugs attached to the wire ends. Jump wire material for ready-made or homemade wires should usually be 22 AWG (0.33 mm^2) solid copper, tin-plated wire - assuming no tiny plugs are to be attached to the wire ends. The wire ends should be stripped $^3⁄_{16}$ to $^5⁄_{16}$ in (4.8 to 7.9 mm). Shorter stripped wires might result in bad contact with the board's spring clips (insulation being caught in the springs). Longer stripped wires increase the likelihood of short-circuits on the board. Needle-nose pliers and tweezers are helpful when inserting or removing wires, particularly on crowded boards.

Fig. 1.3.2 JUMPER WIRES

Differently colored wires and color-coding discipline are often adhered to for consistency. However, the number of available colors is typically far fewer than the number of signal types or paths. Typically, a few wire colors are reserved for the supply voltages and ground (e.g., red, blue, black), some are reserved for main signals, and the rest are simply used where convenient.

1.3.3 LCD SCREEN

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is 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 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

Fig. 1.3.3 LCS SCREEN

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

1.3.4 POTENTIOMETER

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.

The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential, the component is an implementation of the same principle, hence its name.

Fig. 1.3.4 POTENTIOMETER

Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power, since the power dissipated in the potentiometer would be comparable to the power in the controlled load.

1.3.5 COLOR SENSOR

The TCS3200 and TCS3210 programmable color --light-to-frequency converters that combine configurable silicon photodiodes and a current-to-frequency converter on a single monolithic CMOS integrated circuit. The output is a square wave (50% duty cycle) with frequency directly proportional to light intensity (irradiance).

The full-scale output frequency can be scaled by one of three preset values via two control input pins. Digital inputs and digital output allow direct interface to a microcontroller or other logic circuitry. Output enable (OE) places the output in the high-impedance state for multiple-unit sharing of a microcontroller input line.

In the TCS3200, the light-to-frequency converter reads an 8 x 8 array of photodiodes. Sixteen photodiodes have blue filters, 16 photodiodes have green filters, 16 photodiodes have red filters, and 16 photodiodes are clear with no filters.

Fig. 1.3.5 COLOR SENSOR

In the TCS3210, the light-to-frequency converter reads a 4 x 6 array of photodiodes. Six photodiodes have blue filters, 6 photodiodes have green filters, 6 photodiodes have red filters, and 6 photodiodes are clear with no filters.

The four types (colors) of photodiodes are interdigitated to minimize the effect of non-uniformity of incident irradiance. All photodiodes of the same color are connected in parallel. Pins S2 and S3 are used to select which group of photodiodes (red, green, blue, clear) are active. Photodiodes are 110 µm x 110 µm in size and are on 134-µm centers.

2. RELATED WORK

This method is developed in perspective for replacing the existing system which is to conduct the soil test in laboratory's for which farmers have to travel to distance for which they have to spend their time or to have to buy expensive equipment which most of them farmers will no be able to afford it.

A soil test is important for several reasons to optimize crop production, to protect the environment from contamination by runoff and leaching of excess fertilizers, to aid in the diagnosis of plant culture problems, to improve the nutritional balance of the growing media and to save money and conserve energy by applying only the amount of fertilizer needed.

India's population reached beyond 1.2 billion and the population rate is increasing day-by-day; then after 25–30years there will be a serious problem for food, so the development of agriculture is necessary. The main objective of the project is to check the amount of the three major macronutrients, nitrogen (N), phosphorus (P), and potassium (K), in the soil thereby saving time, money, and power of the farmer. The N, P, and K amounts in the soil sample are determined by comparing the solution with color chart. This will describe the amount of N, P, and K as high, medium, and low. The traditional farm-land techniques require manual intervention. With the automated technology of irrigation, the human intervention can be minimized.

- To overcome the problem to "Soil test for macro-nutrients".
- Get the results instantly.
- Cost efficient.

3. MOTIVATION

The motivation for this project comes when I was watching news in which it was describing how agriculturalists of Telangana are struggling to get their soil sample tested as there are only 5 laboratories in our state to which they have to travel other districts for which they will be spending their valuable time as well as money.

Problem was that people were just talking to help them but no one was taking an incentive and there was no proper guidance or instruction given to farmers by which they could improve their cultivation of crops.

Several elements take part in the growth and development of plants, and those absorbed from the soil are generally known as plant nutrients. Besides these, the plant takes up carbon, oxygen and hydrogen, either from the air or from the water absorbed by roots. In all, 16 elements have been identified and are established to be essential for plant growth. There are carbon (C), hydrogen (H), Oxygen (O), nitrogen (N), phosphorus(P), potassium (K), calcium(Ca), magnesium (Mg), iron (Fe), Sulphur (S), zinc (Zn), manganese (Mn), copper (Cu), boron (B), molybdenum (Mo), and chlorine(Cl). These elements serve as raw materials for growth and development of plants, and formation of fruits and seeds.

The soils are studied and classified according to their use which is termed as land capability classification. In this classification, inherent soil characteristic, external land features and environmental factors are given prominence. For this purpose, soil survey is carried out to record the crop limiting factors such as soil depth, topography, texture-structure, water holding capacity, drainage features, followed by evaluation of soil fertility status, based on soil testing / analysis. The soils are thus classified in to 8 classes, four of which are considered suitable for agricultural purpose (Class I & IV) and Class V to VIII are non-arable lands and can be used for silviculture and forest and need strong conservation measures. An effective linkage between soil testing and soil survey is useful to ensure formulation of a sound soil fertility evaluation programmed.

4. DESGIN METHODOLOGY

4.1PROPOSED WORK

AGRICULTURAL SOIL MONITORING is a process and effort to overcome the problem faced by farmers. The propose system is to make soil testing easer for famers by making a portable setup which can be used anywhere by not going to visit labs and could be affordable.

Pre- plant media analyses provide an indication of potential nutrient deficiencies, pH imbalance or excess soluble salts. This is particularly important for growers who mix their own media. Media testing during the growing season is an important tool for managing crop nutrition and soluble salts levels. Which aid in the diagnosis of plant culture problems, to improve the nutritional balance of the growing media and to save money and conserve energy by applying only the amount of fertilizer needed.

ADVANTAGES

- The aim of this project is to reduce the time take to travel to laboratories.
- Easy to operate and instant results
- Highly portable

IoT

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect, collect and exchange data.

IoT involves extending Internet connectivity beyond standard devices, such as desktops, laptops, smartphones and tablets, to any range of traditionally dumb or non-internet-enabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the Internet, and they can be remotely monitored and controlled.

4.2 SYSTEM ARCHITECTURE

The below figure is the basic architecture of **AGRICULTURAL SOIL MONITORING**. Data collects from sensors, sends to Arduino. If the value is greater than threshold value then it will display message exceeded.

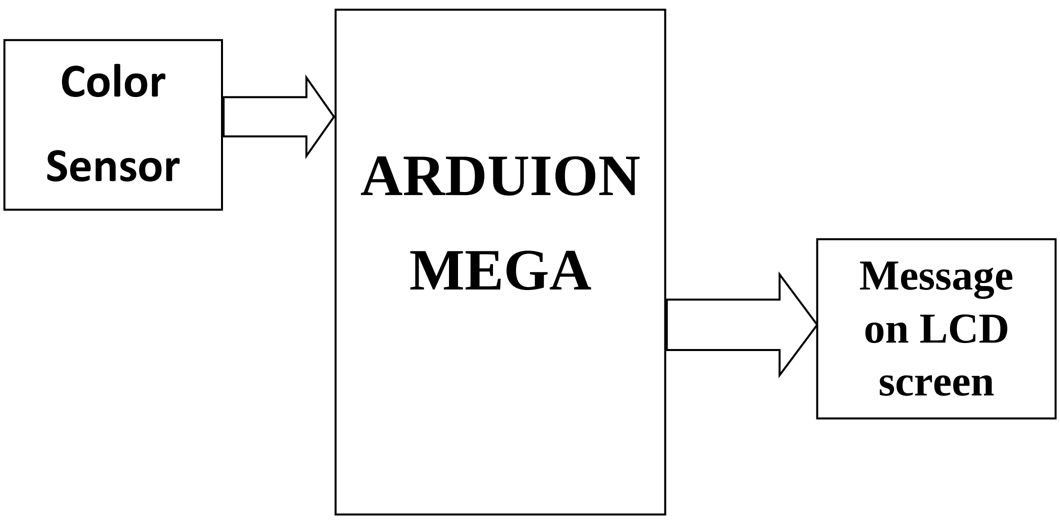

Fig. 4.2 System Architecture

4.3 MODULES

4.3.1 COLOR SENSOR

- The TCS230 senses color light with the help of an 8 x 8 array of photodiodes. Then using a Current-to-Frequency Converter the readings from the photodiodes are converted into a square wave with a frequency directly proportional to the light intensity. Finally, using the Arduino Board we can read the square wave output and get the results for the color.
- If we take a closer look at the sensor, we can see how it detects various colors. The photodiodes have three different color filters. Sixteen of them have red filters, another 16 have green filters, another 16 have blue filters and the other 16 photodiodes are clear with no filters.
- Each 16 photodiodes are connected in parallel, so using the two control pins S2 and S3 we can select which of them will be read. So, for example, if we want to detect red color, we can just use the 16 red filtered photodiodes by setting the two pins to low logic level according to the table.
- The sensor has two more control pins, S0 and S1 which are used for scaling the output frequency. The frequency can be scaled to three different preset values of 100 %, 20 % or 2%. This frequency-scaling function allows the output of the sensor to be optimized for various frequency counters or microcontrollers.

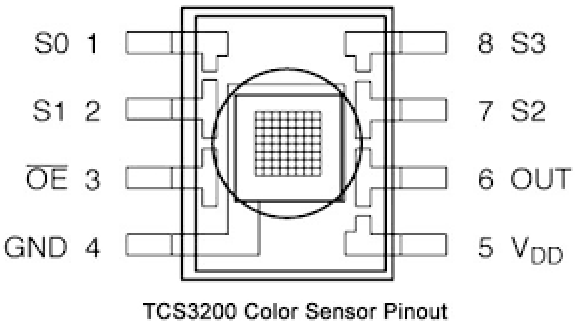

Fig. 4.3.1.1 COLOR SENSOR PINOUT

- To TCS3002D, when choose a color filter, it can allow only one particular color to get through and prevent other color. For example, when choose the red filter, only red incident light can get through, blue and green will be prevented. So, we can get the red-light intensity. Similarly, when choose other filters we can get blue or green light.
- TCS3002D has four photodiode types. Red, blue, green and clear, reducing the amplitude of the incident light uniformity greatly, so that to increase the accuracy and simplify the optical. When the light project to the TCS3002D we can choose the different type of photodiode by different combinations of S2 and S3.

Fig. 4.2.1.2 COLOR SENSOR

- TCS3002D can output the frequency of different square wave (occupies empties compared 50%), different color and light intensity correspond with different frequency of square wave. There is a relationship between the output and light intensity. The range of the typical output frequency is 2HZ~500KHZ. We can get different scaling factor by different combinations of S0 and S1. Look at the form as follows.

4.3.2 ARDUINO BOARD

The Arduino is a family of microcontroller boards to simplify electronic design, prototyping and experimenting for artists, hackers, hobbyists, but also many professionals. People use it as brains for their robots, to build new digital music instruments, or to build a system that lets your house plants tweet you when they're dry. Arduinos (we use the standard Arduino Mega) are built around an AT mega microcontroller — essentially a complete computer with CPU, RAM, Flash memory, and input/output pins, all on a single chip. Unlike, say, a Raspberry Pi, it's designed to attach all kinds of sensors, LEDs, small motors and speakers, servos, etc. directly to these pins, which can read in or output digital or analog voltages between 0 and 5 volts. The Arduino connects to your computer via USB, where you program it in a simple language (C/C++, similar to Java) from inside the free Arduino IDE by uploading your compiled code to the board. Once programmed, the Arduino can run with the USB link back to your computer, or stand-alone without it — no keyboard or screen needed, just power.

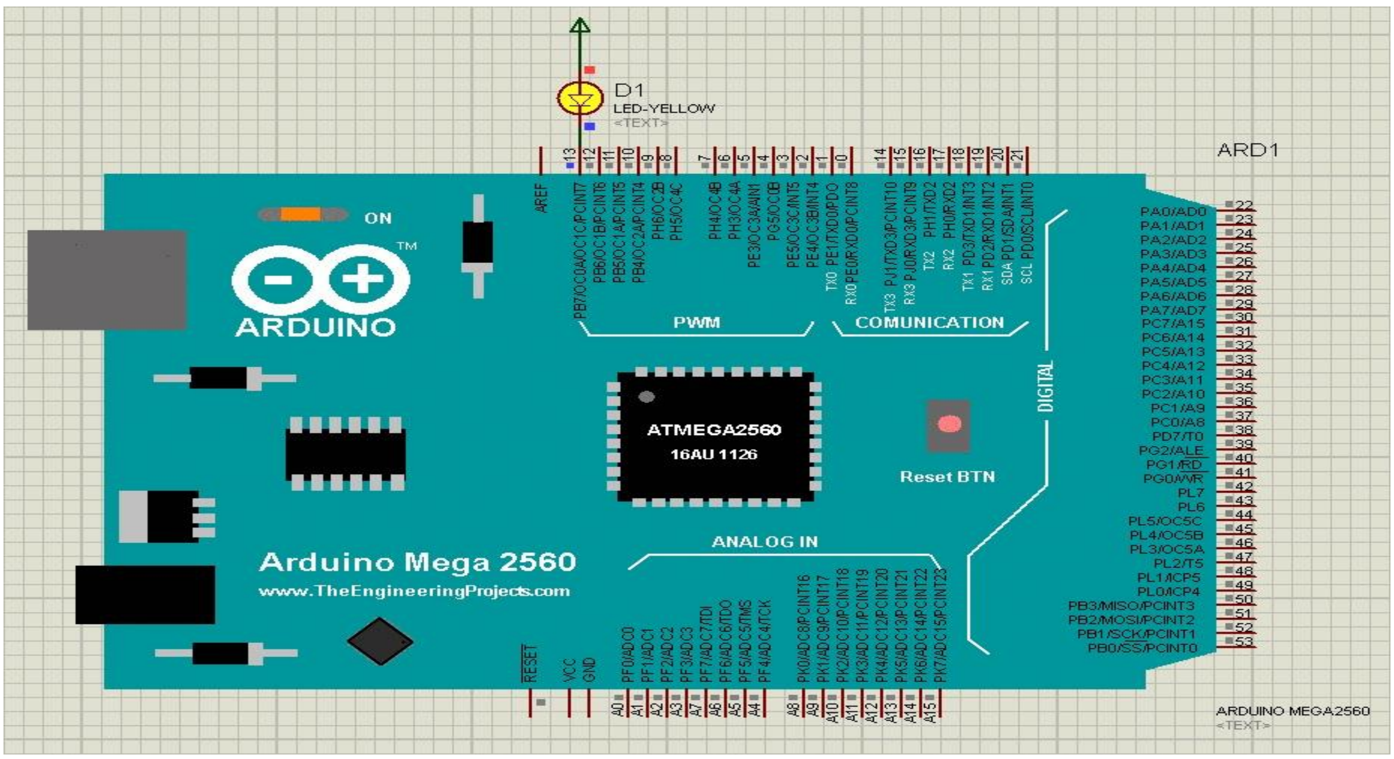

Fig: 4.3.2 STRUCTURE OF ARDUINO MEGA BOARD

Looking at the board from the top down, this is an outline of what you will see (parts of the board you might interact with in the course of normal use are highlighted)

Digital Pins

In addition to the specific functions listed below, the digital pins on an Arduino board can be used for general purpose input and output via the pin Mode(), Digital Read(), and Digital Write() commands. Each pin has an internal pull-up resistor which can be turned on and off using digital Write() (w/ a value of HIGH or LOW, respectively) when the pin is configured as an input. The maximum current per pin is 40mA.

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. On the Arduino Decimal, these pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip. On the Arduino BT, they are connected to the corresponding pins of the WT11 Bluetooth module. On the Arduino Mini and Lily Pad Arduino, they are intended for use with an external TTL serial module (e.g. the Mini-USB Adapter).
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11** Provide 8-bit PWM output with the analog Write() function. On boards with an ATmega8, PWM output is available only on pins 9, 10, and 11.
- **BT Reset: 7.** (Arduino BT-only) Connected to the reset line of the Bluetooth module.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- **LED: 13.** On the Decimal and Lily Pad, 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.

Analog Pins

In addition to the specific functions listed below, the analog input pins support 10-bit analog-to-digital conversion (ADC) using the analog Read() function. Most of the analog inputs can also be used as digital pins: analog input 0 as digital pin 14 through analog input 5 as digital pin 19. Analog inputs 6 and 7 (present on the Mini and BT) cannot be used as digital pins.

- **I^2C: 4 (SDA) and 5 (SCL).** Support I^2C (TWI) communication using the Wire library (documentation on the Wiring website).

Power Pins

- **VIN** (sometimes labeled "9V"): The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. Also note that the Lily Pad has no VIN pin and accepts only a regulated input.
- **5V:** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3** (Decimal-only) : A 3.3 volt supply generated by the on-board FTDI chip.
- **GND:** Ground pins.

Other Pins

- **AREF:** Reference voltage for the analog inputs. Used with analog Reference().
- **Reset:** (Decimal-only) Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

ARDUINO CHARACTERISTICS

The Arduino Mega 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 be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows:

- **IOREF.** This pin on the Arduino 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.

4.3.3 LCD SCREEN

- LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is 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.

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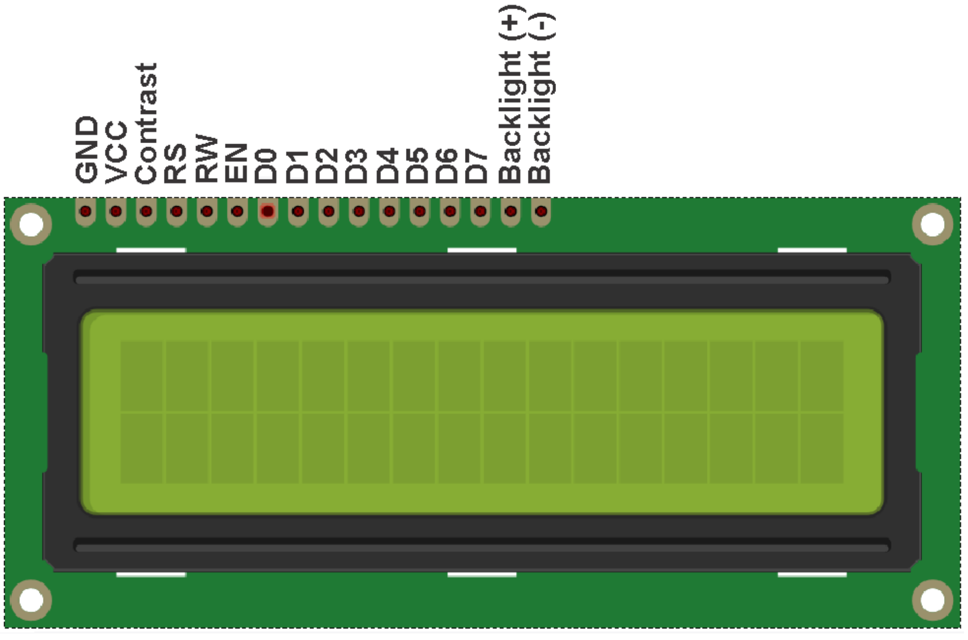

Fig. 4.3.3 LCD SCREEN

- The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of an LCD.

4.3.4 SOIL TASTING KIT

It all starts with the soil. Whether you're gardening 10 sq. ft or farming thousands of acres, smart growers know that soil tests pay for themselves in increased productivity and targeted fertilizing made possible by a specific diagnosis of the soil's strengths and weaknesses. Whether you send in a soil sample for professional lab soil testing, buy a DIY soil test kit.

To get the color sample we have to perform the soil testing using the chemicals which are the copyrighted products od IOTA Laboratories. For this there is an instruction manual which explains you about how much of the solution you should use and the way of performing the titration.

Fig. 4.3.4 SOIL TASTING KIT

4.4 REQUIREMENT SPECIFICATION

Functional Requirements

- Level detection: The level of alcohol.

SYSTEM REQUIREMENTS

- Arduino Compiler.
- Operating System: Windows10.

HARDWARE REQUIREMENTS

- Arduino Mega
- Connecting Wires
- Color Sensor (TCS 3200)
- Potentiometer
- LCD Screen 16X2
- System: Intel i3,2.4GHz
- Hard disk: 40GB
- Ram: 4GB

4.5 UML DIAGRAMS

Introduction

The Unified Modelling Language is a rich visual modelling language created for architecture, design and implementation of complex software systems both structurally and behaviorally. UML consists of different types of diagrams. They describe the boundary, structure and the behavior of the system and the objects with in it.

The vocabulary of UML consists of the following:

1. Things
2. Relationships
3. Diagrams

THINGS OF UML

Things are the abstractions that are first-class citizens in a model. There are four kinds of things

- Structural Things
- Behavioral Things
- Grouping Things
- An notational Things

Structural Things

Structural things are the nouns of the UML models. They represent elements that are physical

Behavioral Things

They are dynamic parts of UML model. Behavioral things are the verbs of a model, representing behavior over time and spaces. The different types of behavioral things are

- Interactions
- State Machine

Grouping Things

Grouping things are the organizational parts of the UML model. This includes different packages for example: a package can have name, business rules, date, etc.

An notational Things

Explanatory parts of the UML models. This includes nodes these nodes can briefly explain what it is, when it happened, and who is responsible for it etc.

RELATIONSHIPS

Different types of relationships in UML they are as follows:

Association:

It is a relationship between classifiers which is used to show that instances of a classifiers could be either linked to each other or combined logically or physically.

Aggregation:

A special form of association that specifies a whole – part relationship between the aggregate and a component part.

Composition:

It is a type of aggregation that is strong

Generalization:

Generalization is a process of extracting shared characteristics from two or more classes and combining them into generalized super class.

4.5.1 CLASS DIAGRAM FOR AGRICULTURAL SOIL MONITORING

It is a static diagram that gives static view of an application. Class Diagram is a collection of classes, interfaces, association, collaboration, and constraints. It is also known as a structural Diagram. These are the only UML diagrams that can be mapped directly with object-oriented languages. It describes the attributes and operations of a class and also the constraints imposed on the system.

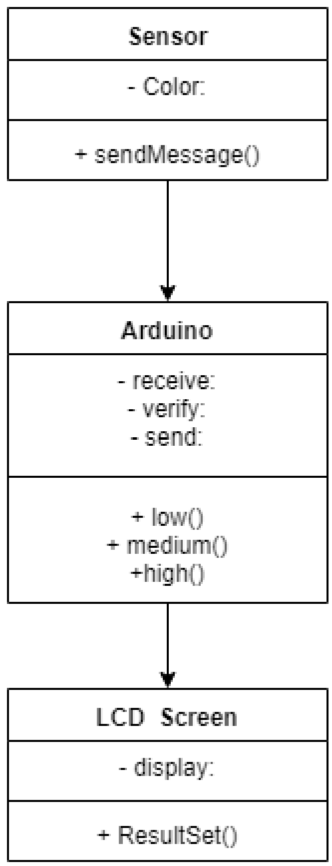

Fig: 4.5.1 Class diagram for AGRICULTURAL SOIL MONITORING

4.5.2 SEQUENCE DIAGRAM

Sequence diagram is a type of interaction diagram that is mostly used. It mainly focuses on the message interaction between a number of lifelines.

It is a popular dynamic modelling focuses on the interaction occurring within the system. This diagram mainly focuses on the lifeline of an object and the communication between these lifelines.

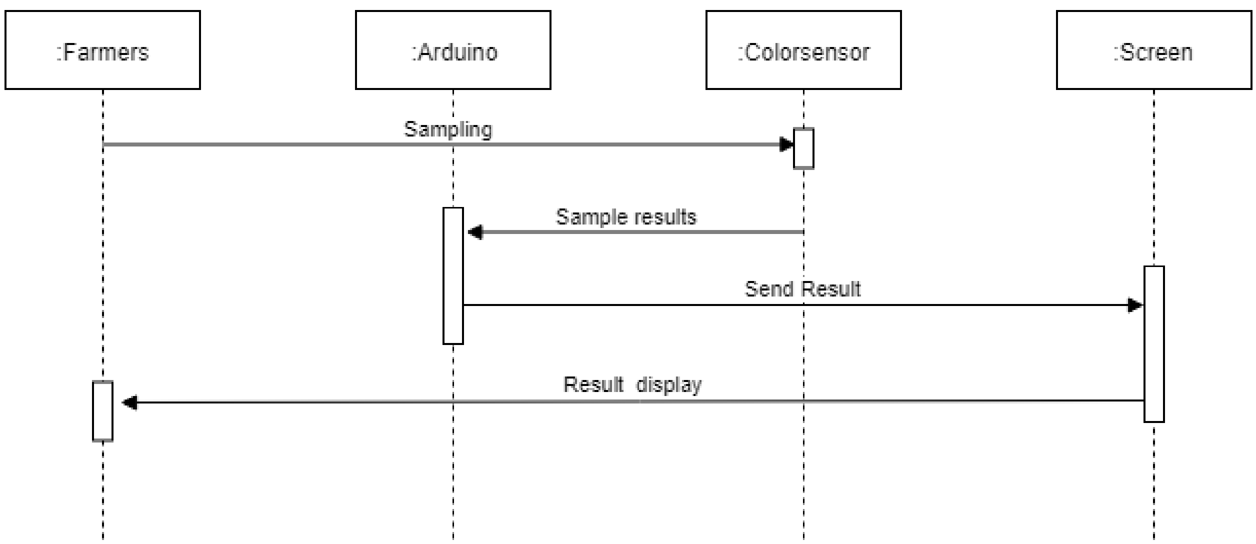

Fig: 4.5.2 Sequence diagram for AGRICULTURAL SOIL MONITORING

4.5.3 USECASE DIAGRAM FOR AGRICULTURAL SOIL MONITORING

It is a behavior diagram used to describe set of use cases that some system will perform in combination with some actors

Actor: Actor represents roles that user takes on then they use the IT system. E.g., User role in our website is an actor

- Use Case: Use cases describe the interactions that take place between actors and IT systems during the execution of business processes
- Association: An association is a connection between an actor and a use case. An association indicates that an actor can carry out a use case. Several actors at one use case mean that each actor can carry out the use case on his or her own and not that the actors can carry out the use case together.
- Includes Relationships: It indicates that the use case to which the arrow points is included in the use case on the other side of the arrow.

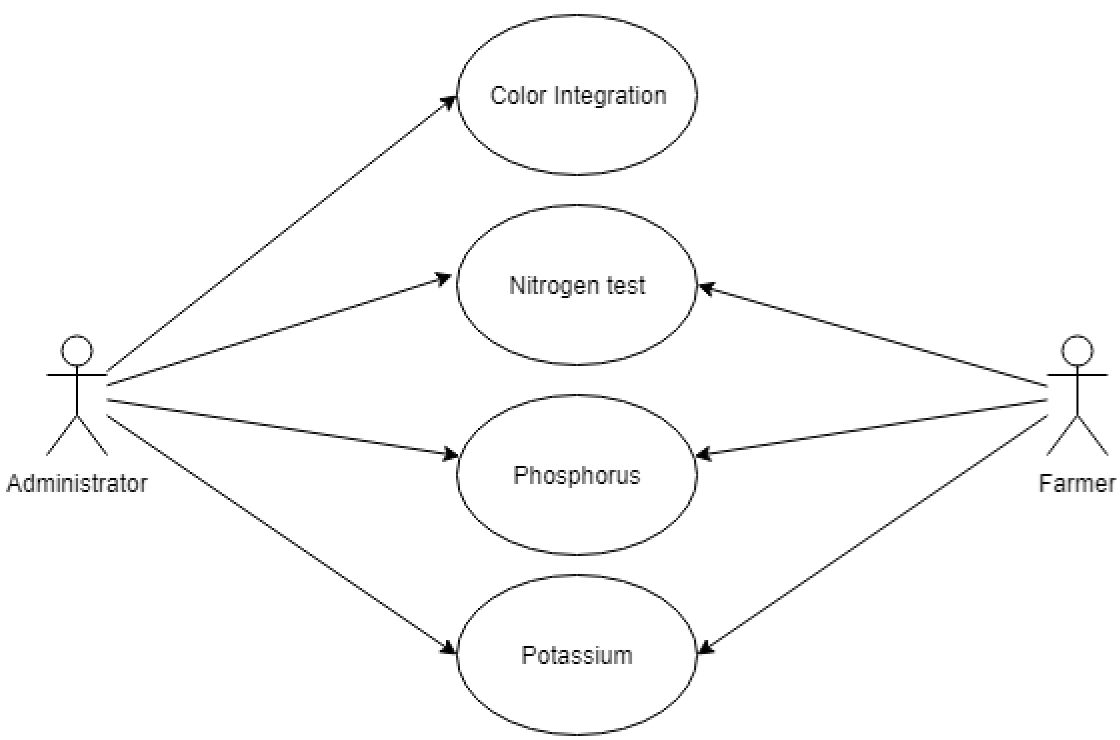

Fig: 4.5.3 Use case diagram for AGRICULTURAL SOIL MONITORING

4.5.4 ACTIVITY DIAGRAM FOR AGRICULTURAL SOIL MONITORING

It is one of the important diagrams that describe the dynamic aspects of the system. It is like a flow chart that represents flow from activity to another activity. It is used to show message flow from one activity to another

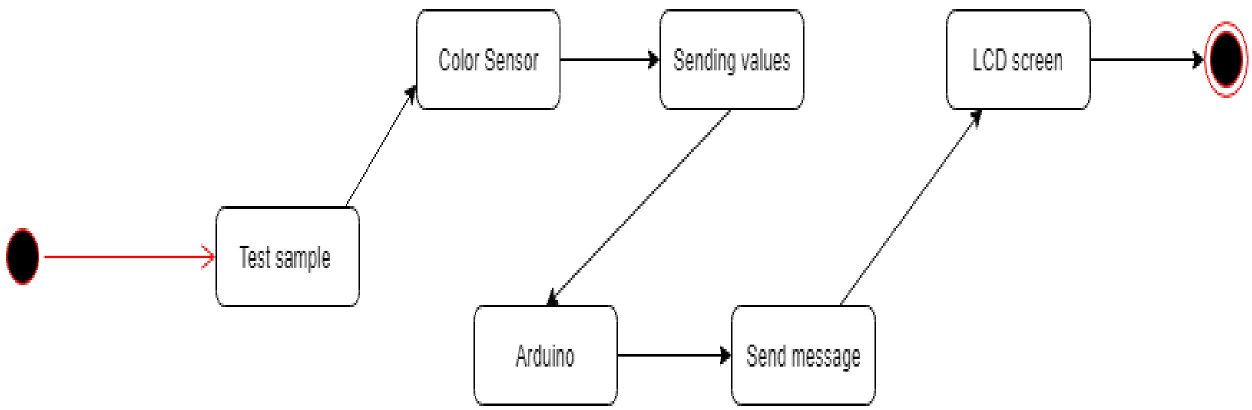

Fig: 4.5.4 Activity diagram for AGRICULTURAL SOIL MONITORING

4.5.5 STATE DIAGRAM FOR AGRICULTURAL SOIL MONITORING

A state diagram is used to represent the condition of the system or part of the system at finite instances of time. It’s a behavioral diagram and it represents the behavior using finite state transitions. State diagrams are also referred to as State machines and State-chart Diagrams. These terms are often used interchangeably. So simply, a state diagram is used to model the dynamic behavior of a class in response to time and changing external stimuli. We can say that each and every class has a state but we don’t model every class using State diagrams. We prefer to model the states with three or more states.

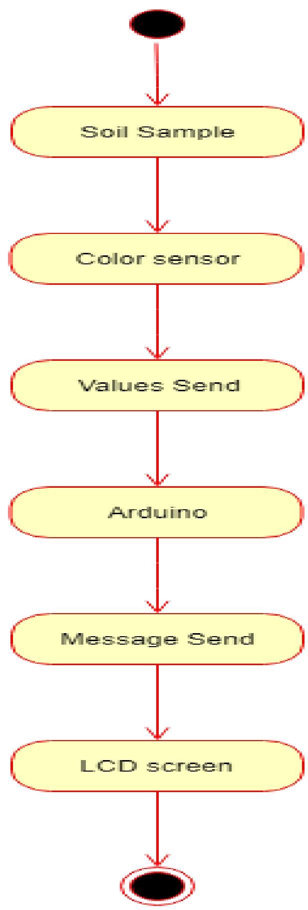

Fig: 4.5.5 State diagram for AGRICULTURAL SOIL MONITORING

5. EXEPERIMENTAL STUDIES

5.1 TESTING PROCESS

OVERVIEW OF TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

We can verify through testing, the various interactions, integration of components and the requirements which were implemented. It provides timely feedback to resolve the quality issues, in a timely and cost-effective manner. The ultimate goal of testing is to assess the quality of the end product. Quality assessments often consider process quality and organizational factors as well as direct product quality.

Testing is not a single activity, nor is it a phase in the project during which we assess quality. If developers are to obtain timely feedback on evolving product quality, testing must occur throughout the lifecycle: we can test the broad functionality of early prototypes: we can test the stability, coverage and performance of the architecture while there is still an opportunity to fix it; and we can test the final product to assess its readiness for delivery to customers.

Dimensions of Testing

To assess product quality, different kinds of tests, each one with a different focus, are needed. These tests can be categorized by several dimensions

Quality dimension

The major quality characteristic or attribute that is the focus of test.

Stage of testing

The point in the lifecycle at which the test, usually limited to a single quality

Type of testing

The specific test objective for an individual test, usually limited to a single quality dimension.

Stages of Testing

Testing is not a single activity, executed all at once. Testing is executed against different types of targets in different stages of the software development. Test stages progress from testing small elements of the system, such as components (unit testing), to testing completed systems (system testing). The 3 stages have the following purposes:

Unit Testing

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases. Field testing will be performed manually and functional tests will be written in detail.

Test objectives

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.

Features to be tested

- Verify that the entries are of the correct format
- No duplicate entries should be allowed
- All links should take the user to the correct page.

Integrated Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects. The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Types of Testing

After a test plan has been developed, system testing begins by testing program modules separately, followed by testing “bundled” modules as a unit. A program module may function perfectly in isolation but fail when interfaced with other modules. The approach is to test each entity with successively larger ones, up to the system test level.

System Testing

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration-oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

Program testing

A program represents the logical elements of system. For a program to run satisfactorily, it must compile and test data correctly and tie in properly with other programs. Achieving an error-free program is the responsibility of the programmer.

Program testing checks for two types of errors: syntax and logic. A syntax error is a program statement that violates one or more rules of the language in which it is written. A logic error, on the other hand, deals with incorrect data fields, out of range items, and invalid combinations. When a program is tested, the actual output is compared with the expected output. When there is a discrepancy, the sequence of instructions must be traced to determine the problem. The process is facilitated by breaking the program down into self-contained portions, each of which can be checked at certain key points. The idea is to compare program values against desk calculated values to isolate the problem.

String Testing:

Programs are invariably related to one another and interact in a total system. Each program is tested to see whether it conforms to related programs in the system. Each portion of the system is tested against the entire module with both test and live data before the entire system is ready to be tested.

This test we conducted by the help of a color chart which had the predefined color values which indicate the lave of macro nutrients present in soil

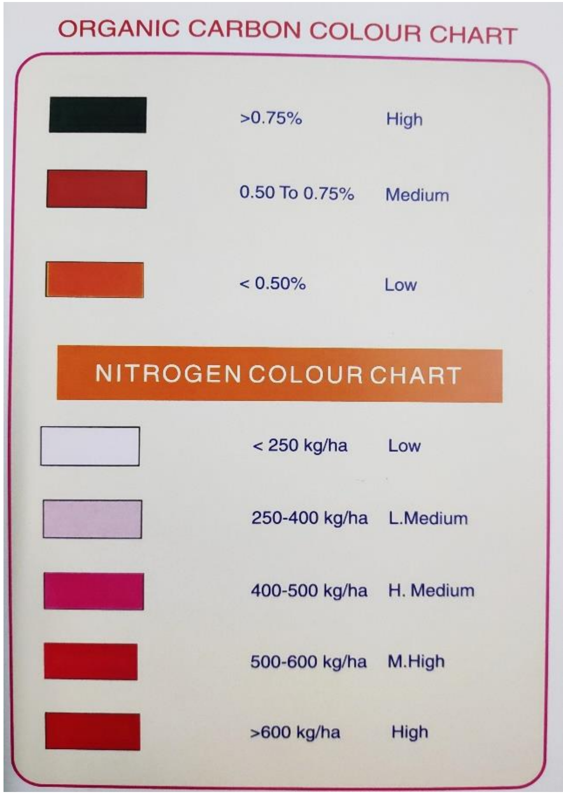

Fig: 5.1.1 Nitrogen color chart

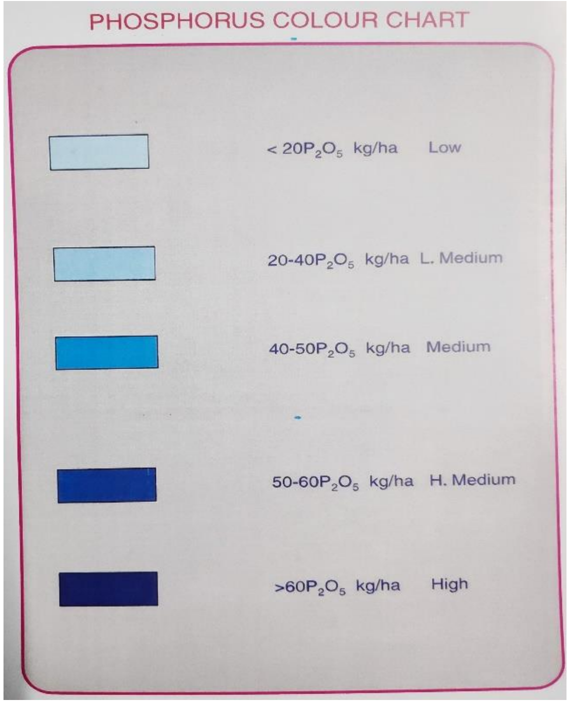

Fig: 5.1.2 Phosphorus color chart

Fig: 5.1.3 Potassium color chart

5.2 TEST CASEs

User Acceptance Testing:

An acceptance test has the objective of selling the user on the validity and reliability of the system. It verifies that the system's procedures operate to system specifications and that the integrity of vital data is maintained. Performance of an acceptance test is actually the user's show. User motivation and knowledge are critical for the successful performance of the system. Then a comprehensive test report is prepared. The report indicates the system's tolerance, performance range, error rate, and accuracy.

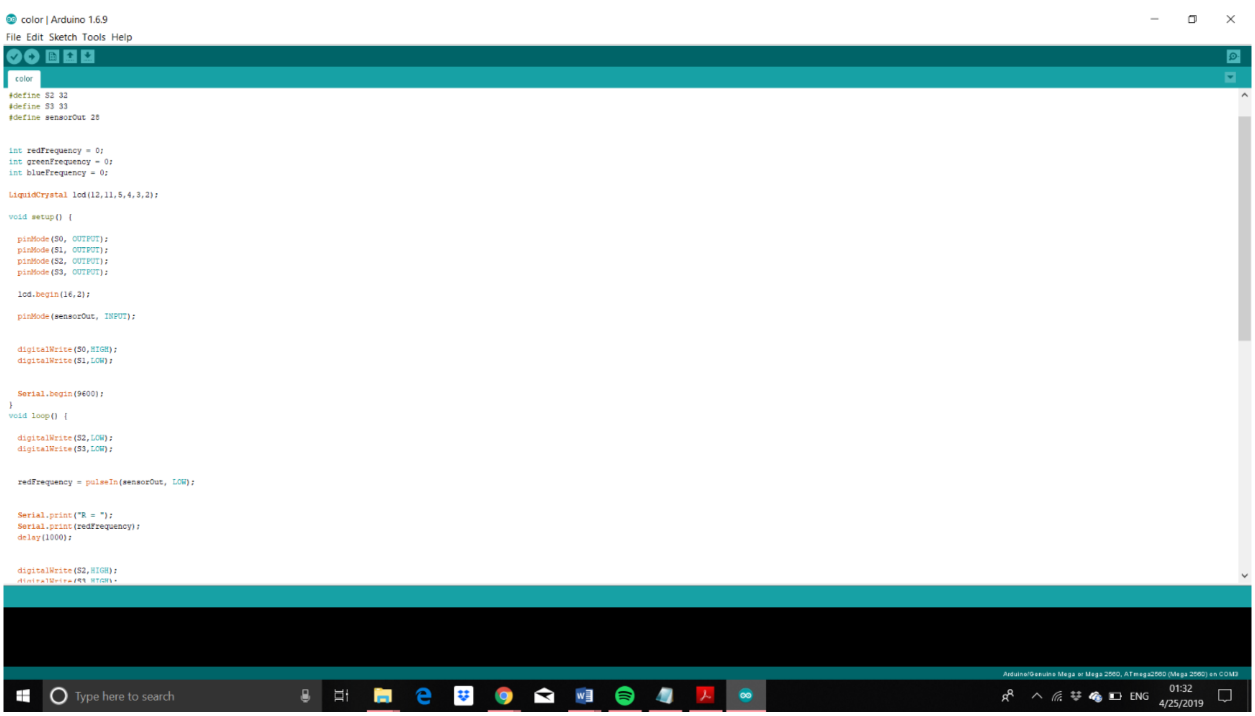

Fig: 5.2 User Acceptance Testing

5.2.1 Nitrogen Test Case:

S. No	Input	Expected Output	Actual Output	Results
1.	Color Sample	Nitrogen level is medium	Not matching values	FAIL
2.	Color Sample	Nitrogen level is medium	Nitrogen level is medium	Pass

In the below figure we can see that at the time of testing there was pink color sample so message which is displayed is “Nitrogen level is medium”. Also, displayed values are the calibration values.

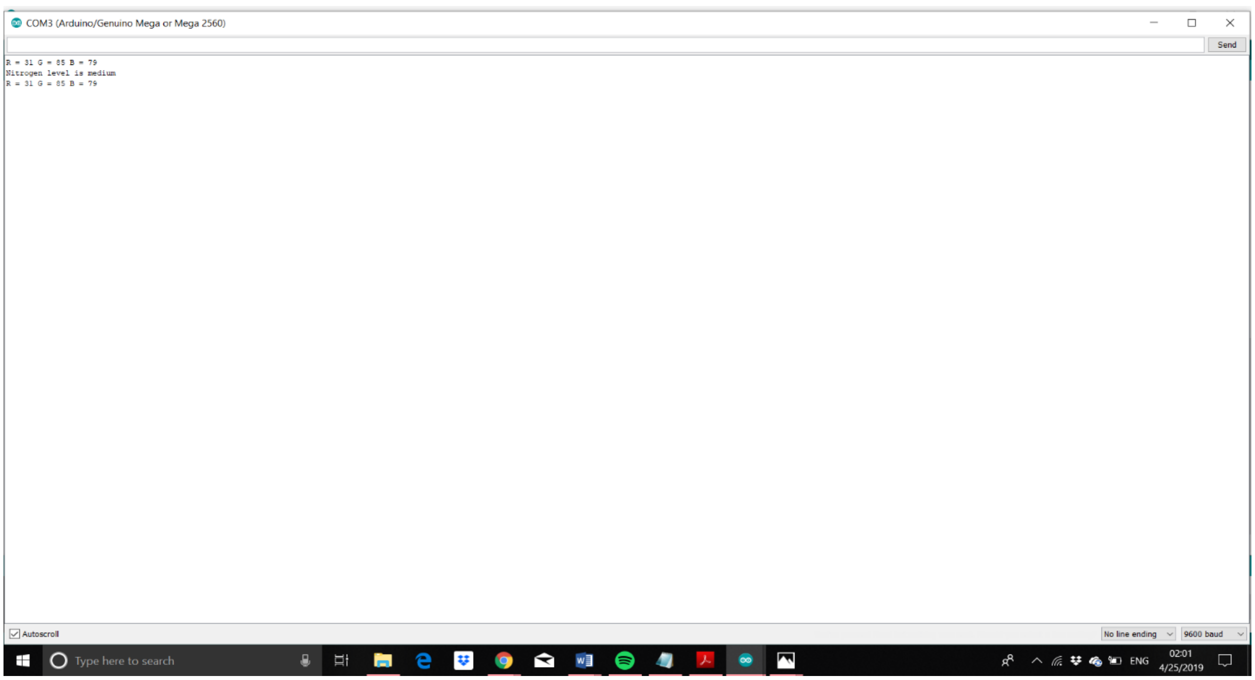

Fig: 5.2.1.1 Nitrogen test case result in serial monitor

Fig: 5.2.1.2 Nitrogen test case result on LCD screen

5.2.2 Phosphorus Test Case:

S. No	Input	Expected Output	Actual Output	Results
1.	Color Sample	Phosphorus level is high	Not matching values	Fail
2.	Color Sample	Phosphorus level is high	Phosphorus level is high	Pass

Now in this below figure we can see that due to the presents of blue color solution the message which is displayed over is “Phosphorus level is high”.

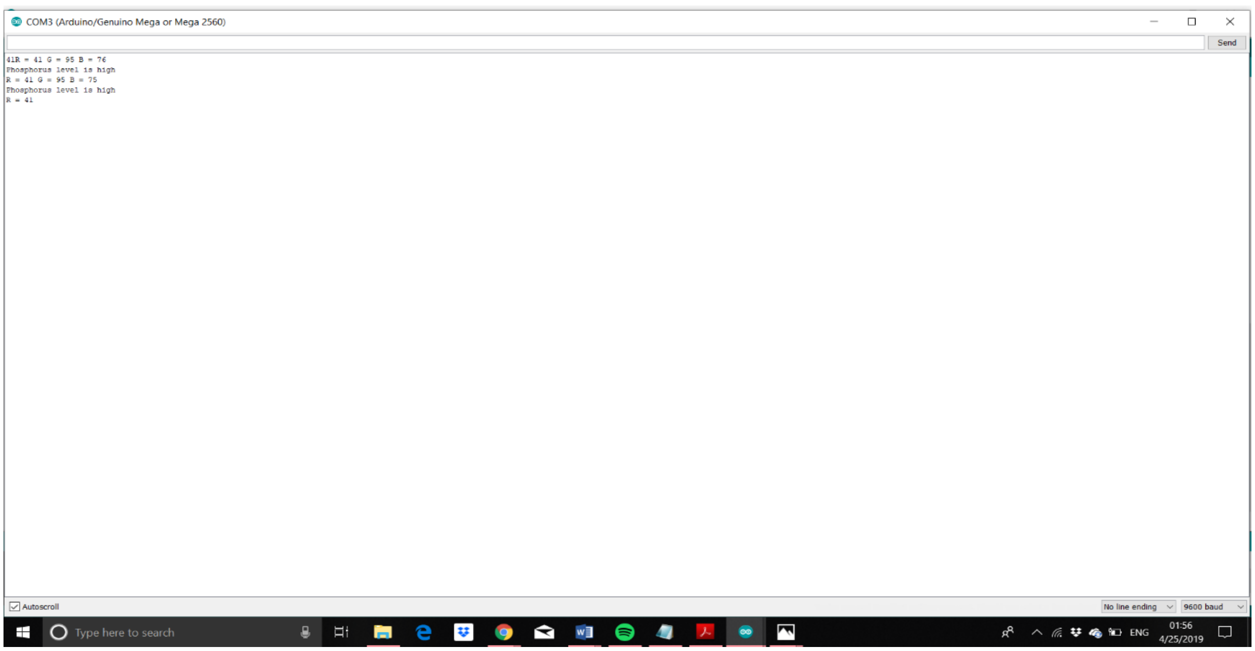

Fig: 5.2.2.1 Phosphorus test case result in serial monitor

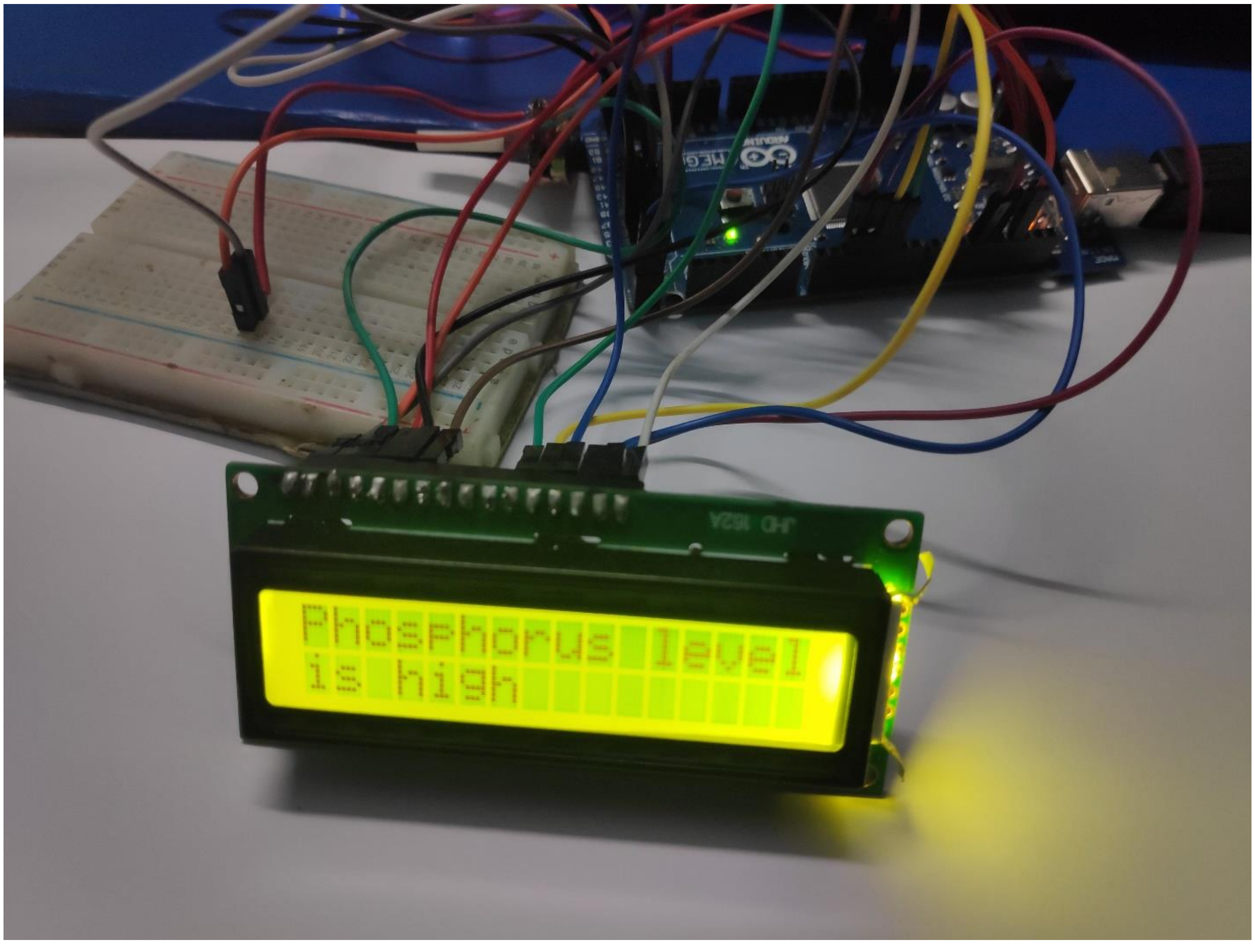

Fig: 5.2.2.2 Phosphorus test case result on LCD screen

5.2.3 Potassium Test Case:

S. No	Input	Expected Output	Actual Output	Results
1.	Color Sample	Potassium level is high	Not matching values	Fail
2.	Color Sample	Potassium level is high	Potassium level is high	Pass

In the below figure we can see that at the time of testing there was viscus white color sample so message which is displayed is "Potassium level is high". Also, displayed values are the calibration values.

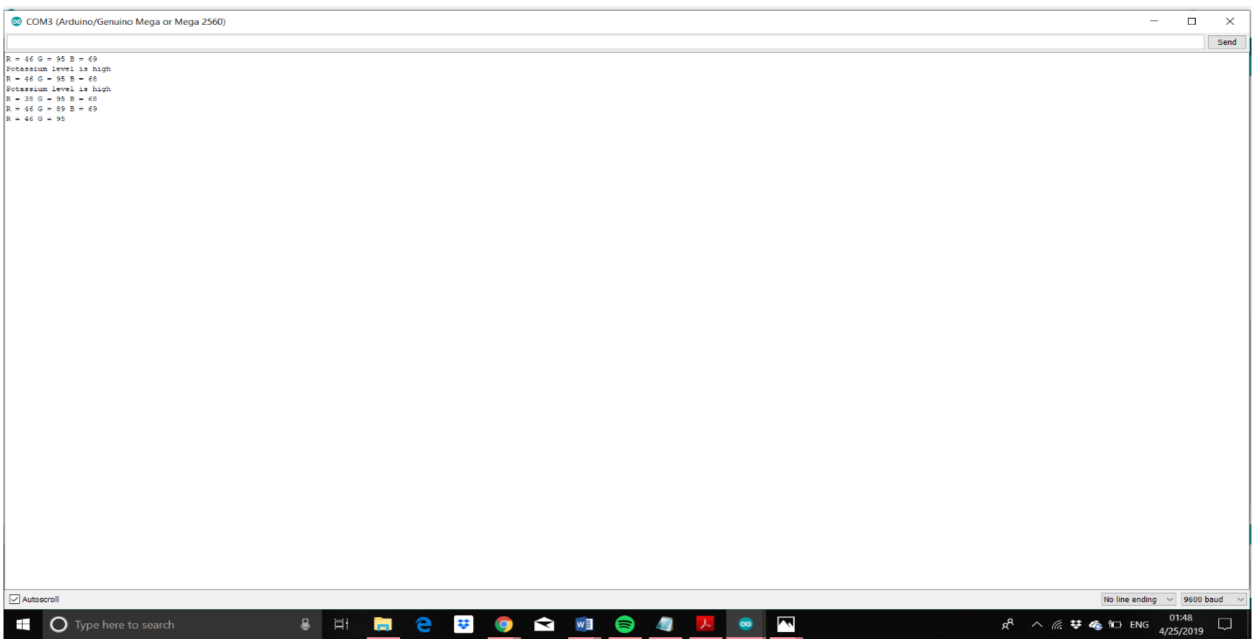

Fig: 5.2.3.1 Potassium test case result in serial monitor

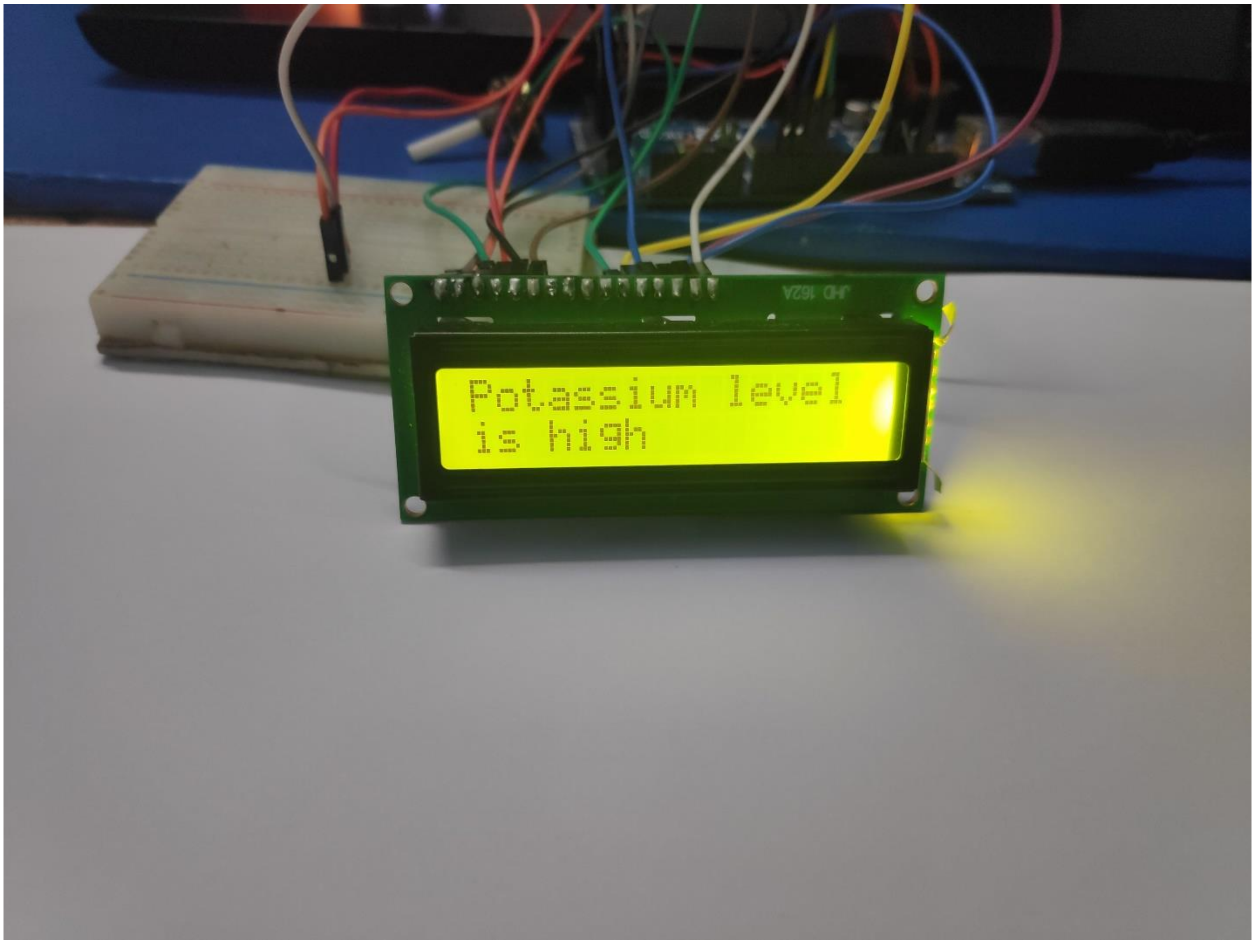

Fig: 5.2.3.2 Potassium test case result on LCD screen

6. CONCLUSION AND FUTURE SCOPE

By the help of the embedded system it is much easier to operate and the cost for making is very low. As this product are of low cost it could be easily replaced and could be experimented a lot, and this embedded system could use for the IOT (Internet Of Things). So, it could be used in more efficient and advance manner as the size of this product is very small and get fitted any place easily.

For the further scope I suggest for make the results to be displayed in reginal language like Hindi, Telugu, Punjabi, Tamil etc. This could help the people who don't recognize English to understand the results and implement on it. This also could be improved by making a collection on results after the test and predict the future soil nutrients by the help of machine learning and artificial intelligence. By doing so we government also could help farmers directly by checking their data sets and provide assistance.

REFERENCE

[1] D. S. Suresh, Jyothi Prakash K. V., Rajendra C. J. “Automated Soil Testing Device”, ITSI Transactions on Electrical & Electronics Engineering (ITSI-TEEE) ISSN (PRINT): 2320–8945, Vol. 1, Issue 5, 2013.

[2] Dr. A. D. Shaligram, Nishant Singh, “NPK Measurement in Soil & Automatic Soil Fertilizer Dispensing Robot”, International Journal of Engineering Research & Technology (IJERT) Vol. 3, Issue 7, July. 2014.

[3] Yunseop (James) Kim, Robert G. Evans, and William M. Iversen, “Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network”, IEEE transactions on instrumentation and measurement, VOL. 57, NO. 7, PP 1379–1387, JULY 2008.

[4] Gayatri Londhe, Prof. S.G. Galande, “Automated Irrigation System By Using ARM Processor”, IJSRET, ISSN 2278–0882, Vol. 3 Issue 2, May 2014.

[5] Tanmay Baranwal, Nitika, Pushpendra Kumar Pateriya, “Development of IoT based Smart Security and Monitoring Devices for Agricultural” IEEE, Vol., pp 592–602, Issue 2016.

[6] G. Parameswaran, K. Sivaprasath, “Arduino Based Smart Drip Irrigation System using Internet of Things” IJESC, Vol. 6, Issue 10, April. 2016.

[7] Leenata Vedpathak, Pooja Salape, Snehal Naik, “An Automated Agricultural Robot”, IJARCCE, Vol. 4, Issue 3, March 2015.

[8] Shweta S. Patil, Ashwini V. Malviya, “Agricultural Field Monitoring System Using ARM”, IJAREEIE, Vol. 3, Issue 4, April 2014.

[9] Nisha Mary Lemos, Shruti Narayan Nair, Sonali Sanjay Yadav, Prof. Dr. Vijaya Rahul Pawar, “Building a Smart City through an of Internet of Things (IoT)’, IJSRD, Vol. 4, Issue 02, 2016| ISSN (online): 2321–0613.

[10] https://www.arduino.cc/

[11] https://www.tutorialspoint.com/

[12] https://www.ibm.com/blogs/internet-of-things/what-is-the-iot/

[13] https://www.mouser.com/catalog/specsheets/TCS3200-E11.pdf

[14] http://www.mpkrishi.org/engdocs/agrileft/soilt/soilthome.aspx

[15] IOTA Laboratory