APPLICATION OF IoT IN DETERMINING SOIL PH AND FERTILIZER SUGGESTION

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Dr. Syed Akhter Hossain, Department Head, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Soil pH is a key parameter for higher crop productivity. Soil pH is a proportion of hydronium particle (more ordinarily the H+) movement in the soil arrangement. Soil nutrient analysis is very important for a good harvest. On the off chance that the soil is in great condition it is extremely appropriate for a supportable harvest. We can rely upon the soil pH for a decent nutrient pointer. At the point when soil corrosiveness changes, the solvency of various metal particles additionally change. Plant development is extremely influenced by the changing centralization of these metals in arrangement instead of by the corrosiveness itself. The point in overseeing soil pH isn't to accomplish a specific pH esteem, however to modify the causticity to the point where there are no dangerous metals in arrangement and the accessibility of supplements is at its greatest. This condition is normally accomplished when the dirt pH is somewhere in the range of 5.8 and 6.5, anyway a few plants have extraordinary corrosiveness necessities. We are proposing a system that measures the soil pH and sends the specific fertilizer amount to be applied on the field to the users. Our system measures the pH value of the soil which determine the nutrient elements present in the soil, as a result the users of our system can easily know the condition of their fields. They not only get to know the pH value but also the solution means the amount of fertilizer to be added in their fields for attaining the optimal pH suitable for better production.

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CHAPTER 1
Introduction

1.1 Introduction

Agriculture is the biggest work area in Bangladesh. The execution of this division overwhelmingly affects major macroeconomic destinations like work production, destitution mitigation, HR advancement, nourishment security, and so forth. Agriculture contributes about 19.6 percent to the national GDP of Bangladesh. It also provides about 63 percent of employment. As per the World Bank, the aggregate arable land in Bangladesh is 61.2 percent of the aggregate land in this region. The three main crops produced are rice, jute, and tea. Rice is the staple sustenance in the regular eating regimen of Bangladeshis. The production of rice, which can be reaped 2 or even 3 times each year. According to BRKB (Bangladesh Rice Knowledge Bank) Bangladesh produces about 25 million tons of rice to feed the population. As for overgrowing population the total production area for rice will shrink to 10.28 million hectors for which the production needs to be increased from the present 2.74 to 3.74 t/ha by the coming 20 years. Although we have a variety of rice but the production still needs to be improved. According to the BJMC (Bangladesh Jute Mills Corporation) jute is produced about 1.09 million tons in about 12.35 lac acres which is good enough but still needs to be improved. According to a report of The daily star at year 2012 Bangladesh produced the highest tea of about 63.85 million kg at about 56,846 hectares of land.

But these growths are not constant. They change over time because of the soil nutrient changes with each harvest. Farmers may think using the same fertilizer or utilizing the land same as last time would give them the same harvest. But this does not happen because nutrient elements do not remain same at a certain place. These needed nutrient point can be achieved through an indicator.

So our system will work here in indicating the amount of pH, which is a good indicator of soil nutrient and according to that value our system will recommend amount of specific fertilizer to be applied in the filed for good harvest, to the users through SMS or phone call.

A pH meters estimates the centralization of the hydrogen particles [H+] in a solution. An acidic arrangement has much more decidedly charged hydrogen particles in it than a soluble solution, so it can possibly deliver an electric flow under certain conditions. It resembles a battery that can create a more noteworthy voltage. A pH meter exploits this and work like an ordinary voltmeter. It comprises of a couple of anodes associated with a meter equipped for estimating little voltages, on the request of mili volts.

It gauges the voltage (electrical potential) delivered by the arrangement whose acridity we are keen on contrasts it and the voltage of a known standard arrangement and utilization the distinction in voltage (the potential distinction) between them to ascertain the distinction in pH.

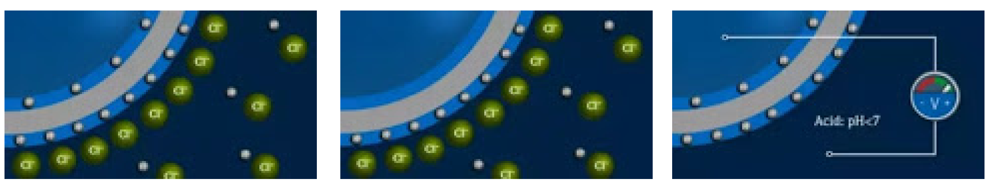


Fig1.1: How pH meter works

At the point when the test is inundated in the arrangement of Hydrochloric acid, the littler hydrogen particles can infiltrate the limit territory of the glass layer and the bigger chloride particles stay in the arrangement itself. Along these lines, the outcomes is a partition of charge. On the off chance that the hydrogen particle focus, in the external arrangement varies from that of within arrangement, at that point a quantifiable potential distinction is distinguished and pH is at the same time ascertained.

1.2 Motivation

As a developing country Bangladesh has to import food from other countries to feed the over growing population. Though it has made many successes in agriculture, still today there are many farmers who are facing problems to communicate with the agricultural officer for their problems or concern. Our system is going to eliminate the communication gap between the farmer and agriculture officer providing him the effective solution instantly.

There are even many places where the agriculture officers do not visit and it becomes problematic for the farmer to find proper solutions of his concerns. Where farmers of developed countries can use their smartphones to remotely monitor their equipment, crops, and livestock, as well as obtain stats on their livestock feeding and produce. They can even use this technology to run statistical predictions for their crops and livestock. We are still depending the traditional system eliminating the scope of using the potentiality of our fields fully. So for creating new opportunities and new employment and for better crop production we have made a system which will measure the pH value of the soil and suggest fertilizers through SMS or phone call to the users' mobile number.

1.3 Objectives

Our objectives for making the system are-

1. To build up an effective communication between farmers and their field.
2. To make a system suggesting solution for the problem a farmer is facing.
3. To remove the hassle of the farmer.
4. To improve crop production.
5. To storing the data for further analysis.
6. To creating new employment opportunity for technical people.
7. To improving Economy.

1.4 Expected Outcome

We are expecting our system will work properly with a great efficiency creating a lot of opportunities and improving the crop production of our country.

We expect to-

1. Building “DIGITAL AGRICULTURE” in Bangladesh.
2. Produce more crops with efficiency.
3. Effective use of resources available for farmers.
4. Making the soil more fertile.
5. Effective recommendation system for fertilizer.

1.5 Report Layout

This report contains five chapter in which we described all necessary things of our project. This section consists of preview of all the chapters.

1. Chapter one consists of introduction, motivation and expected outcome of our study.
2. In chapter two the related research work is discussed. This chapter also provides problem scopes of the research.
3. Chapter three consists of requirements of the proposed system, system architecture and system flow diagram.
4. Chapter four of this report describes our proposed system design, implementation and testing.
5. Lastly in chapter five we discussed about conclusion, limitations, comparison and future study.

CHAPTER 2

Background

2.1 Introduction

Bangladesh's rustic economy, and particularly horticulture, have been intense drivers of neediness decrease in Bangladesh since 2000. Without a doubt, farming represented 90 percent of the decrease in destitution somewhere in the range of 2005 and 2010. Bangladesh has gained admirable ground in the course of recent years in accomplishing food security, in spite of incessant catastrophic events and populace development (nourishment grain creation, for instance, tripled somewhere in the range of 1972 and 2014, from 9.8 to 34.4 million tons). With one of the quickest rates of efficiency development on the planet since 1995 (averaging 2.7 percent for each year, second just to China), Bangladesh's agrarian area has profited from a sound and reliable strategy system upheld up by generous open interests in innovation, provincial foundation and human capital. Be that as it may, Bangladesh is among the most helpless nations to environmental change, which represents a long haul risk to the nation's agrarian segment, especially in regions influenced by flooding, saline interruption, and dry season. In excess of 70 percent of Bangladesh's populace and 77 percent of its workforce lives in rustic territories. Almost 50% of the majority of Bangladesh's specialists and 66% in provincial zones are straightforwardly utilized by farming, and around 87 percent of rustic family units depend on horticulture for in any event part of their salary. As for the growing population the land for food production is decreasing day by day. So it is becoming more necessary to produce more food in limited area of production.

2.2 Related works

U. Hashim and M. N. Haron have worked with the advanced showcase framework for Ion Sensitive Field Effect Transistor (ISFET) by utilizing Peripheral Interface Controller (PIC) for testing the pH of substances [1]. Sachin Kumar, Babankumar, Ritula Thakur, Manish kumar have reviewed different soil pH measurement techniques [2]. Sandeep Kumar Jha and Stanislaus F. D'Souza have developed a computer controlled pH meter using op-amp circuit [3]. Yash P. Kalra have proposed different methods to measure the pH of soil [4]. Robert D. Forest have worked with various chemical properties of soil [5]. Dr. A. Cottenie have worked with soil testing for recommending fertilizer [6]. William McGlynn suggests that specific pH meter should be used during food production to maintain the quality of food [7]. B.SalehaBegum and A.Suresh Kumar have worked with the embedded instrumentation for the measurement of the pH of soil [8]. Martin Bílek, Jiří Rychtera, Karel Myška and Petra Skalická have discussed about using real and virtual pH meters [9]. Carl E. Moore and Bruno Jaselskis have worked with the pros and cons of the pH meter [10]. Sonikajha and Suneetha V have analyzed the soil of different places for the nutrient elements [11]. Samuel E. de Lucena has worked with the electronic detail of pH meter [12]. Michael Schirrmann, Robin Gebbers, Eckart Kramer and Jan Seidel have worked with the soil pH mapping [13]. All of them have proposed models of pH measurement of different substances and some of them proposed soil pH testing.

2.3 Scope of the Problem

We can clearly see that pH plays undeniable role in crop production. Though Bangladesh is going with a good production but for meeting the new upcoming demand it needs to make good use of its little resources with potentiality. So our pH based fertilizer recommendation system will work efficiently in meeting the new demands for crop production.

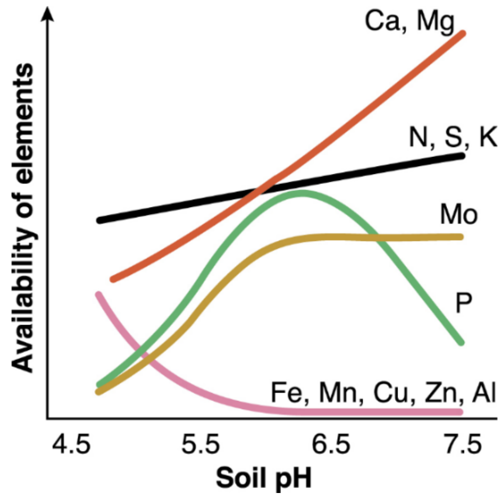


Fig2.3.1: Nutrients in specific pH level

From the above figure we can see that at pH level of 6.5 to 7.5 all the elements necessary for production of crops are available. Our system will help the user to attain this pH level recommending the necessary fertilizers

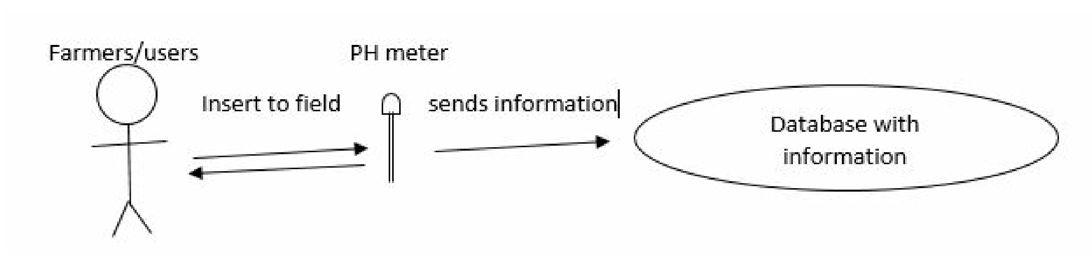


Fig2.3.2: How our system works

2.4 Challenges

We remarked some of the challenges for making our system –

1. Using the low cost equipment.

   We are using low cost equipment for implementing our system, as a result sometimes our system fails to measure the pH accurately and make wrong suggestion.

2. Proper maintenance of the product.

   As a new user and as the device is new maintaining properly is a great challenge.

3. Working with sensitive sensors

   As all the sensors were really sensitive to work with, it was really hard to determine the output. In the implementation process we made some serious damage to some parts of our device. Sometimes the outputs were too confusing to deal with.

4. Working with new sensors

   As we were working with a new kind of sensor that we had no knowledge of, it was sometimes very much difficult for us to handle situation that are not known to us

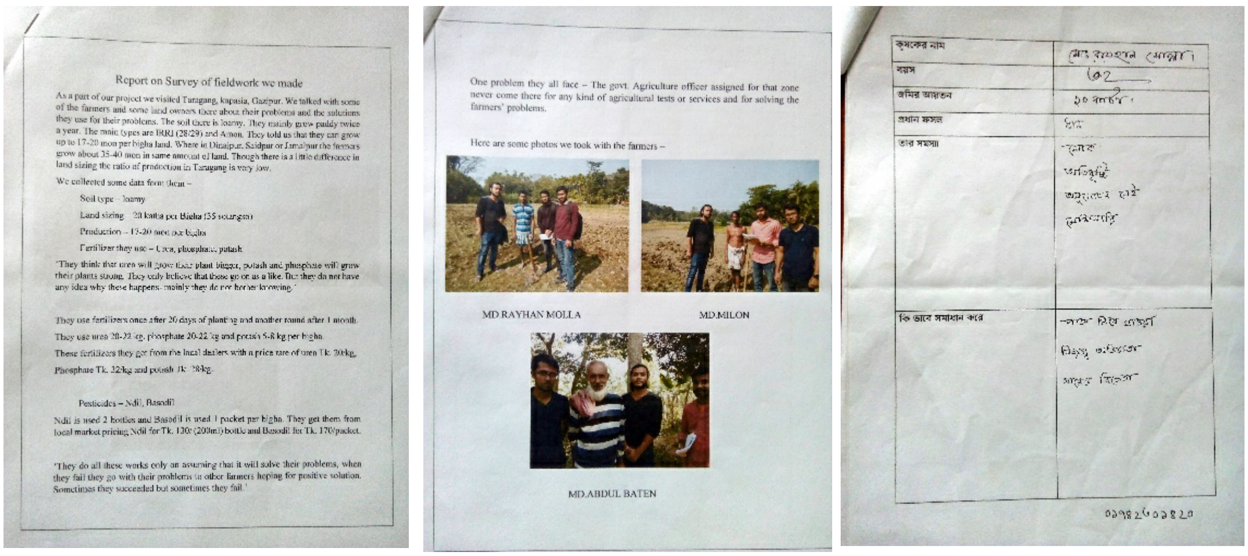
CHAPTER 3

Requirement Specification

The farmers of Bangladesh currently use their own knowledge or previous experience for selecting fertilizer for their fields. They use the traditional method for cultivation which leads them to some unknown problems that are difficult for them to solve. Requirement Specification. Our proposed system is intended to offer an access to the farmers' fields remotely to gather the information about the nutrients of the soil which will later be saved on the database and required solution will be forwarded to the farmer through SMS or phone call.

3.1 Requirement Collection and Analysis

We collected the necessary data from the farmers and discussed the context of our system model with them, they appreciated our approach and had a positive ness for using our system. We made a questionnaire form to collect the data. Here are some attachments of our data collection and questionnaire form –


Report on Survey of fieldwork we made

As a part of our project we visited Taragang, kapasia, Gazipur. We talked with some of the farmers and some land owners there about their problems and the solutions they use for their problems. The soil there is loamy. They mainly grow paddy twice a year. The main types are IRRI (28/29) and Amon. They told us that they can grow up to 17-20 mon per bigha land. Where in Dinajpur, Saidpur or Jamalpur the farmers grow about 35-40 mon in same amount of land. Though there is a little difference in land sizing the ratio of production in Taragang is very low.

We collected some data form them –

Soil type – loamy

Land sizing – 20 katha per Bigha (35 sotangsho)

Production – 17-20 mon per bigha

Fertilizer they use – Urea, phosphate, potash

'They think that urea will grow their plant bigger, potash and phosphate will grow their plants strong. They only believe that these go on as a like. But they do not have any idea why these happens- mainly they do not bother knowing.'

They use fertilizers once after 20 days of planting and another round after 1 month.

They use urea 20-22 kg, phosphate 20-22 kg and potash 5-8 kg per bigha.

These fertilizers they get from the local dealers with a price rate of urea Tk. 20/kg, Phosphate Tk. 22/kg and potash Tk. 28/kg.

Pesticides – Ndil, Basodil

Ndil is used 2 bottles and Basodil is used 1 packet per bigha. They get them from local market pricing Ndil for Tk. 130/ (200ml) bottle and Basodil for Tk. 170/packet.

'They do all these works only on assuming that it will solve their problems, when they fail they go with their problems to other farmers hoping for positive solution. Sometimes they succeeded but sometimes they fail.'

One problem they all face – The govt. Agriculture officer assigned for that zone never come there for any kind of agricultural tests or services and for solving the farmers' problems.

Here are some photos we took with the farmers –

MD.RAYHAN MOLLA

MD.MILON

MD.ABDUL BATEN

কৃষকের নাম	মোঃ রায়হান মোল্লা
বয়স	৬২
জমির আয়তন	[illegible]
প্রধান ফসল	[illegible]
তার সমস্যা	[illegible]
কি ভাবে সমাধান করে	[illegible]

Fig 3.1.1: requirement collection form and documentation

3.2 Use Case Modeling and Description

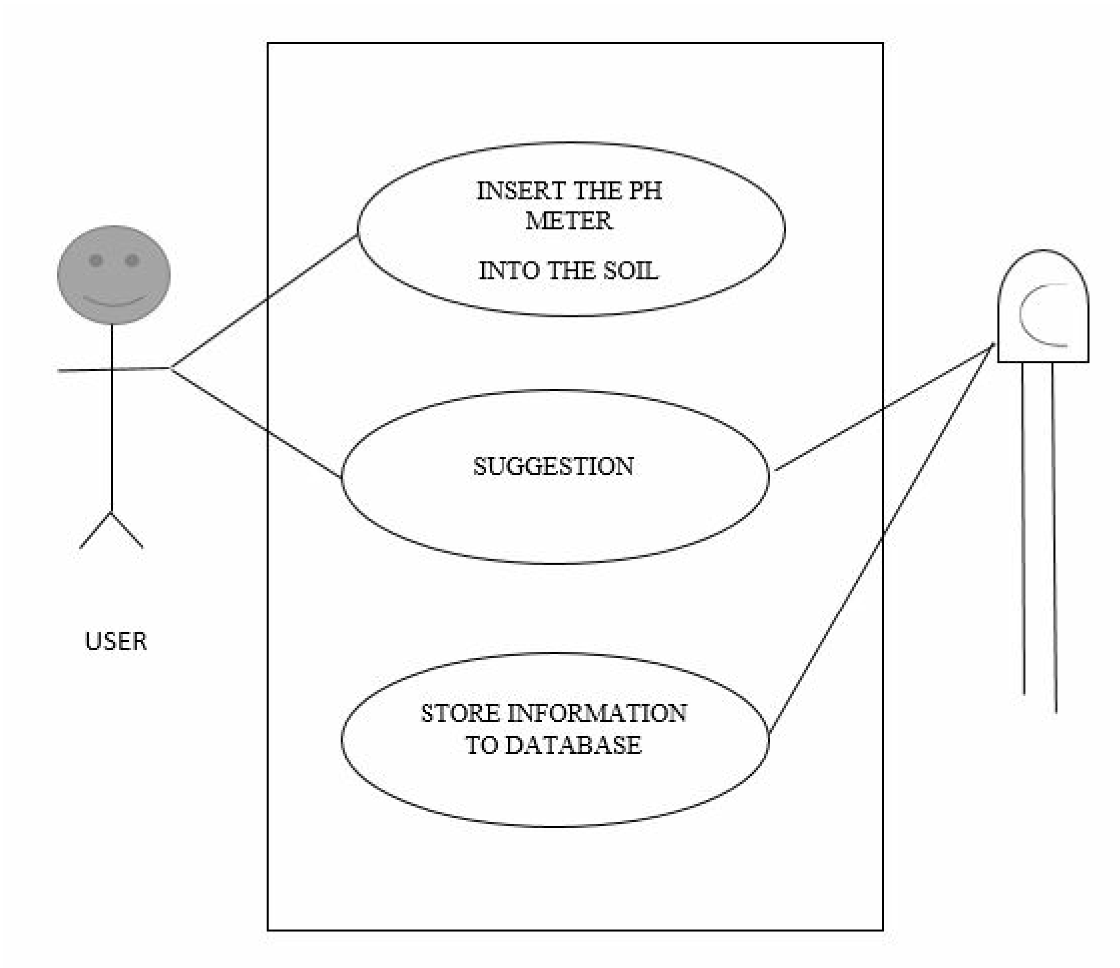


Fig3.2: system boundary

Use Cases

Insertion of The device

Table 3.2.1: use case for insertion of the device

Use Case Name:	Insertion the PH meter to field Suggestion
Brief Description:	While user will insert the device the whole system will work The system will make suggestion of fertilizer according to the recorded PH value
Priority	Essential
Priority	Essential
Trigger	N/A
Trigger	N/A
Precondition	User must activate the device
Precondition	User must successfully insert the device to their field
Basic Path	After insertion the device will get a PH value of the field based on which the
Basic Path	The attached GSM module will send information to the database as well as the user The attached GSM module will send information to the database according to the reading from the PH meter
Alternate Path	N/A
Post condition	N/A User will have to remove the device after getting value and clean in before second use
Exception Path	If there is a connection failure device will recommend the user as instructed
Exception Path	If there is a connection failure device will recommend the user as instructed

Suggestion

Table 3.2.2: use case for suggestion process

Use Case Name:	Sending Information to Database
Brief Description:	The system will recorded the PH value of the soil of the user to a database
Priority	Essential
Trigger	N/A
Precondition	User must switch on the device
Basic Path	The attached GSM module will send information to the databases according to the reading from the PH meter
Alternate Path	N/A
Post condition	N/A
Exception Path	If there is a connection failure device will recommend the user as instructed

Sending Information to Database

Table 3.2.3: use case for sending information to database

3.3 Logical Data Model

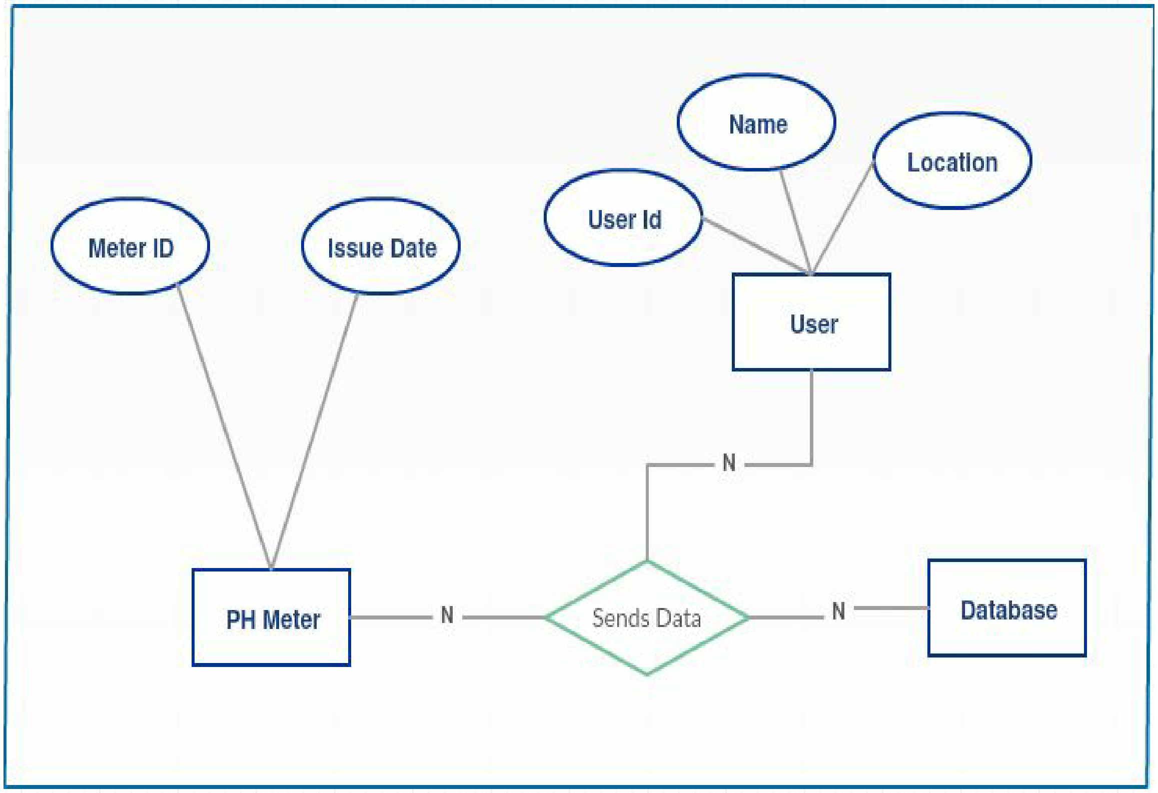


Fig3.3: Logical model of our system

3.4 Non-functional requirements

Performance Requirements

The system shall function in real-time, Sending SMS to user and storing the PH value to the database will be performed simultaneously.

Availability & Reliability

All the information of the field will be sent to the database from where any farmer can get their information through authorization (If they wish to get information).

Security Requirements

The system will be switched off with the click of one button. User must be careful about the usage of the battery otherwise it will make them to buy new batteries.

Replacing the device (in case of failure) requires the user's physical presence.

3.5 Equipment's for Proposed System

- Arduino Uno
- pH meter
- GSM Module (Sim 808 v3.2)
- Arduino IDE

3.5.1 Arduino Uno

Arduino Uno is a microcontroller board dependent on the ATmega328P (datasheet). It has 14 advanced info/yield pins (of which 6 can be utilized as PWM yields), 6 simple data sources, a 16 MHz quartz precious stone, a USB association, a power jack, an ICSP header and a reset catch. It contains everything expected to help the microcontroller; essentially associate it to a PC with a USB link or power it with an AC-to-DC connector or battery to begin.

Fig 3.5.1: Arduino UNO

3.5.2 pH meter

A pH meter is a logical instrument that estimates the hydrogen-particle movement in water-based arrangements, demonstrating its causticity or alkalinity communicated as pH. The pH meter estimates the distinction in electrical potential between a pH cathode and a reference terminal, thus the pH meter is some of the time alluded to as a "potentiometric pH meter". The distinction in electrical potential identifies with the acridity or pH of the arrangement.

Fig 3.5.2: pH probe meter

3.5.3 GSM Module

A Quad-Band module that consists with GSM/GPRS also combined with GPS technology. It is fast and cost efficient. We have used this for sending message to the users.

Fig 3.5.3: GSM module

3.5.4 Arduino IDE

For our project, Arduino IDE has been used to upload the program on microcontroller device for measuring the pH value. Arduino is an unreservedly disseminated model stage which involves a circuit board, that can be programed (implied as a microcontroller) and a moment programming bundle called Arduino IDE (Integrated Development Environment). This IDE keeps running on PC to compose, accumulate and transfer program in various kinds of physical board.

The Arduino Platform has ended up being especially notable among specialist and designers. Arduino items are uninhibitedly disseminated equipment and programming under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL).

Fig 3.5.4: Arduino IDE

CHAPTER 4

Design, Implementation and Testing

4.1 Introduction

Approaches that has been taken for solving our system will be discussed in this section. Our system is for those farmers and users who do not get the proper help from the agriculture officer for their problems as well as the do not know how they can improve the condition of their fields for more production. The pH meter will measure the pH of the soil and that value will indicate the amount of nutrient present in the soil. After that our system will suggest the amount of fertilizer to be applied in the field for betterment and gaining optimal condition for production. We have used the GSM module for that

4.2 System Design

Our system has two parts –

One is to measure the pH of the soil, for this we are using the pH probe meter and the Arduino development board.

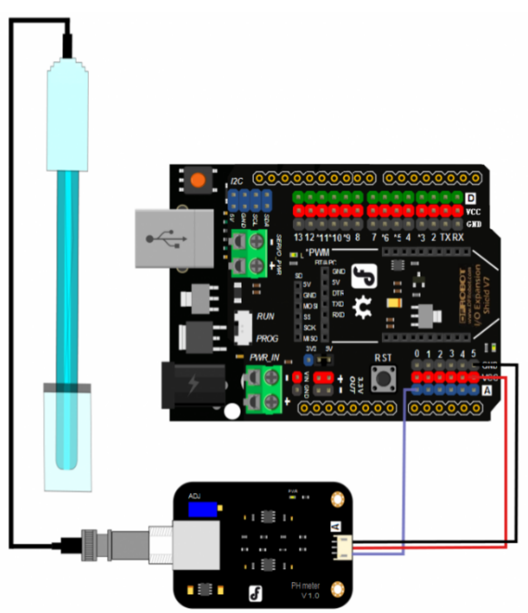


Fig4.2.1: measuring the pH

Another part is to send suggestion to the user containing the amount of fertilizer.

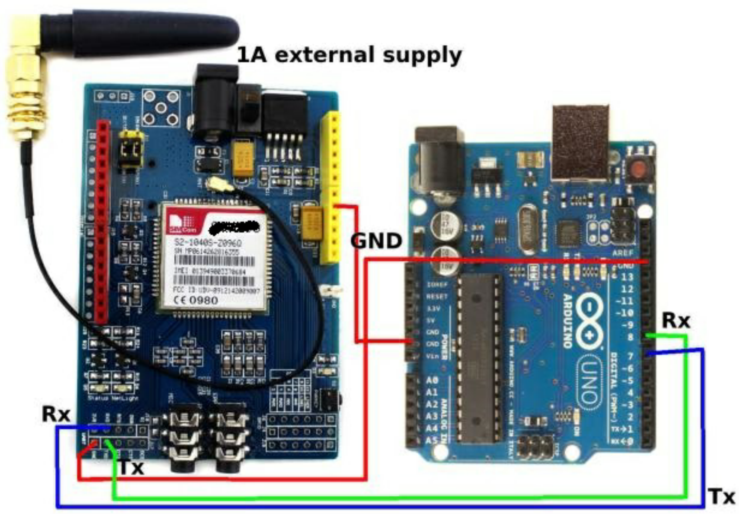
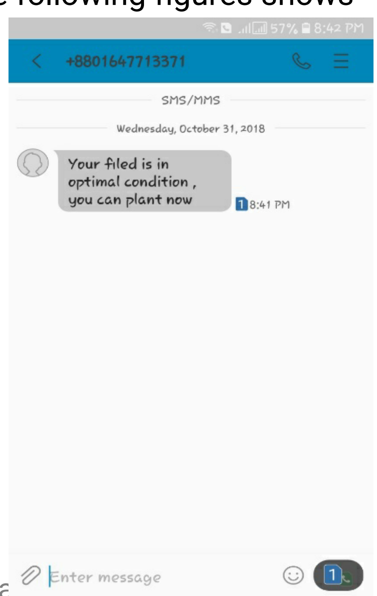


Fig4.2.2: Sending the suggestion

4.3 Implementation of the System

We have implemented the full system in working conditions. The following figures shows that.



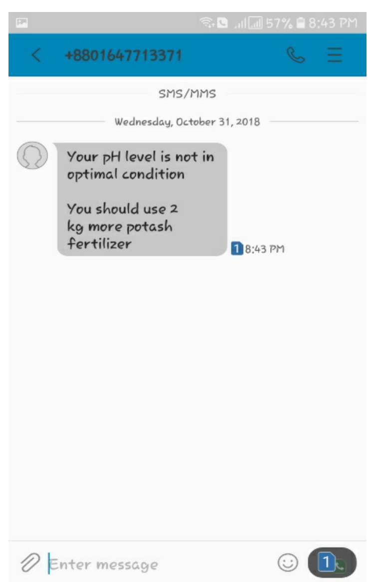


Fig4.3.1: SMS result from our system

Here are the block diagrams of our system –

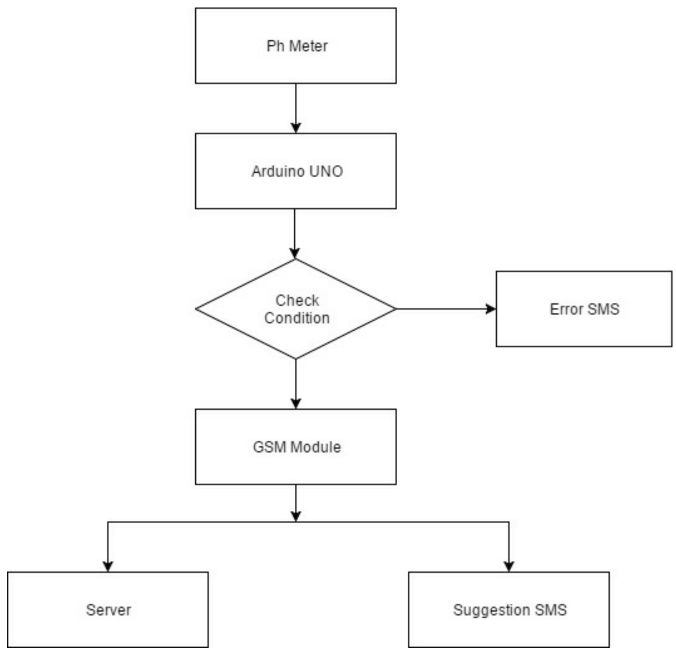


Fig 4.3.2: block diagram for pH measurement

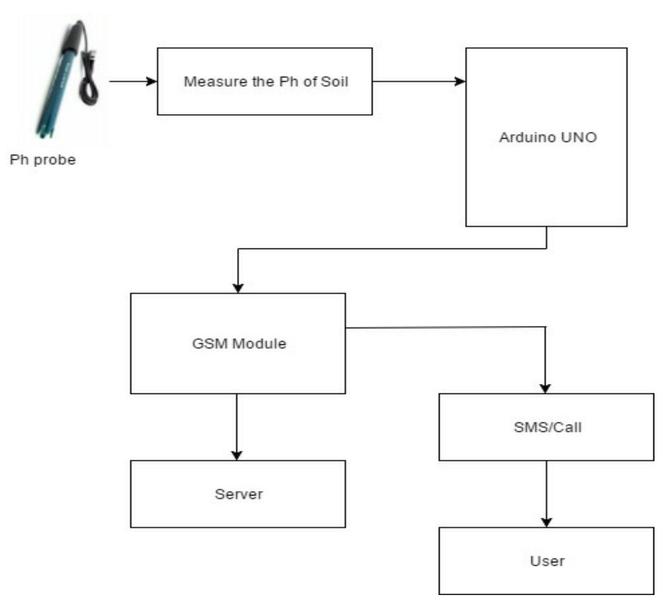


Fig 4.3.2: System architecture

Circuit Diagram of our system

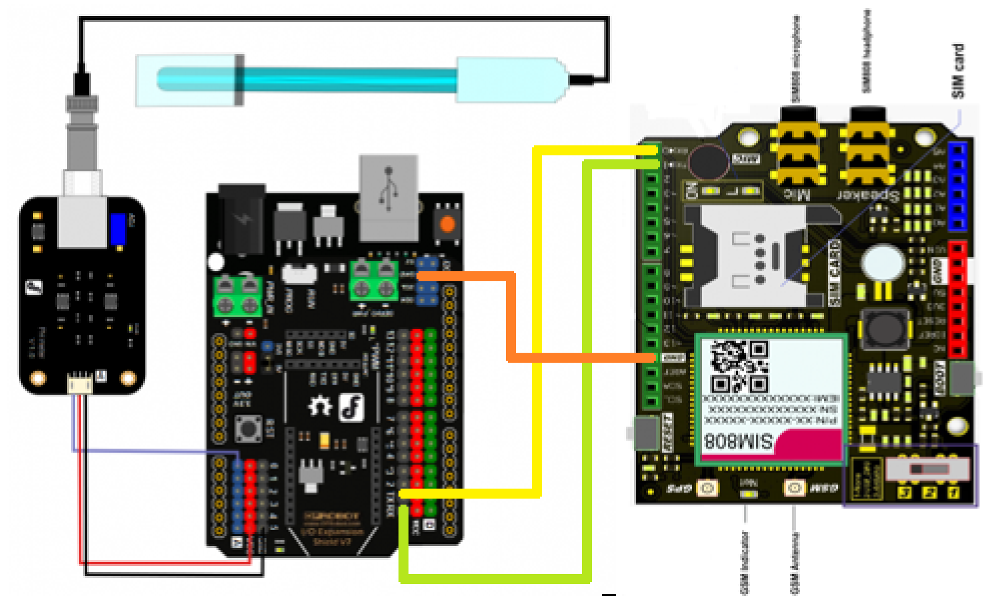


Fig4.3.3: Circuit diagram of our system

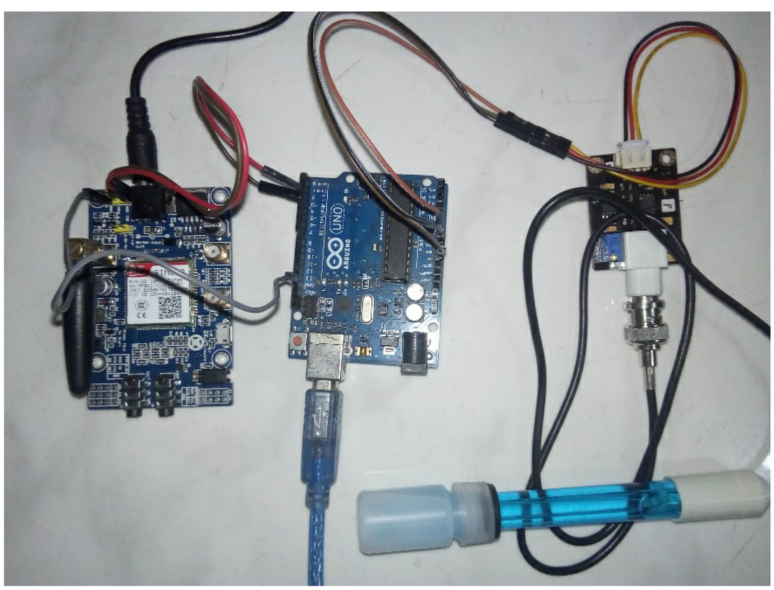


Fig4.3.4: Circuit diagram of system

Results of our system

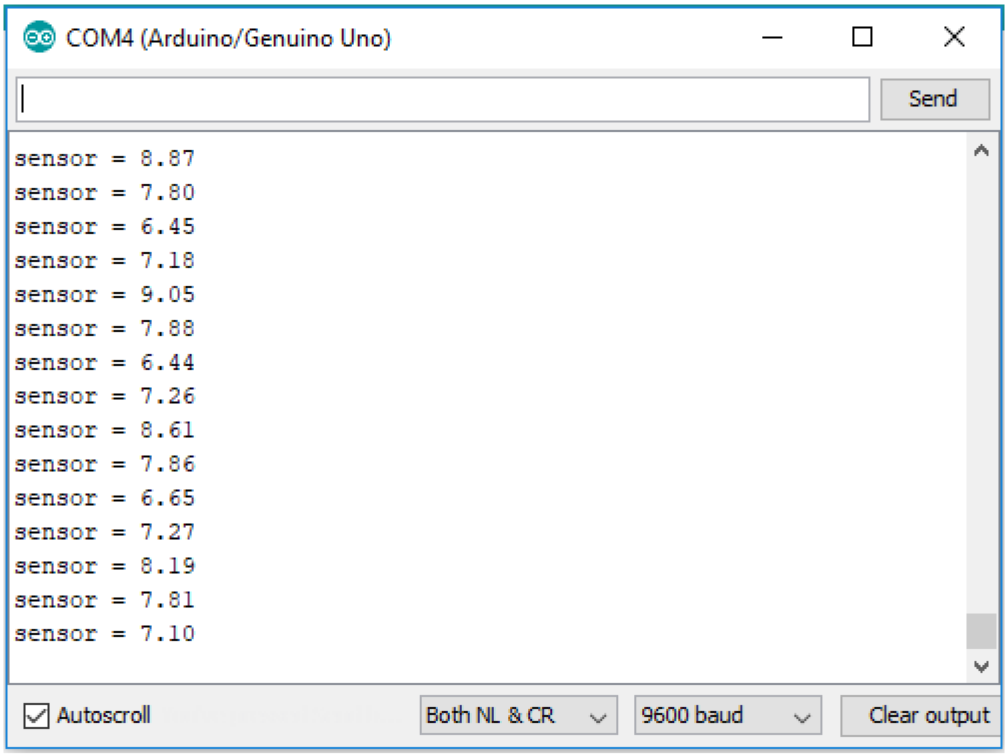


Fig4.3.5: Result- Reading of pH meter

4.4 Testing

Unit Testing

Unit testing have focused on verifying the least unit of the designed software. White box testing is applied here. Measuring the pH value is tested and if it gives correct values then value is sent to the corresponding users.

Integration test

Integration testing is the black box testing where software is tested. For verifying functionality and its performance integration testing is performed. We have tasted our system through integration testing. All module including in our system design are tested.

TABLE 4.4.1: INTEGRATION TEST

Test Case	Expected Result	Observed Result	Test Result
Measuring pH of substance	Can measure properly	Can measure properly	pass
		Can't measure properly	fail
Send notification via SMS to user	Can send SMS properly	Can Send SMS properly	pass
		Can't Send SMS properly	fail
Send error notification via SMS to user	Can send SMS properly	Can Send SMS properly	pass
		Can't Send SMS properly	fail

CHAPTER 5

Conclusion, Implication for Future Scope

5.1 conclusion

Measurement of the pH is a good indicator of soil ingredients. Our model is going to help better production for meeting the future demand in Agriculture. This gadget is more practical, solid, and compact. Utilizing this instrument, agriculturists can quantify pH physically or progressively with normal interims. Continuous observing is critical, where the cathode is fitted in the dribble water system framework, where we can screen the pH of the liquids directed in the trickle water system channels. Utilizing this framework rancher can assess the soil nutrient present in the dirt and absence of level of supplements to be included for a particular harvest by utilizing predefined information gave. Users can have the recommendations from our system, so he can enhance the product yields in a proficient way.

5.2 Limitations

The obtained result may contain some errors. As we were not able to work with the actual sensors the errors occurred due to the sensors' not being enough qualitative. Sometimes the GSM fails to send the correct SMS due to some sort of connection errors and wrong measurements.

5.3 Comparison between existing system and our system

All the existing systems works with the pH analysis of different substances, food elements. Some of the studies are about soil testing and some are about soil ingredient analysis. But our proposed system works with the measurement of the soil pH and then understanding the amount of soil nutrient and then suggesting the amount of fertilizer to be applied in the corresponding fields. Which will help users a better production than before.

5.4 Future Scope

We are planning to improve our system with more efficient sensor and at the same time storing the value of the soil ingredients to a database so that the data can be analyzed for further studies. We hope we will make our system suggesting fertilizer for a specific crop through an android application

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Appendix

Corrosiveness- The quality

Unreservedly- completely

Ascertained- Make sure of

Destitution- poverty

Rustic – Rural

Agrarian- Land for cultivation

Disseminate- Spread