ST. XAVIER'S COLLEGE

(Affiliated to Tribhuvan University)

Maitighar, Kathmandu

Final Year Project Report

on

Sajilo Agronomy: IOT in soil study and automated irrigation for plantation and farming in Nepal - [CSC- 404]

A Final Year Project Report submitted in the partial fulfillment of the requirement for the degree of Bachelor of Science in Computer Science and Information Technology awarded by Tribhuvan University

Under the supervision of

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Submitted to
ST. XAVIER'S COLLEGE
Department of Computer Science
Maitighar, Kathmandu, Nepal
August 6, 2017

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CERTIFICATE OF APPROVAL

The undersigned certify that they have read and recommended to the Department of Computer Science for acceptance, a project proposal entitled **"Sajilo Agronomy: IOT in soil study and automated irrigation for plantation and farming in Nepal"** submitted by **Anu Kadel (2674/070) and Hemanchal Joshi (2688/070)** for the partial fulfillment of the requirement for the degree of Bachelor of Science in Computer Science and Information Technology awarded by Tribhuvan University.

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ABSTRACT

This system comprises of information for the large scale agriculture and it tends to simplify the difficulties in smaller gardening processes as well. As agriculture and farming requires the crops to harmonize with the soil they are planted in soil study is an important mechanism in agriculture. Agriculture requires irrigation, and with every year we have more water consumption than rainfall, it becomes critical for farmers to find ways to conserve water while still achieving the highest yield.

Sajilo Agronomy is mobile application that facilitates farmers with soil study and automated irrigation with the involvement of IOT. Automated Irrigation is a modified form of drip irrigation which is a valuable tool for accurate soil moisture control and irrigation. This project is a methodology to overcome under irrigation, over irrigation that causes leaching and loss of nutrient content of soil. The idea of automated irrigation and soil study helps to resolve major hardships the farmers along with locals are facing regarding gardening and agriculture, leading them to utilize their effort for efficient farming producing highest yield.

Keywords: Automatic Irrigation, Drip Irrigation, Soil moisture sensor

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LIST OF ABBREVIATION

GDP	Gross Domestic Product
ITC	Information and communication technology
IOT	Internet of Things
IDE	Integrated Development Environment
GSM	Global System for Mobile communication
SMS	Short Message Service
NARC	Nepal Agricultural Research Council
USB	Universal Serial Bus
JDK	Java Development Kit
UML	Unified Modeling Language
ER	Entity Diagram
DFD	Data Flow Diagram
IIS	Internet Information Services

CHAPTER 1: INTRODUCTION

1.1 Background

Nepal is an agriculture based country for main source of food, income, and employment. About 88% population live in rural area and depend on agriculture for livelihood. Nepal being an agricultural country employs more than 2/3 of country's population. But, contributing to 35% of the country's GDP is one of the highly unproductive sector [1].

Today a new paradigm of agricultural development is fast emerging: in both developing and developed countries and ICT is playing a great role for it. ICT can bring new information services to rural areas where farmers, as users, will have much greater control than before over current information channels. The role of ICT to enhance agricultural market and support farming cannot be ignored. Its role in agriculture, which includes use of computers, Internet, geographical information systems, mobile phones, radio and television — was endorsed at the World Summit on the Information Society 2005 [2].

"**Sajilo Agronomy: IOT in soil and automated irrigation for plantation and farming in Nepal**" is mobile application which is based on Arduino Uno: ATmega328 microcontroller based embedded design that is used to test the soil moisture level and controls the water supply in the field to be irrigated.

The sensor that is placed on the field detect the humidity in the soil (agricultural field) and supply water to the field which has water requirement. When the sensor senses the requirement of the water in the field, whether there is over or under water supply, it sends the signal to the microcontroller. Microcontroller then supply water to that particular field which has water requirement till the sensors is deactivated again or sends the notification so as to stop the process of water supply. This is done using the Bluetooth module that is connected to the Arduino and the mobile that we are using. In

case, when there are more than one signal for water requirement then the microcontroller will prioritize the first received signal and irrigate the fields accordingly.

1.2 Problem Statement

Agriculture retains the livelihood of more than half of the population of Nepal. Plantation does not always refers to a large scale farming, it can be in a small scale also i.e. Planting trees, various flowers, gardening and many more. As Soil and water are the basic needs for plantation, people have difficulty in analyzing the soil type for the plants they want to grow. Not only this watering the plants every now and then is very time consuming and can lead to wastage of time and effort. Agriculture also requires irrigation, and with every year we have more water consumption than rainfall, it becomes critical for farmers to find ways to conserve water while still achieving the highest yield. With the lack of knowledge of soil type and plantation, there can arise a condition of over-irrigation or under-irrigation as different plants consume different level of water. Taking in mind all these difficulties, Sajilo Agronomy monitors the irrigation and provides the user with detailed information regarding the soil, farming and its feasibility.

1.3 Objectives

The objectives that this project is set to achieve are:

1. To build a trend of using simplified automated irrigation instead of manually watering the plants
2. To digitize the field of agronomy(i.e. both agriculture, horticulture and gardening in small or large scale)
3. To enable farmers as well as commoners to get information about the soils types, yield of the plants in the context of Nepal.

1.4 Significance of the study

In the developed nations, the farming and plantation methodologies have already been digitized. People are uplifting their living standard involving the use of IOT, ICT and various other technical influences in agronomy. Due to prevalence of remote areas where people are unaware about the ICT, disorganization of governments, geographical and political difficulties and lack of public awareness, the agriculture and plantation field which is perceived as backbone of our country has been ignored since ages. The people here have the following difficulties:

1. Lack of information on the geographical diversity and soil study.
2. Lack of simple digitized infrastructure for agronomy.
3. Lack of idea on how to mobilize ICT for plantation and farming

This project is aimed to resolve the difficulties:

1. Delivering the information regarding plantation, farming and soil types.
2. This concept can be used for small-scale as well as large-scale agronomy.
3. Providing farmers with a platform to digitize the farming process to make agronomy easy.

1.5 Project Features

This Project studies on the application of ICT in automatic irrigation in agriculture. It illustrates the use of ICT in agriculture for sensing the moisture of soil and automatic watering of the fields with the use of drip irrigation for optimize use of available water.

As there is lack of the use of automatic irrigation in the context of Nepal, this project provides the research done on the platform that can be used in the fields for automatic irrigation. Constantly being on the field, checking the requirement of the water for the crops is tiresome work, this project provides farmers for the easy implementation of the work where they can check the moisture of the soil using the soil moisture sensor. The

state of the reading then estimates whether the water is to be supplied or not as if the sensor detects that soil is dry, it automatically turns the water pump on and sends the notification to mobile of the farmer who is monitoring the field. Then after the moisture level reaches certain threshold, the water pump is off and again the notification is sent to the farmer's mobile.

The design of the application is done using Android studio and the business logic is written in C for Arduino which serves as microcontroller.

1.6 Feasibility Study

Feasibility analysis, is one of the important process in developing a system, it is an analysis and evaluation of a proposed project to ensure if it is technically, economically and operationally feasible. This discuss whether or not the analysis and research done in the context increases the likelihood of the farmers. Our application is feasible in following factors.

1.6.1 Technical Feasibility

The current application developed is technically feasible. Our application is built in Android Studio platform using C programming language and can run in Windows, Mac OS X, and Linux.

1.6.2 Economic Feasibility

The system requires the use of Arduino IDE which is open source and has features of saving and exporting and also displays errors. Developing the mobile application using Android studio is also quite feasible. The use of the hardware used in this project is quite minimal as is done for small scale work. The maintenance of the system would also be low.

1.6.3 Legal feasibility

The application designed does not violate any rules or regulations. Whatever the formulas and measures were researched and used are noted with references of their paper published and author names. Also this project will not violate copyright act because with full description of references we have documented each and every minor parts thinking sensitively. And in regards of codes, they are coded by our team members and the copyright solely goes to our team member only.

1.6.4 Operational feasibility

Operational feasibility aspects of the project are to be taken as an important part of the project implementation as projects are beneficial only if they can be worked into real-world System. The system is to be targeted in accordance with some important issues. For the system to work properly all the factors should be taken into thought while carrying out the development and testing activities. If user requirement analysis and timely testing is done then the system works better after implementation. Some of the important issues raised are to test the operational feasibility of a project includes the following: -

- How feasible is the system in the real-world scenario?
- Will the system work properly as it is developed and implemented?
- Whether or not the system will be easy using and beneficial for the user?

The more research and factors one takes into consideration while developing a system, the more the system becomes feasible.

1.7 System Requirements

Requirement analysis is one of the initial tasks performed in software engineering. It is usually comprised of studying the existing system, data collection, hardware requirement and software requirement.

1.7.1 Software Requirement

The minimum software requirements of this system are as follows:

- Operating System: Windows, Mac OS X, and Linux.
- Arduino IDE

1.7.2 Hardware Requirement

The minimum hardware requirements of this system are as follows:

- Computer system / Mobile device
- Arduino, water pump, transistor
- Power supply: 3.3v or 5v
- Output voltage signal: 0~4.2v

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In today's world where population is rapidly increasing, agriculture is becoming more essential to meet the demands of the human race [3]. Counted amongst the naturally blessed Nations, Nepal is a rich country in geographical diversity and water resources. It is an agriculture oriented country where the occupation of majority of the people living in the rural areas is agriculture and farming. Since Irrigation and soil study are two major factors that agriculture and plantation depend upon, watering the plants efficiently and studying the soil according to their feasibility should be prioritized [3][4]. Due to reckless manual irrigation methodology, the water resources are depleting rapidly which can be considered as a threat for an agriculture dependent Nation like ours [5]. To overcome all the difficulties faced due to the unavoidable circumstances during plantation and farming, there is a need of introducing a smart and efficient way of irrigation and soil study that can help us to conserve our water resources that are recklessly being used [6].

A study to focus on soil condition of a certain plantation area and determine when the plants need to acquire adequate water can resolve major problems that arise during plantation and farming [7]. Monitoring the use of water during plantation and farming is a smart way of using resources in agriculture and using IOT for facilitating anyone with wireless communication for irrigation for large scale agriculture as well as a small scale plantation is the basic idea of our project [7] [8].

Nepal Government have been introducing various drip irrigation projects so as to boost the efficiency of agricultural activities. Similarly, World bank is also funding a project called Irrigation and Water Resources Management Project [9]. This project is being implemented under foreign grant assistance or rehabilitation/construction of Farmer's Managed Surface small and medium typed of irrigation projects and assist development of groundwater sources for irrigation together with transfer of management of schemes to farmer's community of some existing agency managed irrigation projects (Kankai,

Sunsari, Morang, Narayani, and Mahakali). Implemented in 4 components, the project aims at to increase production and productivities through the improvement in the irrigation facilities [9] [10]. However, Access to information as a whole is poor in developing countries due to limitations in communication technologies but agriculture methodologies are constantly evolving and the demand of ICT, IOT are increasing in the agriculture sector [11].

IOT is the most recent innovation in the field of ICT defining a worldwide network infrastructure linking virtual and physical objects through maximization of communication capabilities and data capture whereas agriculture today is extended into agronomy which involves farming and plantation of various crops, fruits as well as flowering and non-flowering plants [11] [12] [13]. For such an extended platform the use of technology and communication is a must. IOT/ICT essentially facilitates the creation, management, storage retrieval and dissemination of any relevant data, knowledge and information that may have been processed and adopted [14].

Furthermore, people are unknown about the abundant knowledge available regarding the geographical diversity and feasible crops for the soil types available in their region [15, 16]. This can forbid people from identifying the soil compatible plantation techniques that can increase the productivity [16]. The physical, geological factors and geographical distribution of Nepal is shown in the table below:

Features	**Terai**	**Siwaliks**	**Middle Mountain**	**High Mountain**	**High Himal**
Climate	Sub-tropical	Sub-tropical (but warm temperate in higher hill spurs)	Sub- tropical, warm temperate, cool temperate on high ridges	Warm to cool temperate, alpine	Alpine to arctic (Snow 6-12 months)

Moisture Regime	Sub humid in FW+MWDR; humid in W+C and EDR	Sub humid in most of the area, humid in N-aspect of W+C+EDR and dun valleys	Humid, per humid above 2000 m	Sub humid to per humid	Semi and benid Himal
Rainfall Intensity	High	High	Medium	Low	Low
Vegetation	Sal +mixed hardwoods	Sal + mixed hard woods + pine forest	Pine forest+mixed hardwood and oak forest	Fir, pine, birch and rhododendron	Open meadows +tundra vegetation
Soils	**Ustochrepts, haplustolls, haplaquepts, haplustalfs, ustifluvents & ustorthents**	**Ustochrepts, haplustolls, Rhodustalfs, ustothents, Dystrochrepts, Haplaquepts and Ustifluvents**	**Ustochrepts, haplustalfs, rhodustalfs, haplumbrepts, ustorthents and ustifluvents**	**Eutrochrepts, dystrochrepts, haplumbrepts, cryumbrepts, cryorthents and ustorthents**	**Cryumbrepts, cryorthents and rock**
Crops	Rice, maize, wheat, mustard Sugar cane Jute, Tobacco, Cotton and Tea	Rice, maize, wheat, millet, radish, potato, ginger, tea.	Rice, maize, wheat, millet, barley, pulses, sugar cane, ginger, cardamom	Oat, barley, wheat, potato, buckwheat, yams, amaranthus, medicinal herbs	Grazing (June to Sep)
Horticulture	Mango, litchi, pineapple, jackfruit, imli, potato, tomato	Mango, papaya, banana, potato	Mango,papaya,banana, orange,lime,lemon, peach, plum, potato,cauliflower	Chestnut, walnut, apple, peach, plum, apricot, potato	Apple, walnut, vegetable seed, potato
Note: FW= Far Western, MWDR= Mid Western Development Region, WDR= Western Development Region, CDR= Central Development Region, EDR= Eastern Development Region					

Table 1: Characteristics of physiographic regions of Nepal [17]

Furthermore, along with the soil study and identification of plant feasibility, another major factor for efficient plantation and farming is irrigation. Improving irrigation efficiency can contribute greatly to reducing production costs of vegetables, making the

industry more competitive and sustainable [18] [19]. Recent technological advances have made soil water sensors available for efficient and automatic operation of irrigation systems [20]. Automatic soil water sensor-based irrigation seeks to maintain a desired soil water range in the root zone that is optimal for plant growth.

Automated Irrigation systems are already digitized in the developed countries but is unknown to numerous developing countries due to various circumstances [21]. In-spite of various projects proposed regarding automated irrigation and soil study there is no proper implementation as well as development on automated irrigation in developing countries like Nepal [22]. The automated irrigation system made from studying the agricultural background and its necessities is set to solve the major problems regarding the over and under use of water resources and regarding the plantation and farming. Similarly, an application that enables us to know about the soil types and major information regarding plantation can take a positive step on implementing the information technology on the rural agricultural development [23].

Taking into account the ever growing requirement of the population, modern techniques are introduced to fulfill the demand of food. To increase the food production modern tools, fertilizers, irrigation facilities, soil study etc. are used. In order to give proper attention to the land located far away from the human settlement, supervisory automatic control systems like multi-terminal control systems are used [23] [24]. This project agronomy is managed on the basis of soil information and the plantation techniques. All the agricultural development activities need proper research and actions that depend on the thorough study. The working of the agriculture dependent technology depends on county's context, agricultural land structure and specific agricultural issues like modernization of agriculture, sustainable development, development of agro-environmental practices etc. and agricultural stakeholders such as central administrations, regional decision-makers and local communities [25] .

The information providing application and automated irrigation connected to that application tend to solve almost all the difficulties regarding the rapid water resource use and lack of soil knowledge and geographical structure of the country [26].

Technology is spreading its wings day by day and the elevation of technology towards the development of agriculture is growing efficiently building concepts for the advancement of irrigation and other factors that affect plantation and farming.

2.2 Overview of the similar approaches and case study

An automated irrigation system was developed to optimize water use for agricultural crops [27]. There are various approaches for irrigation (i.e. manual and automated) that are being experimented worldwide. Use of different infrastructure for different outcomes in efficiency and productivity is being checked from time to time. The use of hardware as per the environment variable tend to make the system more efficient [28]. The automated irrigation and monitoring system is flexible and can work diversely with any compatible infrastructures. Mostly GSM modules are used in the system for making it easier to implement the system in rural areas with no android monitoring but it tends to be costly and complicated. Among many modifications and system module variations some similar approaches are:

2.2.1 Use of GSM Module:

GSM module is used for sending SMS to the user. It is a module that can easily be embedded by customer or hobbyist and in an automated irrigation and monitoring system. It is feasible for rural areas as well as urban areas. SIM900 GSM Module provides an industry-standard interface; the SIM800 delivers GSM/GPRS850/900/1800/1900MHz performance for voice, SMS, Data with low power consumption [29].

2.2.2 Use of Solar Panel:

The use of solar energy in agriculture is becoming increasingly popular and the energy produced from this renewable source can be used either on the farm or in the local power grid, As electricity can be the main issue, villagers usually don’t have facility of electricity. In that case solar power is used to power water pumps. In Solar Panel using

system, a charge controller circuit is used to charge the photovoltaic cells for supplying the solar energy to the whole circuit [30]. In solar power auto irrigation system, solar charge controller is used to store dc power of solar panels in batteries. This stored battery is used to power water pumps automatically [31].

2.2.3 Zigbee Module

Zigbee technology is the standard of choice among other wireless technologies due to its efficient low- power connectivity and ability to connect a large number of devices into a single network. Zigbee technology uses the globally available, license-free2.4GHz frequency band. Zigbee technology is the standard of choice among other wireless technologies due to its efficient low- power connectivity and ability to connect a large number of devices into a single network. Zigbee technology uses the globally available, license-free2.4GHz frequency band [32].

2.3 A Case Study at NARC

Nepal Agricultural Research Council (NARC) was established in 1991 as an autonomous organization under "Nepal Agricultural Research Council Act - 1991" to conduct agricultural research in the country to uplift the economic level of the people [33].The vision of the Nepal Agricultural Research Council (NARC) is to tap institutional, human, and financial resources from the government and a wider spectrum of stakeholders—civil society, research centers, donors, and ultimately the private sector—to move the system from agricultural research and development to agricultural research for development [34]. Situated in abundant land in Lalitpur districts, NARC has various departments that conduct various experiments to improvise the Agricultural practices in Nepal. In accordance to the project there is a soil department, a botany department, an engineering department and an agronomy department which covers most of the work done by NARC.

While going through every department studying about the current practices of technology in agriculture to scientists of the different departments, inspecting the field, available resources and experiments for several days, following points were noted:

- The engineering department is mostly responsible for the use of technology in agricultural sector.
- In Spite of a small manual drip irrigation conducted in the engineering department, there was no such experiment which studied the soil, its properties and linked it with irrigation.
- Water Supply for the field is provided manually from a reservoir (Pond) through pipes and a motor.

Figure 1: Drip irrigation experiment in a small tomato field at NARC

As Nepal is a developing country, there is still a lot of room for improvement in the field of agriculture regarding the use of technology. After a lot of research the idea of automated irrigation and soil study was proposed and the proposed project possess the capability to change the scenario if properly modified and implemented in near future.

CHAPTER 3: SYSTEM DEVELOPMENT

3.1 Project Management Strategy and tools

3.1.1 Project Management Strategy

Project management as "the application of knowledge, skills, tools and techniques to a broad range of activities in order to meet the requirements of a particular project." A project is a unique, transient endeavor, undertaken to achieve planned objectives, which could be defined in terms of outputs, outcomes or benefits. A project is usually deemed to be a success if it achieves the objectives according to their acceptance criteria, within an agreed timescale and budget [35].

Project management is essentially aimed at producing an end product that will effect some change for the benefit of the organization that instigated the project. It is the initiation, planning and control of a range of tasks required to deliver this end product. Projects that require formal management are those that [36]:

- produce something new or altered, tangible or intangible;
- have a finite timespan: a definite start and end;
- are likely to be complex in terms of work or groups involved;
- require the management of change;
- Require the management of risks.

3.1.2 System Development tools

System development tools are the tools used for the completion of this project. Some of the tools that are used in this project are described as follows:

3.1.2.1 Android Studio

Android Studio is the official Integrated Development Environment (IDE) for Android app development, based on IntelliJ IDEA [37] As an IDE then, Android Studio provides the interface for to create the apps and to handle much of the complicated file-management behind the scenes. This is used as it is faster and responds to changes more rapidly [38]. In this project, for the development of the mobile app we have used Android studio. We created User Interface for the mobile application along with the necessary components.

3.1.2.2 Arduino Uno R3

Arduino is used for controlling whole the process of this Automatic Plant Watering System. The Arduino UNO is the microcontroller board based on ATmega328. It has 14 digital input/output pins, 6 analog inputs, 16MHz ceramic resonator, USB connection, a power jack. Arduino consists of a microcontroller and Integrated Development Environment (IDE). IDE is used to write and upload computer code to the microcontroller. It can be powered by USB cable or power jack of 5v. The use of Arduino is done in this project because it has simple and accessible user experience. It contains everything needed to support the microcontroller. Arduino simplifies the process of working with microcontroller as it contains everything needed to support microcontroller. This is inexpensive and provides open source and extensible hardware along with extensible software [39].

3.1.2.3 YL -69 Moisture Sensor

Measuring soil moisture is very important in agriculture to help farmer for managing the irrigation system. This is done by soil moisture sensor which measures the content of water in the soil using the LM393 comparator [40]. The module consists of, detection probe, and sensor board. It is having triple output mode, digital, analog, and serial with exact readings. The sensor will detect the moisture of the soil surrounding it, i.e. shortage of water content of the soil. If the contents are low the module output will be high otherwise the output will remain in neutral conditions. This moisture sensor has two probes used to pass the current into the soil, and then it reads that resistance

between two probes to get the moisture level. More water present in the soil makes the soil conduct electricity more easily indicate less resistance, while dry soil having less water conducts electricity poorly indicate more resistance [41]. We connected the VCC (5V) input of Arduino to VCC of the sensor and the GND (Ground) to the GND of the sensor. The analog reading of the moisture value was taken by A0 pin of the sensor and passed onto Arduino's A0 pin which saved the moisture value.

3.1.2.4 Bluetooth Module HC-05

The sensor nodes can obtain the soil moisture, temperature, humidity information in real time, and then transferred to the remote monitoring center by the gateway via the transmission network. Bluetooth module HC 05 works on serial communication. The android app is designed sending serial data to the Bluetooth module when certain button is pressed. The Bluetooth module at other end receive the data and send to Arduino through the TX pin of Bluetooth module (RX pin of Arduino). The Code fed to Arduino check the received data and compares [42].

3.1.2.5 C programing language

C is a high-level and general-purpose programming language that is ideal for developing firmware or portable applications. Originally intended for writing system software, C was developed at Bell Labs by Dennis Ritchie for the Unix Operating System in the early 1970s. C belongs to the structured, procedural paradigms of languages. Because c is supported by Arduino and is easy to use, is flexible and powerful so this programing language is used [43]. We used this language for programming Arduino to collect the sensor value from the soil moisture sensor and transmitted the data to the other device with the help of the Bluetooth module.

3.1.2.6 Java Development Kit

The Java Development Kit (JDK) is a software development environment used for developing Java applications and applets. It includes the Java Runtime Environment (JRE), an interpreter/loader (java) [44]. This provides a runtime environment that "sits

on top" of the operating system layer as well as the tools and programming that developers need to compile, debug, and run applets and applications written in the Java language [45].

3.1.2.7 Draw.io

Draw.io is a browser based diagramming application. It is available as an online application with optional integration to various cloud storage options. Draw.io is free online diagram software for making flowcharts, process diagrams, org charts, UML, ER and network diagrams. This editor built is around Google Drive(TM) that enables us to create flowcharts, UML, entity relation, network diagrams, mockups and more. The data is stored in Google Drive, so no additional third-party to trust with our data which is of great advantage to us [46]. The use of this application was done for the diagrams that helped for to overlook the entire working of the system. We created flowcharts, basic architecture, DFDs, USE CASE, E-R diagram using this application.

3.1.2.8 Circuits.io

Created by AutoDesk, 123D Circuits is part of the company's "sandbox" initiative that offers simple 3D simulators, 3D printing apps, and other tools for beginners and advanced users to take part in the Maker movement. This helped us to learn electronics using a virtual Arduino board and breadboard without blowing up capacitors or burning ourselves with solder on our work table. As Circuits.io is entry-level Arduino tools, it helped improve the product and make it easier for us to get into hardware hacking without any difficulty [47]. We used this application to draw circuit of the entire hardware system that gave visual representation to gain insight in the connection between Arduino, Bluetooth and the sensor.

3.2 System Analysis

The detailed study of the various activities performed by a system from the time of development and even after its implementation is called as system Analysis. It is a

process of collecting and analyzing facts with respect to the existing system operation of the situation prevailing so that an effective computerized system may be designed and implemented if proved feasible. While developing a system a system passes through various phases and in those phases the working mechanism and nature should be studied in detail for the better performance of the system.

Amongst the various platforms available for the system, the framework is to be only chosen after detail research and study. While developing any system, a system follows certain protocols of a system development model for better results. For the project V-process model was followed which includes series of verification and validation techniques for better system development.

3.2.1 V-Process Model

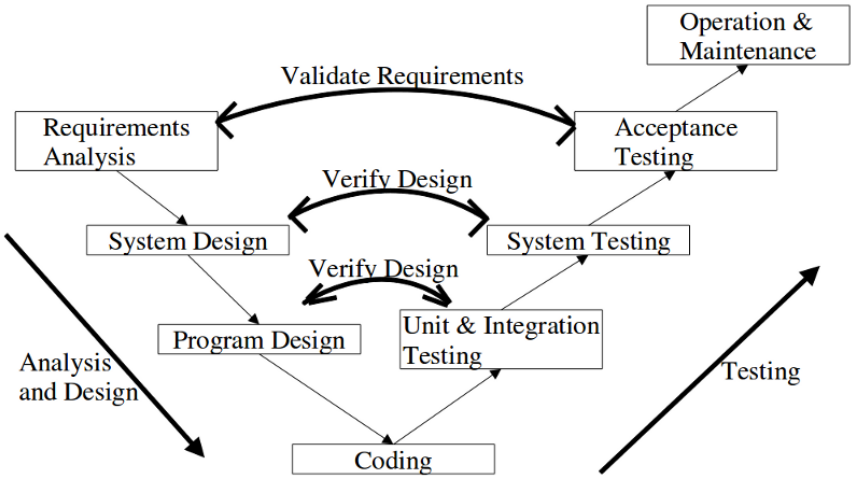


Figure 2: The V-process model [48]

The V-model is an SDLC model where execution of processes happens in a sequential manner in a V-shape. It is also known as Verification and Validation model. The V-Model is an extension of the waterfall model and is based on the association of a testing phase for each corresponding development stage. This means that for every single phase in the development cycle, there is a directly associated testing phase. This is a highly-disciplined model and the next phase starts only after completion of the previous phase.

3.3 System Design

3.3.1 Conceptual Idea

The basic idea behind this project is to provide a digital as well as non-digital platform for the people to optimize the available water resources and to provide adequate information on soil and its productivity which will help them in plantation activities.

These days everybody possess an ICT infrastructure i.e. either just a phone, smartphone or a television. People in the Android smartphone reachable area can utilize the application for soil study as well as automated irrigation. For the people living in the remote areas it is possible to implement the hardware portion only. The literates can widen the scope of internet and technology and distribute resources for the usage of technology in agriculture.

3.3.2 Basic Architecture

The basic architecture of the system is as shown below:

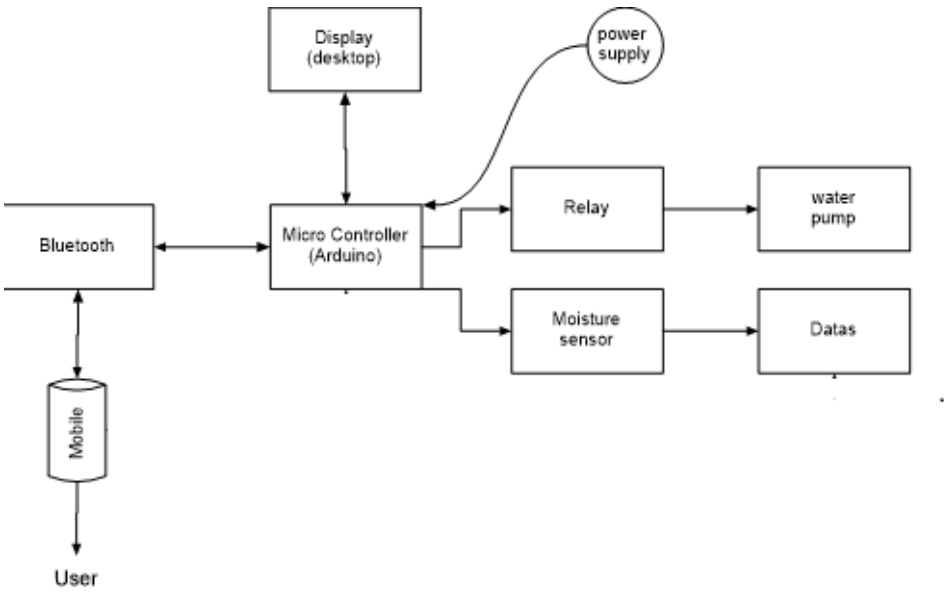


Figure 3: Basic Architecture of the System

The diagram in above shown figure 3 represents the basic architecture for the automatic irrigations implemented using Arduino and Bluetooth module developed by authors. The communication between user and the system work flow is possible with the data transferring mechanism by using Bluetooth (HC-05). The moisture of soil is taken from the sensor and is displayed in the desktop as well as mobile app through the use of Bluetooth that makes the system feasible to use. By the moisture reading done in the system, the user is notified about the state of the water motor.

3.3.3 Flowchart

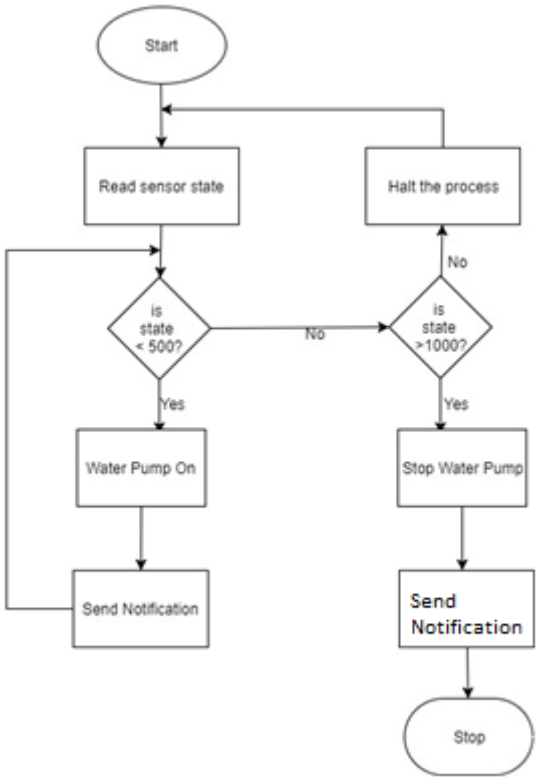


Figure 4: System Flowchart

The diagram in above shown figure 4 illustrates the flowchart of the automatic irrigation system. As the Arduino detects the soil condition of the soil given its designated ranges, it will send an interrupt signal to the relay drivers to switch On/OFF the water pump and deliver the water to the plants. It also then notifies the user with the messages accordingly.

3.3.4 Context Diagram

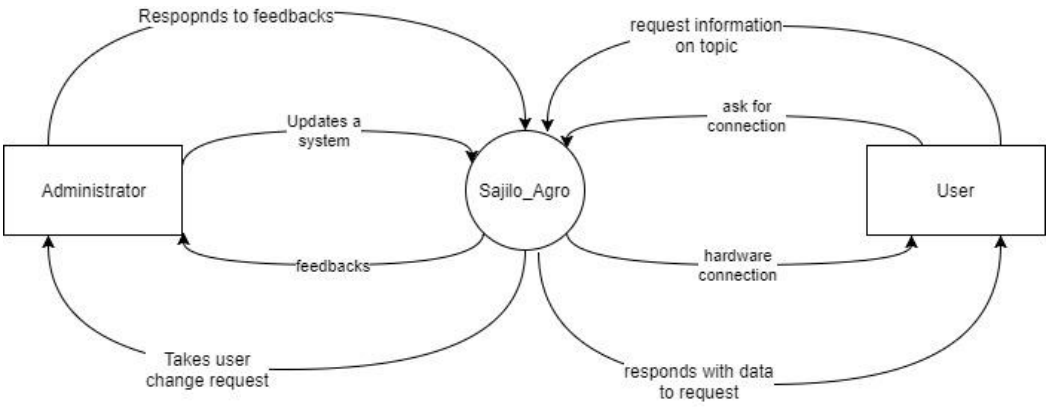


Figure 5: Context Diagram

The diagram in above shown figure 5 illustrates the context diagram of सजिलो Agronomy. It explains the basic entities or stakeholder involved in the system and basic operation performed in the system. A System Context Diagram (SCD) in software engineering and systems engineering is a diagram similar to block diagram and defines the boundary between the system, or part of a system, and its environment, showing the entities that interact with it. This diagram is a high-level representation of a system.

3.3.5 DFD up to Level 2 for major Processes

A data flow diagram (DFD) is a graphical representation of the flow of data through an information system, modelling its process aspects. It gives a overall functioning of a system along with the resources and its relationship with dataflow in the system. DFDs can also be used for structured data designing. It shows dataflow in a system in detail i.e. from where the data comes and where it goes with details. A DFD is carried out in various levels and with an increase in level the dataflow becomes more distinct and detailed.

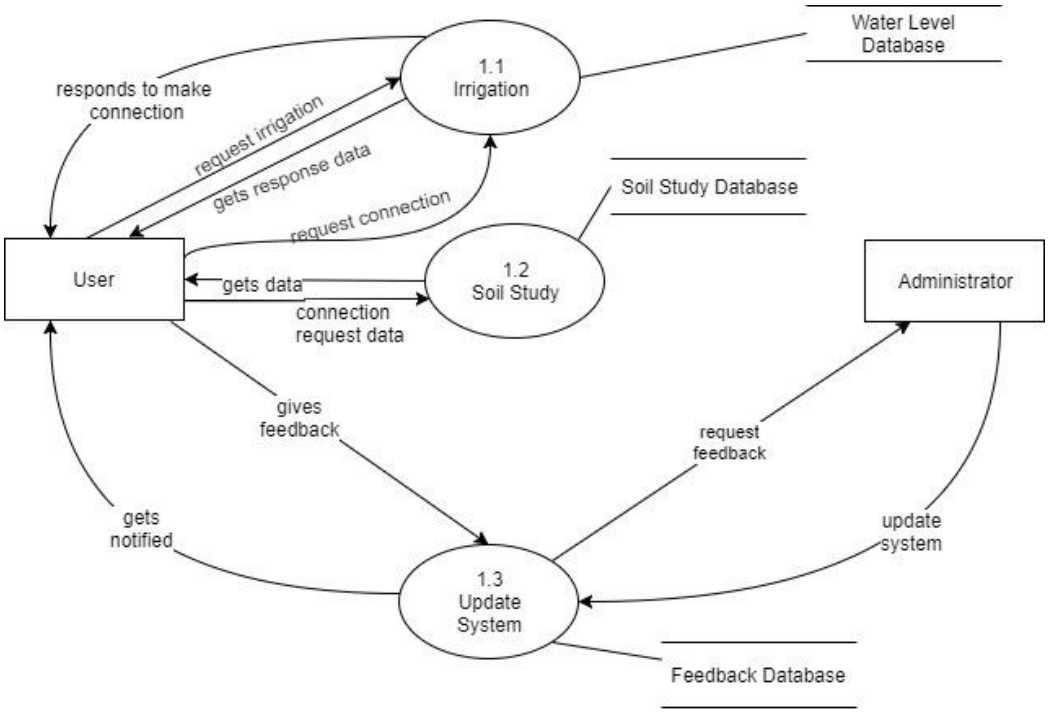


Figure 6: Level 1 DFD

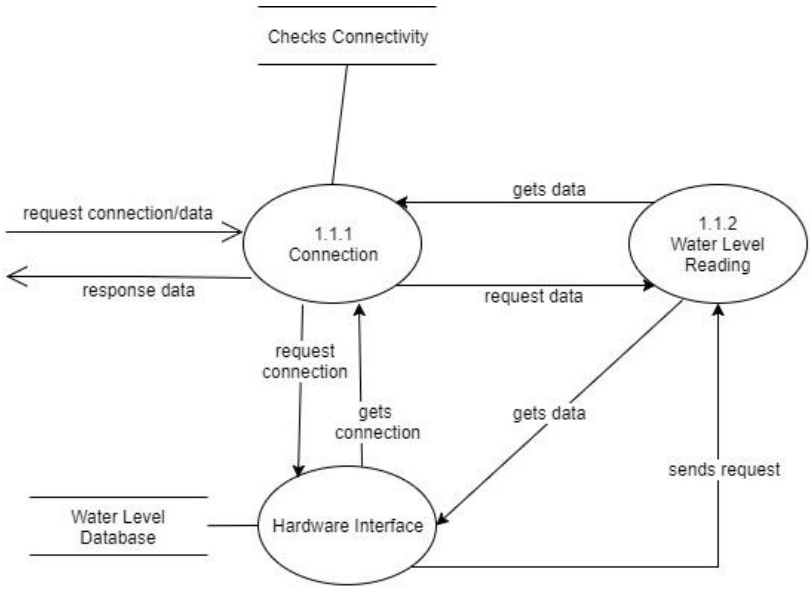


Figure 7: 1.1 Level DFD

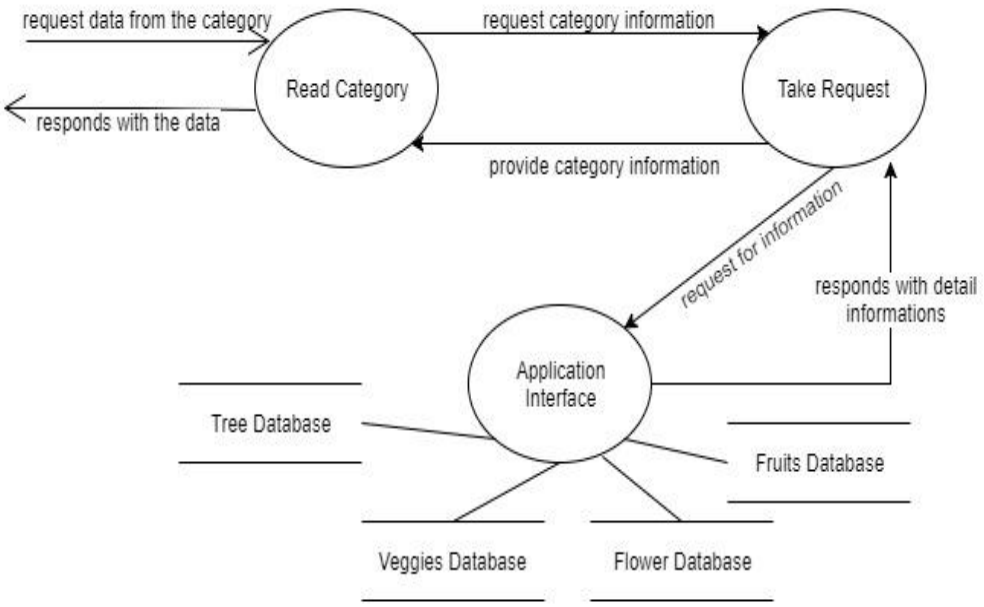


Figure 8: Level 1.2 DFD

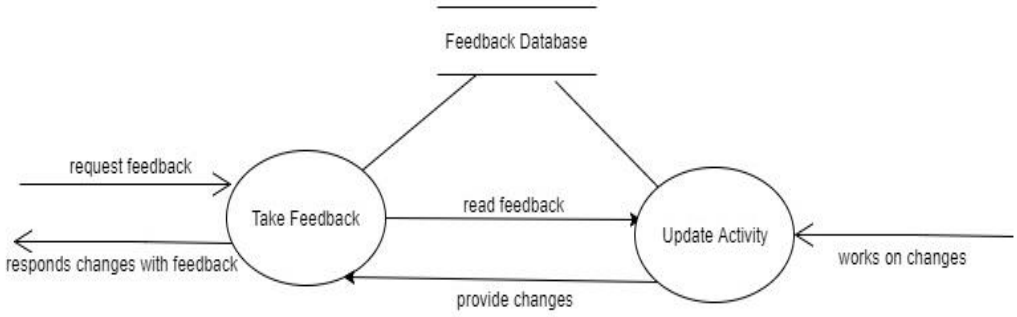


Figure 9: Level 1.3 DFD

The diagram in above shown figures 7, 8, 9 are the level 2 DFD for process 1 of DFD level 1. They give much detailed vision of dataflow in a system with the data source and data base attributes.

3.3.6 E-R Diagram

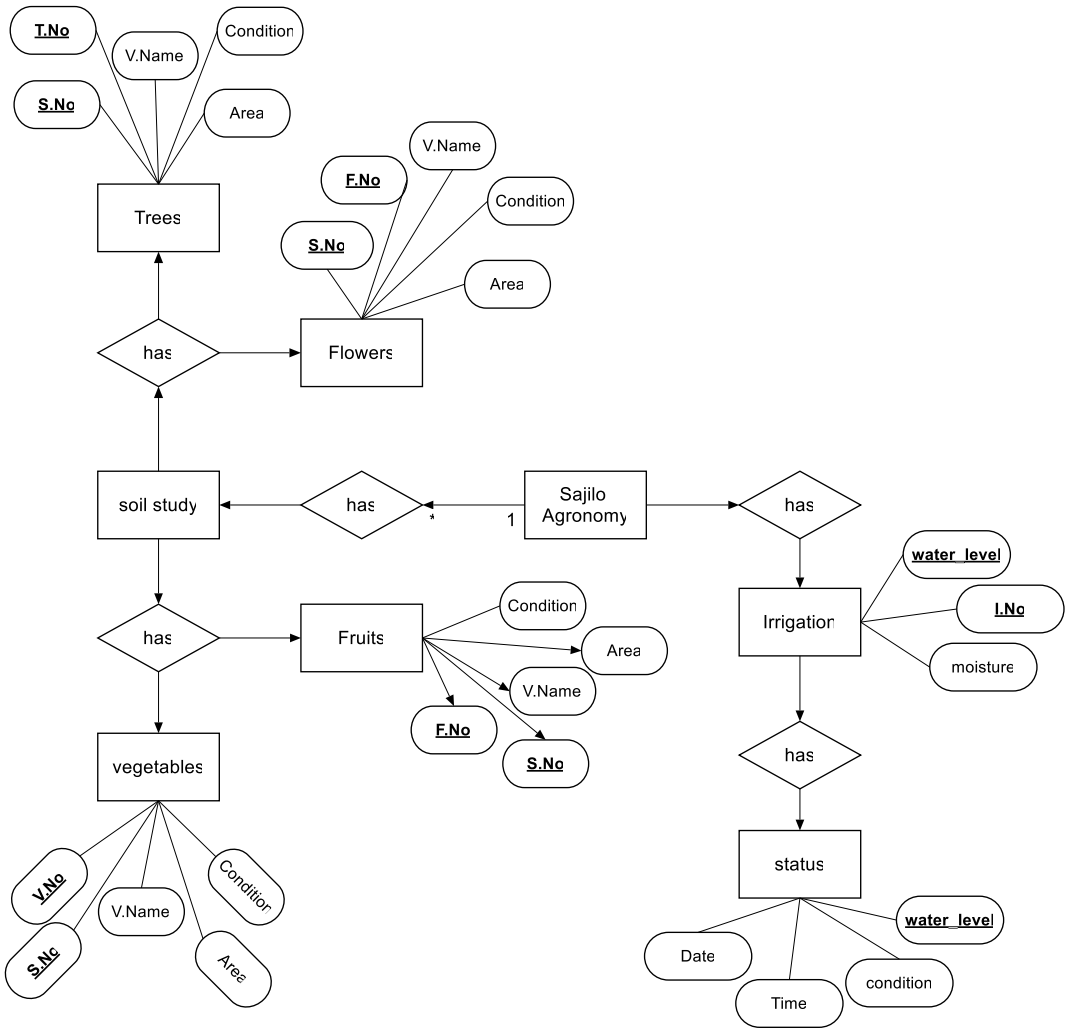


Figure 10: Entity-Relationship (E-R) diagram

The diagram in above shown figure 10 illustrates E-R diagram. The E-R(Entity-Relationship) diagram primarily lists out all the entities present in the system. It gives a clearer concept of the entities, their attributes and the relation between the entities i.e. in what mechanism they work for data flow and how do they synchronize working together in a system. The above E-R diagram represents the entities in the project.

3.3.7 Use Case diagram

Use case diagram consists of use cases and actors and shows the interaction between them. The key points are: i. The main purpose is to show the interaction between the use cases and the actor. ii. To represent the system requirement from user's perspective. iii. The use cases are the functions that are to be performed in the module. iv. An actor could be the end-user of the system or an external system.

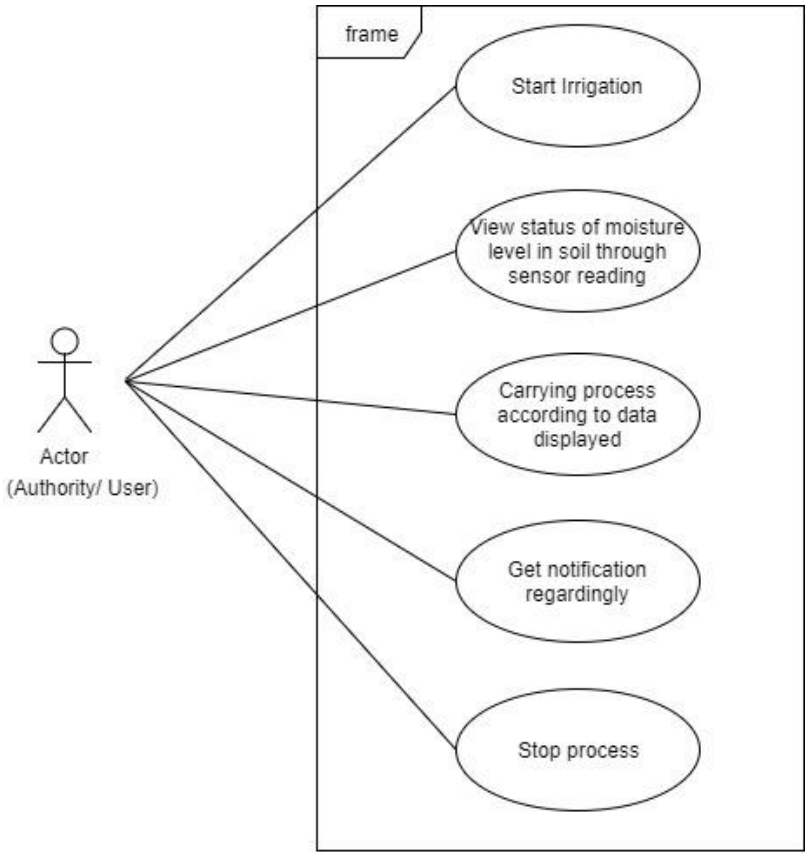


Figure 11: USE CASE Diagram

The diagram in above shown figure 11 represent the use case diagram in the system in which the graphical representation of the events done by an actor are listed out as the system works.

3.3.8 Circuit Diagram

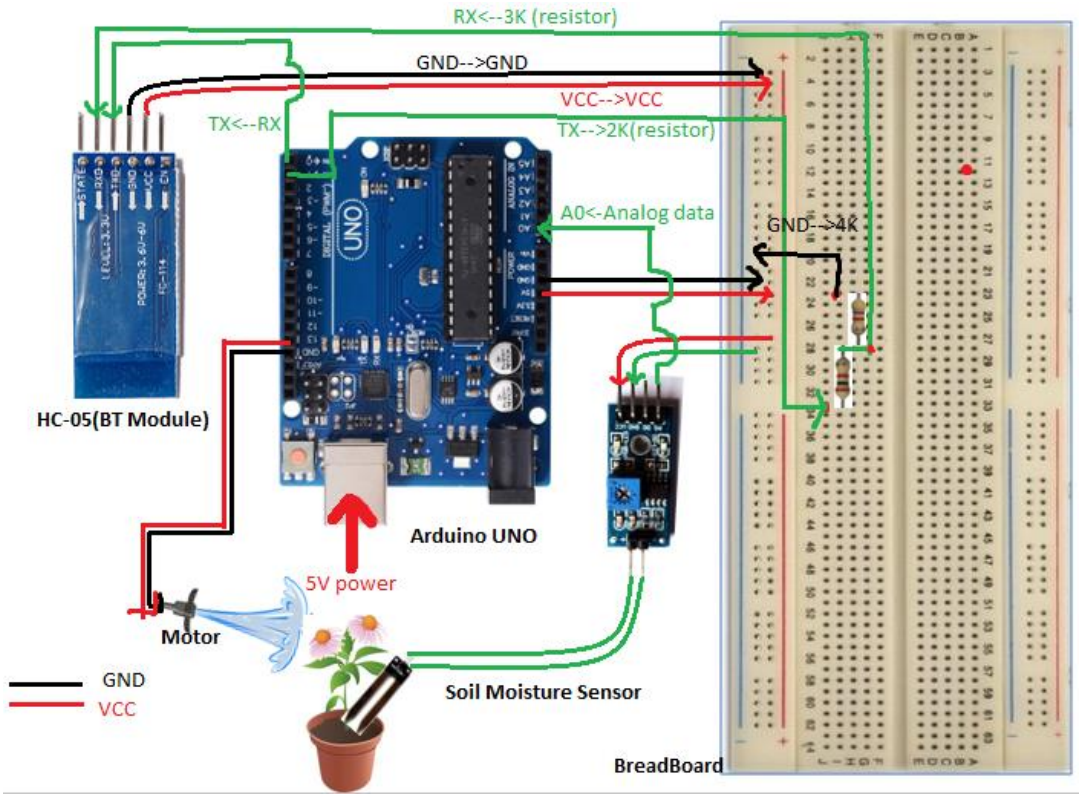


Figure 12: Circuit diagram of the automated irrigation system

The diagram in above shown figure 12 comprises of all the components connected together for a single purpose (i.e. to initiate automated irrigation). The input (VCC-5V and Ground-GND) are given to a breadboard and are transmitted to other components from there. The Soil moisture value is sent to the A0 analog signal carrying pin. The Bluetooth module is wired using resistors to divide the input and get the average. The sensor value is given a threshold according to which the output (PIN 13, GND) works. In this way, the circuit of the system functions

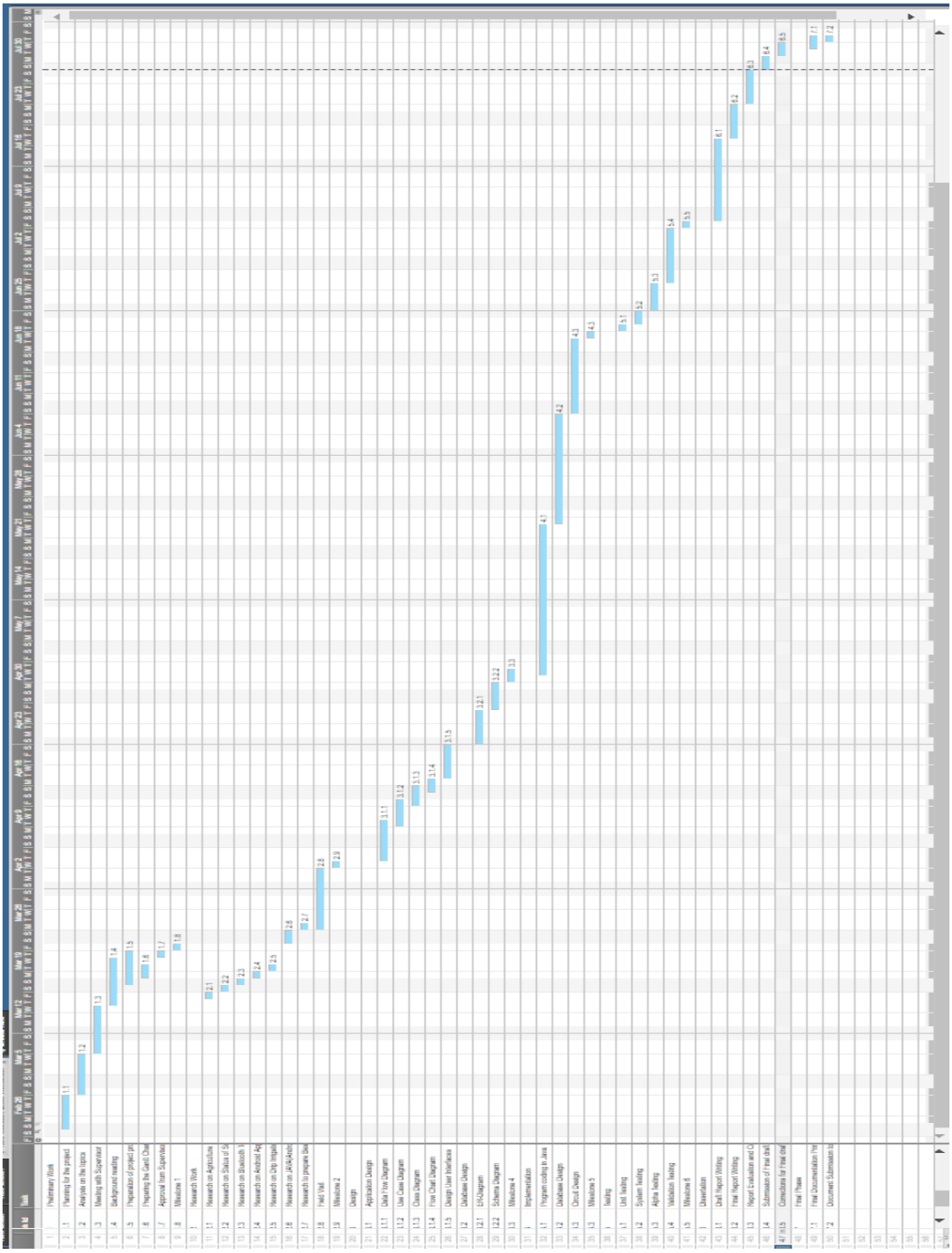
3.4 Project Schedule

3.4.1 Timing Schedule

Task Id	Task	Planned Date			Actual Date		
		Start Date	Duration	End Date	Start Date	Duration	End Date
1	Preliminary Work						
1.1	Planning for the project	02/26/17	5	03/02/17	02/26/17	5	03/02/17
1.2	Analysis on the topics	03/03/17	5	03/08/17	03/03/17	5	03/08/17
1.3	Meeting with Supervisor	03/09/17	7	03/15/17	03/09/17	7	03/15/17
1.4	Background reading	03/16/17	7	03/22/17	03/16/17	7	03/22/17
1.5	Preparation of project proposal	03/19/17	5	03/23/17	03/19/17	5	03/23/17
1.6	Preparing the Gantt Chart and Project Schedule	03/20/17	2	03/21/17	03/20/17	2	03/21/17
1.7	Approval from Supervisor	03/23/17	1	03/23/17	03/23/17	1	03/23/17
1.8	Milestone 1	03/24/17	1	03/24/17	03/24/17	1	03/24/17
2	Research Work						
2.1	Research on Agriculture in Nepal	03/17/17	1	03/17/17	03/17/17	1	03/17/17
2.2	Research on Status of Soil and about Soil moisture	3/18/2017	1	3/18/2017	3/18/2017	1	3/18/2017
2.3	Research on Bluetooth Technology	3/19/2017	1	3/19/2017	3/19/2017	1	3/19/2017
2.4	Research on Android Application	3/20/2017	1	3/20/2017	3/20/2017	1	3/20/2017
2.5	Research on Drip Irrigation	3/21/2017	1	3/21/2017	3/21/2017	1	3/21/2017
2.6	Research on JAVA(Android)	3/25/2017	2	3/26/2017	3/25/2017	2	3/26/2017
2.7	Research to prepare Best Design	3/27/2017	1	3/27/2017	3/27/2017	1	3/27/2017
2.8	Field Visit	3/24/2017	7	3/30/2017	3/27/2017	7	4/4/2017
2.9	Milestone 2	3/30/2017	1	3/30/2017	4/5/2017	1	4/5/2017
3	Design						
3.1	Application Design					1	
3.1.1	Data Flow Diagram	4/1/2017	1	4/1/2017	4/6/2017	5	4/11/2017
3.1.2	Use Case Diagram	4/2/2017	1	4/2/2017	4/11/2017	3	4/14/2017
3.1.3	Class Diagram	4/3/2017	1	4/3/2017	4/14/2017	2	4/16/2017
3.1.4	Flow Chart Diagram	4/4/2017	1	4/4/2017	4/16/2017	1	4/17/2017
3.1.5	Design User Interfaces	4/5/2017	2	4/6/2017	4/18/2017	4	4/22/2017
3.2	Database Design	4/5/2017	2	4/6/2017			
3.2.1	ER-Diagram	4/7/2017	2	4/8/2017	4/23/2017	4	4/27/2017
3.2.2	Schema Diagram	4/7/2017	2	4/8/2017	4/28/2017	3	5/1/2017

3.3	Milestone 4	4/8/2017	1	4/8/2017	5/2/2017	1	5/3/2017
4	Implementation						
4.1	Program coding in Java	4/9/2017	19	4/28/2017	5/3/2017	21	5/24/2017
4.2	Database Design	4/8/2017	11	4/20/2017	5/25/2017	15	6/9/2017
4.3	Circuit Design	4/21/2017	1	4/21/2017	6/10/2017	10	6/20/2017
4.3	Milestone 5	4/24/2017	1	4/24/2017	6/21/2017	1	6/21/2017
5	Testing						
5.1	Unit Testing	4/25/2017	1	4/25/2017	6/22/2017	1	6/22/2017
5.2	System Testing	4/26/2017	1	4/26/2017	6/23/2017	2	6/24/2017
5.3	Alpha Testing	4/27/2017	1	4/26/2017	6/25/2017	4	6/28/2017
5.4	Validation Testing	4/27/2017	1	4/27/2017	6/29/2017	7	7/6/2017
5.5	Milestone 6	4/31/2017	3	5/2/2017	7/7/2017	1	7/7/2017
6	Dissertation						
6.1	Draft Report Writing	5/3/2017	5	5/7/2017	7/8/2017	11	7/19/2017
6.2	Final Report Writing	5/8/2017	2	5/9/2017	7/20/2017	5	7/24/2017
6.3	Report Evaluation and Conclusion	5/10/2017	1	5/10/2017	7/25/2017	5	7/29/2017
6.4	Submission of Final draft copy Report	5/11/2017	1	5/11/2017	7/30/2017	2	7/31/2017
6.5	Corrections for Final draft copy Report	5/12/2017	1	5/12/2017	8/1/2017	2	8/2/2017
7	Final Phase						
7.1	Final Documentation Printing and Binding	5/13/2017	1	5/13/2017	8/2/2017	2	8/3/2017
7.2	Document Submission to College	5/14/2017	1	5/14/2017	8/3/2017	1	8/3/2017

3.4.2 Gantt Chart



3.5 System Testing

Testing is an important part of the software development process. If a system is timely tested according to various references then it improves the output of the system and enhances its functionality. Testing can be also termed as ‘Verification and Validation’ on a timely basis.

Both verification and validation are important for the system to be as it was expected to be. Validation refers to the process of using the new software for the developed system in a live environment i.e., new software inside the organization, in order to find out the errors. The validation phase reveals the failures and the bugs in the developed system. It will be come to know about the practical difficulties the system faces when operated in the true environment.

3.5.1 Unit Testing

Separately each and every functional module is tested and analyzed the result of that module. The module interface is tested to ensure that the information flows in and out of the program under unit test.

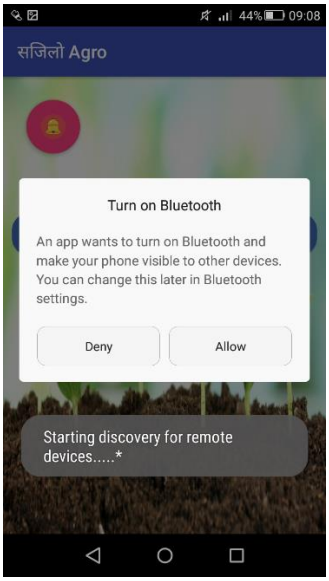


Figure 13: Unit Testing

The diagram in above shown figure 13 shows the Bluetooth module verification in the application. This acts as a gateway of data transfer between Arduino and Android.

3.5.2 Integration Testing

All the modules were separately tested as unit and then integrated as one and errors were rectified accordingly. During integration testing, individual function modules are combined and tested as a group and is carried out after completion of unit testing. The lowest level components are tested first, then used to facilitate the testing of higher level components. The process is repeated until the component at the high level component is tested.

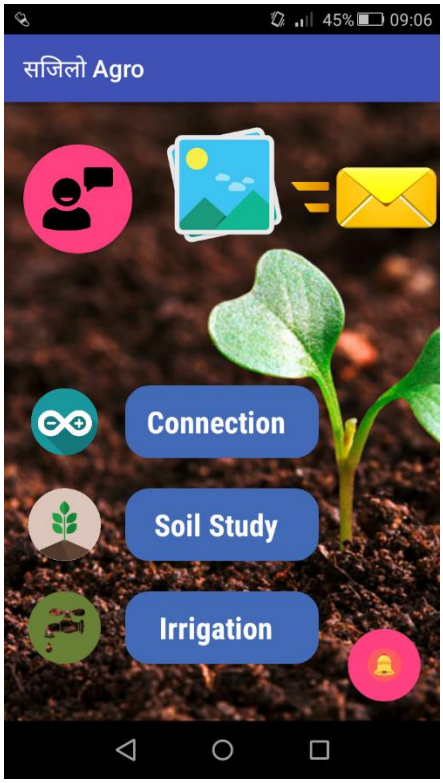


Figure 14: Integration testing

The diagram in above shown figure 14 represents all the modules connection, study and irrigation testing. They are working as an integrated system and doing diverse activities.

3.5.3 System Testing

In system testing the whole application was tested to check the errors. The complete application was deployed in the IIS server remotely and access was given to laptops and mobiles for surfing the site. The errors that arose were checked and improve accordingly.

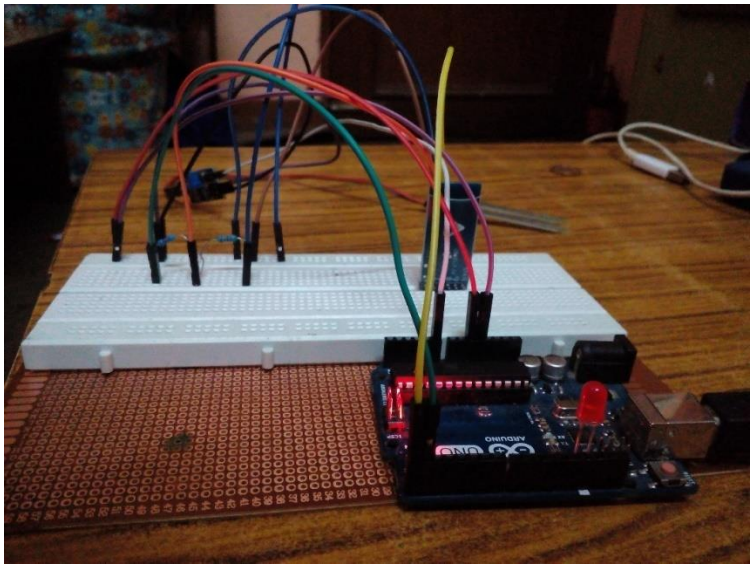


Figure 15: Hardware system testing

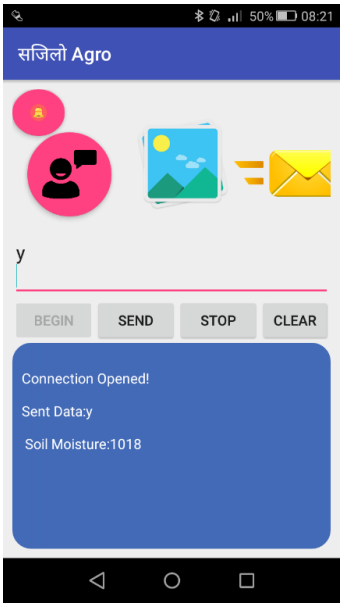


Figure 16: System Testing

As the system consist both hardware and software components, the working of both of them separately as well as integrated as a system is to be done so as to find if the system is developing as expected or not.

3.5.4 User Acceptance Testing

User acceptance testing is done in order to verify whether the application is user friendly and meets the user requirements or not. The application was provided to number of friends and colleagues.

3.6 Implementation

The hardware and software (Arduino and Android) are integrated and synchronized so that they work properly. First, a 5V power supply is given to the microcontroller of the system. The moisture sensor is collects the data and transmits over an analog signal (A0) in the system. The sensor value is accumulated in pin A0 which is looked over by the system. If the sensor value exceeds a certain threshold then the motor (i.e. the Output pin) is automatically turned on and if it does not exceed the value the motor is turned off.

The HC-05 module connected to the system is responsible for the data transmitting section of the system. Android id coded with respect to the data transfer pins of Bluetooth which extract the hardware sensed data on a software application. This project is efficient and works on point if properly managed. Being careful while plugging in the Bluetooth module is the must. As the HC-05 module takes 3K input only but the Arduino passes data at 5K so two resistors of 2k and 4k are used to divide the input to get an average of 3k input.

The project has a wide range of implementation. From a Android based small scale household pot to a large-scale no internet farm automated irrigation can be accessed by anyone if made available. An android application that does not require any

authentication is easy to make through and analyze by various kinds of users. However, Successful completion of the Implementation Phase should comprise:

- Deploying the new application in its target environment. Into the fields(small and large scale)
- Deliver system that meets all the user requirements. The application is host from the server to its clients.
- Training and awaking end-users. In our case, this is very important and compulsory step. A small training is enough for the people in order to use this system.
- Modification and improvising the system as a whole.

CHAPTER 4: RESULT ANALYSIS

4.1 Result

The proper information regarding soil resources and their productivity tends to fascinate the people and help them attain efficiency in agricultural activities. This project helps to optimize the water resources and increase their agricultural productivity. Even the people in urban areas are encouraged for small scale plantation.

Technology (IoT/ICT) should be used in agricultural fields as technology makes the work easier and increases efficiency of the output production. The use of hardware and software saves manpower and time and the productivity and workflow is affected positively. The further enhancement and modification of this project can bring significant change in the field of agronomy.

Screenshots of the Code

Main Interface

```
public class MainActivity extends AppCompatActivity {

    Animation fade_in,fade_out;
    ViewFlipper viewflipper;
    TextView connect;
    TextView ss;
    TextView si;
    ImageView gall;
    ImageView maill;


    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        // Flipper
        viewflipper = (ViewFlipper) this.findViewById(R.id.flipper1);

        fade_in = AnimationUtils.loadAnimation(this,
                android.R.anim.fade_in);
        fade_out = AnimationUtils.loadAnimation(this,
                android.R.anim.fade_out);

        viewflipper.setInAnimation(fade_in);
```

```
        viewflipper.setInAnimation(fade_out);

        //sets auto flipping
        viewflipper.setAutoStart(true);
        viewflipper.setFlipInterval(5000);
        viewflipper.startFlipping();

        // Buttons
        connect = (TextView) findViewById(R.id.check_connection);
        ss = (TextView) findViewById(R.id.soilstudy);
        si = (TextView) findViewById(R.id.s_irrigation);
        gall = (ImageView)findViewById(R.id.gallery);
        maill = (ImageView)findViewById(R.id.mail);

        connect.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {

                Intent intent;
                intent = new Intent(MainActivity.this, arduino.class);
                startActivity(intent);

                Toast.makeText(MainActivity.this, "This is Where you can see
if you are connected to arduino or not", Toast.LENGTH_LONG).show();

            }
        });
```

Figure 17: Screenshot of the main interface of the application

The diagram in above shown figure 17 shows the splash screen, the main interface and the soil study page of the application respectively. You can navigate from the main interface as you like. Connection takes you to Bluetooth connectivity, Irrigation enables you to monitor the automated irrigation and soil study help you to learn about soil distribution. Various other features are also added.

Android Bluetooth Interface Code

```
disconnect.setVisibility(View.GONE);
logo.setVisibility(View.GONE);
logo1.setVisibility(View.GONE);
btAdapter = BluetoothAdapter.getDefaultAdapter();

if(btAdapter.isEnabled()){
    String address = btAdapter.getAddress();
    String name = btAdapter.getName();
    String statusText = name + ":" + address;
    statusUpdate.setText(statusText);
    disconnect.setVisibility(View.VISIBLE);
    logo.setVisibility(View.VISIBLE);
    logo1.setVisibility(View.VISIBLE);
    connect.setVisibility(View.GONE);
}else{
    connect.setVisibility(View.VISIBLE);
    statusUpdate.setText("BLUETOOTH ------> OFF");
    Toast.makeText(arduino.this, "The Bluetooth service is off",
Toast.LENGTH_SHORT).show();
}

connect.setOnClickListener(new OnClickListener() {
    @Override
    public void onClick(View v) {
        //String actionStateChanged = BluetoothAdapter.ACTION_STATE_CHANGED;
        // String actionRequestEnable =
BluetoothAdapter.ACTION_REQUEST_ENABLE;
        //IntentFilter filter = new IntentFilter(actionStateChanged);
        //registerReceiver(bluetoothState, filter);
        //startActivityForResult(new Intent(actionRequestEnable), 0);
        String scanModeChanged = BluetoothAdapter.ACTION_SCAN_MODE_CHANGED;
        String beDiscoverable =
BluetoothAdapter.ACTION_REQUEST_DISCOVERABLE;
        IntentFilter filter = new IntentFilter(scanModeChanged);
        registerReceiver(bluetoothState, filter);
        startActivityForResult(new Intent(beDiscoverable),
DISCOVERY_REQUEST);
    }
}); //end connect OnClickListener

disconnect.setOnClickListener(new OnClickListener() {
    @Override
    public void onClick(View v) {
        btAdapter.disable();
        disconnect.setVisibility(View.GONE);
        logo.setVisibility(View.GONE);
        logo1.setVisibility(View.GONE);
        connect.setVisibility(View.VISIBLE);
        statusUpdate.setText("BLUETOOTH ------> OFF");
    }
}); //end disconnect onClickListener
```

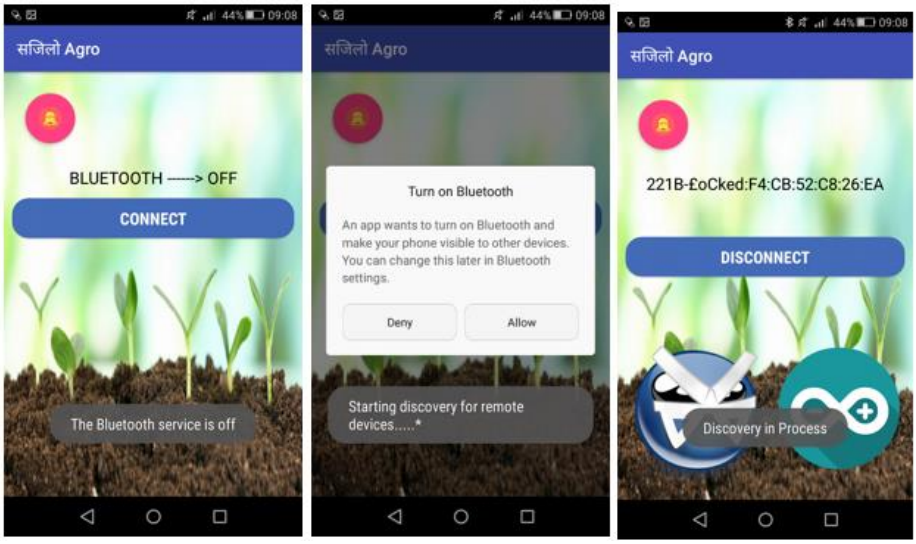


Figure 18: Screenshot of Android Bluetooth interface

The diagram in above shown figure 18 gives us interface preference to enable Bluetooth to set up connection. It asks the Bluetooth request and search for the device. As data transfer between Arduino and app is done with the help of Bluetooth this interface is equally important.

Arduino Bluetooth and data transfer interface Code

```
BluetoothAdapter
bluetoothAdapter=BluetoothAdapter.getDefaultAdapter();
 if (bluetoothAdapter == null) {
        Toast.makeText(getApplicationContext(),"Device doesnt Support
Bluetooth",Toast.LENGTH_SHORT).show();
 }
if(!bluetoothAdapter.isEnabled())         {
Intent enableAdapter = new
Intent(BluetoothAdapter.ACTION_REQUEST_ENABLE);
        startActivityForResult(enableAdapter, 0);
 }
Set bondedDevices = bluetoothAdapter.getBondedDevices();
if(bondedDevices.isEmpty()) {
                  Toast.makeText(getApplicationContext(),"Please Pair the
        Device first",Toast.LENGTH_SHORT).show();
        } else {
                 for (BluetoothDevice iterator : bondedDevices)
        {

        if(iterator.getAddress().equals(DEVICE_ADDRESS)) //Replace with
        iterator.getName() if comparing Device
        names.           {              device=iterator; //device is an
        object of type BluetoothDevice
                        found=true;
```

```
            break;
         }
        }
        }
        socket = device.createRfcommSocketToServiceRecord(PORT_UUID);
        socket.connect();
        outputStream=socket.getOutputStream();
        inputStream=socket.getInputStream();
        int byteCount = inputStream.available();
                if(byteCount > 0) {
                    byte[] rawBytes = new byte[byteCount];
                   inputStream.read(rawBytes);
                    final String string=new String(rawBytes,"UTF-8");
                   handler.post(new Runnable() {
public void run() {
        textView.append(string);
        }
  });
 }

outputStream.write(string.getBytes());
```

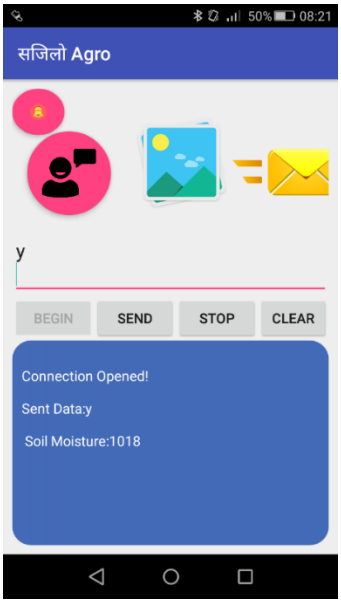


Figure 19: Screenshot of the Arduino data transfer interface

The Android data transfer interface shows the portion of the application where a connection is set up between the Arduino and Android using Bluetooth and then data is extracted from the Arduino into the system to notify the user the status of the irrigation activity.

Hardware (Arduino) Code

```
#include<SoftwareSerial.h>
int ledPin = 13;
int moistureSensor = 0;
SoftwareSerial myserial(0,1);

void setup() {
 Serial.begin(9600);
 myserial.begin(9600);// Default connection rate for my BT module
 pinMode(ledPin, OUTPUT);
 delay(100); //baud rate
}

void readSensor() {
    int s = analogRead(moistureSensor);
    char m[3];
    if ( s >= 1000)    {
      digitalWrite(ledPin, HIGH);
      char m[3] = "ON";
    }else if (s < 500){
    digitalWrite(ledPin, LOW);
    char m[3] = "OFF";
    }else if (isnan(s)){
      Serial.println("Failed to read from Moisture sensor");
      return;
    }
   Serial.print(" Soil Moisture:");
   Serial.print(s);
 }
```

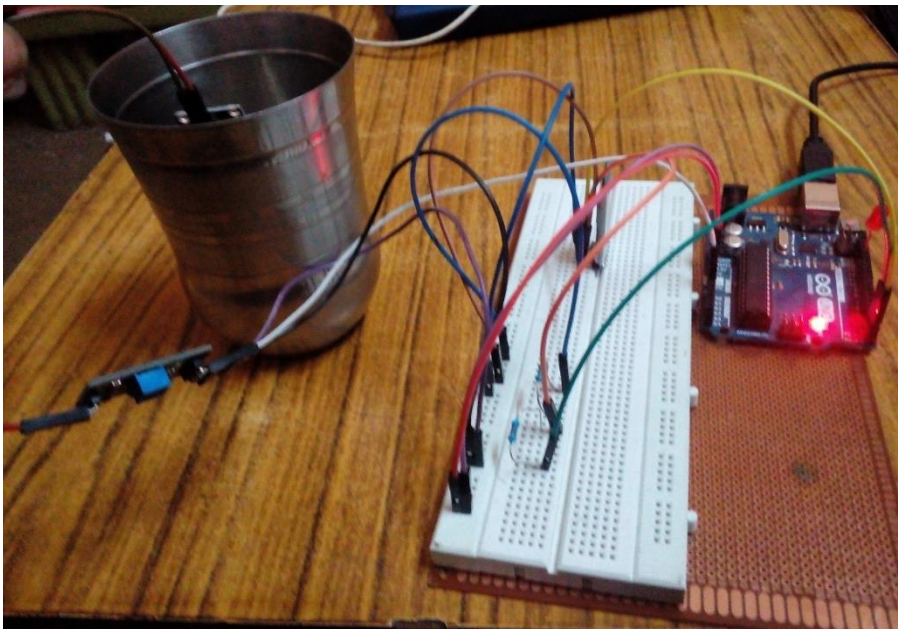


Figure 20: LED OF represents motor is off as moisture is high

Arduino checks the soil moisture and if it is less than the prescribed threshold then led id turned off which symbolizes the motor is ob. Similarly, when the motor is off led is turned off. This is how the system integrates, synchronizes and works.

4.2 Critical Analysis

The viability of the project is determined by various properties and limited number of characteristics that directly or indirectly simulate the project. Such Critical Success factors need to be taken into consideration in order to obtain an efficient project. Nepal's economic future is inextricably linked to the health of its agriculture sector. As Nepal is a developing country, the share of agriculture in total gross domestic product (GDP) has been declining over the years, it still accounts for one-third of GDP. However, stagnation in the agriculture sector is one reason behind a rural poverty rate that is over three times that of urban areas, 35 percent compared to 10 percent. According to various research conducted in the field of agriculture acceptability of public, government funding, defined legislation, usage of the available resources recklessly, minimal use of technology in agriculture are the major factors that have to be worked upon so as to obtain success on implementation of ICT in agriculture sector.

While evaluating all these factors and working upon them the clear objective in mind is to be able to work efficiently in the field using minimal resources, knowledge of better production and enhancement of agricultural activities using technology. Frequent collection of views regarding the barriers and hindrance that people working in the related field are facing can provide us adequate ideas for problem solving. The IoT in agriculture is adopted in different parts of the world and seems very effective in many places. Farmers are the one who get more benefits from the use of IoT. Access, efficiency and affordability of agricultural information continue to be a major impediment for raising agricultural productivity among smallholders. Recently IoT has provided a possible pathway to ameliorate this scenario.

In context of Nepal, different practices are carried out already in field of Agriculture using IoT. There are many other organizations that have been providing the information

to the farmers through various uses of IC/IoT tools such as radio, TV, Mobile etc. but either there are places where there is no hint of technology or the practices are not either carried continuously or effectively. The main reason behind this is the geographical structure of the country, lack of education and ICT either not reachable or not affordable. Global economic liberalization and the country's admission to the World Trade Organization raises new challenges but also opportunities. The subsidies and other support provided to Nepal's farmers and agro-entrepreneurs on either side of the open border with its southern neighbor determine their competitiveness in the cross-border markets. This has created pressure on national agricultural research system to develop cost effective technologies.

After doing all the research on the historical and present scenarios of the IoT/ICT implementation in agriculture in the context of Nepal as well as the world, it was concluded that the farmers in Nepal are not being able to mobilize the available resources like the foreign Nations which is the main reason why Nepal is falling backwards in the field of Agriculture inspite of being rich in resources (i.e. Land, Soil and Water). The only difference observed was there was optimization of the resources in the foreign agricultural methods by the use of technology which improvised their productivity as well. Farmers are unaware of the soil textures, its relationship with plant distribution and productivity due to which they end up using available resources recklessly. Similarly, people in Urban areas also tend to have lost interest in plantation activities due to their busy schedule and are forgetting the importance of plants for human survival.

To solve these problems and to read the current scenario a visit to the NARC (National Agricultural Resource center) was planned. During the visit of the Research center that covers about 70-100 hectares of land, rushing into various departments (Soil, Engineering, Botany and Agronomy), interviews and discussions with the project leaders, the agro-scientists, the soil-scientists and the engineers, looking over the experiments being conducted and the field visit was very fruitful. It was found that there was no proper method of water utilization and the automated irrigation was not still implemented in Nepal. There was a small tomato farm that had manual drip irrigation

which was in very poor condition and a potato farm which used automated irrigation system implemented by foreign aid to some but was not properly monitored. We concluded that there was a need of the soil study for better use of water resources and productivity in places where internet and technology are reachable for encourage people to use technology for plantation as well as a system of automated irrigation using just hardware to rural places where one has no access to internet and android devices. We decided to initiate this idea as a project and gave it a name as सजिलो Agro.

From all the research conducted, some of the major advantages of using IoT in agriculture for optimization of resources can be listed out as follows:

- Provides proper knowledge of soil taxonomy, soil distribution, resources required and its capacity that can increase the productivity.
- Automated irrigation using soil moisture sensor which saves the unnecessary wastage of water resources.
- Encourage the people of urban areas for plantation in small scale.
- Feasibility of automated irrigation using hardware only in rural areas also where internet and Android devices are not available.

In-spite of all these advantages there are certain disadvantages of the project as it is mere an idea being converted into an initiation for the optimization of soil and water resources in Nepal. The use of Bluetooth/Wireless module can limit the area of application for soil study and automated irrigation which can be standardized using the GSM module for notification and motor status checking. The project can be modified and improvised with further data and information in long run.

Various countries have been researching and conducting experiments for implementation ICT/IoT for agriculture as it is assumed that the demand of food is increasing along with the population growth. In Philippines, “ICT for Development (ICT4D) -Taking Science Knowledge to the Farmers,” program was aimed at applying the latest technological innovations in farming that would significantly benefit small holders. Similarly, there are numerous research activities going on in different part of the world for utilizing this era of technology for survival as plants are not only essential

for food but for human survival also. With respect to all the research going on सजिलो Agro is a small initiative to encourage plantation and optimization of water as well as soil resources in Nepal.

As the system is automated it has a simple and feasible working mechanism. We have tried to minimize the complexities by automating the system. The application interface is also easy to use by people who are familiar with android devices as it can be accessed by anyone. The application is informational and data can be further added as per suggestion and research. The system is affordable for small scale plantation and can be modified for large scale implementation.

4.3 Limitation and Future Enhancement

4.3.1 Limitation

With the overall research done regarding this projects, there are still some limitations in the system. Some of which are listed as below:

- The Temperature and the humidity cannot be measured.
- Even though the system provides automatic water supply reading the state of soil, it doesn't measure the amount of water required to be stored to water the plants.

4.3.2 Future Enhancement

The researchers recommend that this research may be used as reference for further development of new methods and devices for watering and protection system of the plantation, such as:

- The database could be added in the system so as to monitor the reading regarding the moisture level of different types of soils which can contribute in study of better production.

- The amount of water required in the field could be studied by adding the weather forecast in the system.
- Wireless modules could be used to automate the irrigation for large scale plantation.
- A CCTV camera could be added to monitor the daily watering of plants and animal disturbances

4.4 Conclusion

The project is most applicable for plantation where this enhanced irrigation system will help to conveniently utilize their crops without monitoring the soil condition most of the time. If installed and programmed properly, this will also help and can be an important instrument in conservation of water consumption which can reduce the excessive use of water in the farming areas.

The Microcontroller based drip irrigation system proves to be a real time feedback control system which monitors and controls all the activities of drip irrigation system efficiently. The present proposal is a model to modernize the agriculture industries at a mass scale with optimum expenditure. Using this system, one can save manpower, water to improve production and ultimately profit.

In present days especially farmers are facing major problems in watering their agriculture fields, it’s because they have no proper idea about when the power is available so that they can pump water. Even after then they need to wait until the field is properly watered, which makes them to stop doing other activities. Here is an idea which helps not only farmers even for watering the gardens also, which senses the soil moisture and switches the pump automatically when the power is ON.

CHAPTER 5: REFERENCES

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