A REPORT ON

Machine Learning Based crop yield prediction system.

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
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FOR THE AWARD OF THE DEGREE

OF

BACHELOR OF ENGINEERING(Computer Engineering)

SUBMITTED BY

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PUNE INSTITUTE OF COMPUTER TECHNOLOGY

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CERTIFICATE

This is to certify that the Project Entitled

Machine Learning Based crop yield prediction system.

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is a bonafide work carried out by students under the supervision of **Prof. S. D. KALE** and it is submitted towards the partial fulfillment of the requirement of **Bachelor of Engineering (Computer Engineering)**.

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We would like to take this opportunity to thank our internal guide ***Prof. S. D. Kale*** *and external guide ————————- for giving us all the help and guidance we needed. We are really grateful to them for their kind support. Their valuable suggestions were very helpful.*

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Abstract

Agriculture, with its allied sectors, is the largest source of livelihoods and has the largest contribution in the GDP of our country. Yet, farmers are not getting enough price value of the crops. It happens mostly due to inappropriate crop selection, improper irrigation or at times the yield of crop is less than expected. A steady crop yield throughout longer periods is not possible due to affecting factors such as soil fertility, availability of water, climate and diseases or pests. By analyzing the soil and atmosphere at particular region best crop in order to have more crop yield and the net crop yield can be predicted. Knowing the possible yield of a crop based on these factors beforehand can help decide the potential and in turn profitability of that crop. For this purpose, machine learning algorithms can be used which can train a model and make predictions as the output. In particular, Random Forest Algorithm is used in this project.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The Data Analysis is method of exploring, cleaning, modelling data with a motive of discovering helpful information and related conclusions. It is a process of analyzing the data, extracting the data and predicting meaningful information from vast data to extract some pattern. This method is employed by firms to get useful information from raw customer data. This analysis can also be utilized in the Agricultural field. Most farmers rely on their long-run experiences within the field to predict the amount and quality of yield in the next harvesting period. Yet, they dont get the price which the crop is worth of. It usually happens because of wrong crop selection, improper irrigation or at times the crop yield gained is comparitively less than expected

Agricultural researchers insist on the necessity for an effective and efficient mechanism to predict and improve the crop growth. Majority of analysis in agriculture focuses on parameters like variety of crop, seed type and environmental parameters such as sunlight,, temperature, soil type (pH), rainfall and humidity to identify crop growth and improve its yield. By analyzing the soil and atmosphere at the particular region, the most suitable crop can be found out in order to have more crop yield and the total crop yield can be predicted.

1.2 Motivation

Farming is an important occupation in India. Most of the businesses, primary and secondary, are dependent on farming. Hence, to get an idea about agriculture and farming, various technologies are been used by the farmers. But, people aren't really aware about the period of cultivation and area which is most suitable for the crop. In this case, an idea to identify and predict the suitability of crops and their yield based on a variety of factors that affect the production can increase the quality and the yield of the crops. This will in turn increase the economic growth and help secure portability.

1.3 Problem Definition and Objectives

1.3.1 Problem Definition

We build and implement Machine Learning Based crop yield prediction system.

1.3.2 Objectives

- Quick results are obtained based on basic information
- Crop yield type is understood considering various regions.
- Its easy to analyse and predict the results
- Customization of crop parameters is done.

1.4 Project Scope and Limitations

1.4.1 Project Scope

- Agriculture Applications

1.4.2 Limitations

- Complexity: The software will have to take into considerations various abnormalities at the same time leading to increase in complexity.

CHAPTER 2

LITERATURE SURVEY

The most important factor while doing research is literature survey. Before we get started with any kind of project, we have to study few previous published papers and study the architecture of the model based on the papers and predict the drawbacks to avoid any complications while building the model.

Below, we have reviewed few papers that we studied related to Crop Yield Prediction and techniques that are used.

B.Manjula Josephine, K.Ruth Ramya, K.V.S.N Rama Rao, Swarna Kuchibhotla, P. Venkata Bala Kishore, S.Rahamathulla : In this paper, Random forest algorithm is used to predict the crop yield based on the parameters like temperature, area of cultivation, soil type and rainfall[1].

K. L. Ponce Guevara1, J. Palacios Echeverra1" Green Farm-DM: Using Data Mining techniques, greenhouse vegetable crop data is analysed using a tool or a model." C4.5 algorithm is used to make a decision tree on the basis of given data entropy, giving us graphical results. [2].

Monali Paul, Santosh K. Vishwakarma, Ashok Verma "Analysis of soil behaviour and prediction of crop yield using data mining approach" : A model is proposed to predict crop yield using Naive Bayes and K-nearest neighbours[3]

Manasa Manjunatha, Parkavi An Estimation of Arecanut Yield in Various Climatic Zones of Karnataka using Data Mining Technique:A model is proposed to predict crop yield using various algorithms like decision tree, Random Forest Algorithm, Fuzzy logic and Linear regression.[4]

Sadia Afrin, Abu Talha Khan, Mahrin Mahia, Rahbar Ahsan Analysis of Soil Properties and Climatic Data to Predict Crop Yields and Cluster Different Agricultural Regions of Bangladesh Methods like K-means, PAM, CLARA and DBSCAN for clustering and four linear regression methods to predict crop yields are used [5].

Md. Tahmid Shakoor, Karishma Rahman, Sumaiya Nasrin Rayta, Amitabha Chakrabarty "Agricultural production output prediction using Supervised Machine Learning techniques" K-Nearest Neighbors Regression and decision Tree Learning-ID3 (Iterative Dichotomiser 3) algorithms are used for crop yield prediction [6].

Dr. Y. Jeevan Nagendra Kumar, V. Spandana , V.S. Vaishnavi, K. Neha ,V.G.R.R. Devi "Supervised Machine learning Approach for Crop Yield Prediction in Agriculture Sector" : A proposed trained model to predict crop yield using Decision Tree and Random Forest Algorithm.[7].

Shriya Sahu, Meenu Chawla An Efficient Analysis Of Crop Yield Prediction Using Hadoop Framework Based On Random Forest Approach. The method proposed in the paper is used to predict crop yield using Random Forest approach [8].

Garg A, Garg, B. A robust and novel regression based fuzzy time series algorithm for prediction of rice yield. Frequency based partitioning has been used subsequently, Fuzzy Logical Relationships of varying Degrees and Regression Analysis Model has been [9].

Anshal Savla,Parul Dhawan,Himtanaya Bhadada,Nivedita Israni,Alisha Mandholia,Sanya Bhardwaj "Survey of classification algorithms for formulating yield prediction accuracy" : Algorithms that are used for yield prediction in this paper are Support Vector Machine, Random Forest, Neural Network,REPTree, Bagging, and Bayes.[10]

CHAPTER 3

SOFTWARE REQUIREMENTS SPECIFICATION

3.1 Assumptions and Dependencies

A number of factors that affect the requirements of the system are:

- The system the application is executing on will have the required resources available as necessary
- Another assumption is that the software and hardware components work in the same way as used while developing this project.

3.2 Functional Requirements

3.2.1 Registration and Authentication

The user should be able to create an account and login on the system using it. While logging in, the system should authenticate that it's the right user details.

3.2.2 Taking user's inputs

After logging in, user will be able to detect crop yield based on soil and crop type and can predict soil type required for cultivation based on the crop.

3.3 External Interface Requirements

3.3.1 Performance Requirements

The performance of the model or a system depends on how well you handle it. Every user should be guided in accordance to use the system to avoid any performance degradation.

3.3.2 Safety Requirements

The system should be monitored regularly to ensure the system safety.To handle errors cases which can be extreme, an internal staff should be trained to ensure the system safety.

3.3.3 Security Requirements

Secure Functional Requirements; this is a security related description that is integrated into each functional requirement. Typically this also says what shall not happen. This requirement artifact can for example be derived from misuse cases. Only authorized doctor will be access this system.

3.3.4 Software Quality Attributes

3.3.4.1 Planned approach towards working: -

The working in the organization will be well planned and organized. The data will be stored properly in database, which will help in retrieval of information as well as its storage.

3.3.4.2 Accuracy: -

The accuracy of this system would be high considering the method that has been used. The prediction would be accurate which will be based on the dataset provided.

3.3.4.3 Reliability: -

The reliability of the system would be high considering the above mentioned reasons. The main reason behind high reliability is that, proper information will be stored and predicted.

3.3.4.4 No Redundancy: -

The main objective of proposed system is to prevent data from duplication on server. This would assure economic use of storage space and consistency in the data stored.

3.3.4.5 Immediate storage of information: -

In manual system there are many problems to store the largest amount of information.

3.3.4.6 Easy to Operate: -

The system should be easy to operate and should be such that it can be developed within a short period of time and fit in the limited budget of the user

3.4 System Requirements

3.4.1 Database Requirements

A database is a system intended to organize, store, and retrieve large amounts of data easily. It consists of an organized collection of data for one or more uses, typically in digital form. One way of classifying databases involves the type of their contents, for example: bibliographic, document-text, statistical. Digital databases are managed using database management systems, which store database contents, allowing data creation and maintenance, and search and other access. Database architecture consists of three levels like External, Conceptual and Internal. The external level defines how users understand the organization of the data. A single database can have any number of views at the external level. The internal level defines how the data is physically stored and processed by the computing system. Internal architecture is concerned with cost, performance, scalability and other operational matters. The conceptual is a level of indirection between internal and external. It provides a common view of the database that is uncomplicated by details of how the data is stored or managed, and that can unify the various external views into a coherent whole.

1. Database: MySQL relational database
2. Version: 5.1

3.4.2 Software Requirements

- Operating System - WindowsXP/7/10
- Coding language - Java
- Software - jdk 1.8.0
- Tool - Eclipse

3.4.3 Hardware Requirements

- Processor - Intel i3 core

- Speed - 1.1 GHz
- RAM - 256 MB (min)
- Hard Disk - 20 GB
- Key Board - Standard Windows Keyboard
- Mouse - Two or Three Button Mouse
- Monitor - SVGA

3.5 Analysis Model

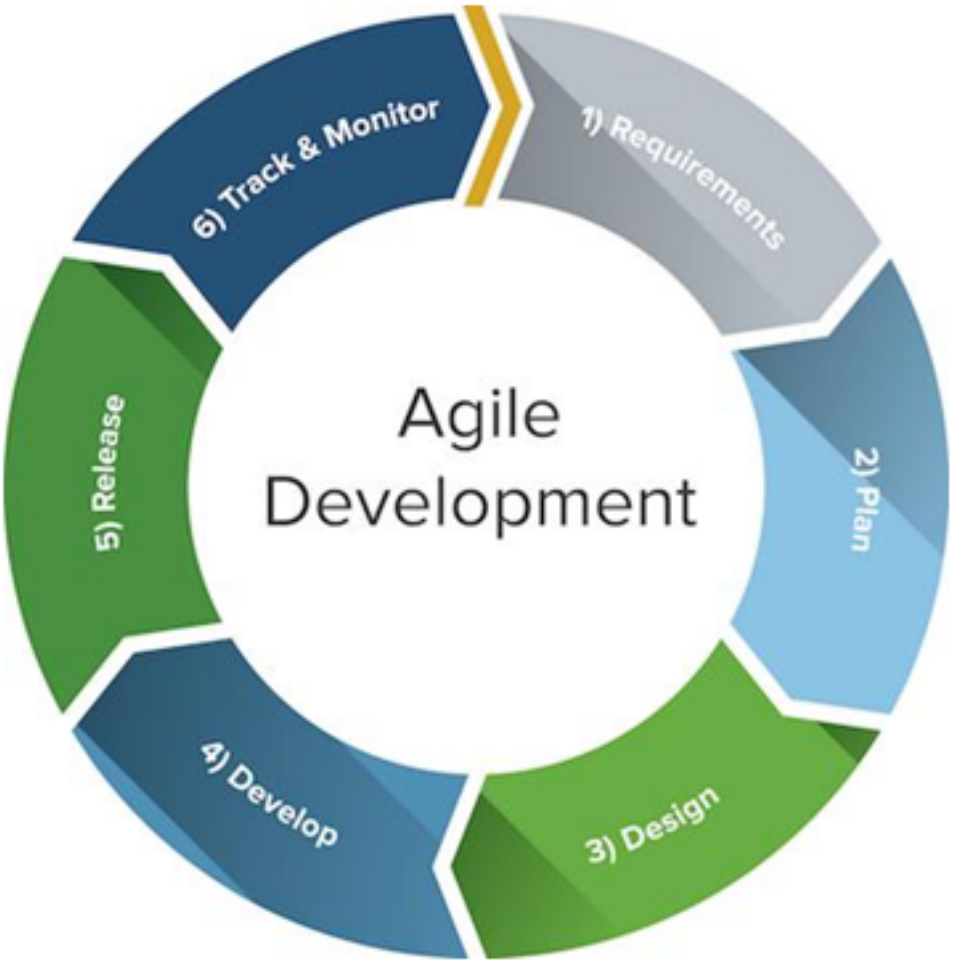

Figure 3.1: Agile SDLC Model

Agile methods are being widely accepted in the software world recently. However, this method may not always be suitable for all products. It is a very realistic approach to software development. It promotes teamwork and cross training. The functionality can be developed rapidly and demonstrated. It is suitable for fixed or changing requirements. It delivers early partial working solutions. It has minimal rules and documentation is also easily employed. It also enables concurrent development and delivery within an overall planned context.

CHAPTER 4

SYSTEM DESIGN

4.1 System Architecture

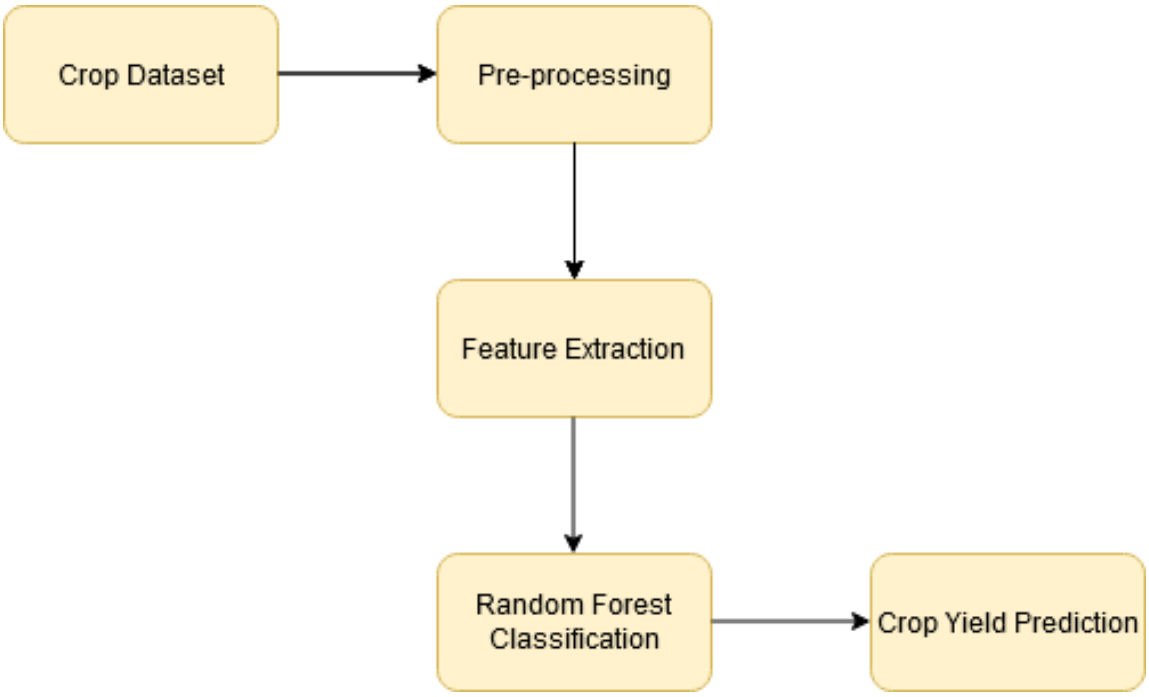

Figure 4.1: System architecture

4.2 Mathematical Model

The mathematical model for Crop prediction is as-
S={I, F, O}
where,
I = Set of inputs
The input consists of set of crop dataset.
F = Set of functions
F={F1, F2, F3}
F1:Data Extraction
F2:Data Pre-processing
F3: Data Feature Extraction
F4: Data Classification

O: Crop Prediction

4.3 Data Flow Diagrams

4.3.1 DFD Level 0

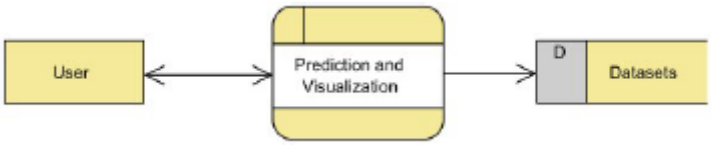

Figure 4.2: DFD 0 Diagram

4.3.2 DFD Level 1

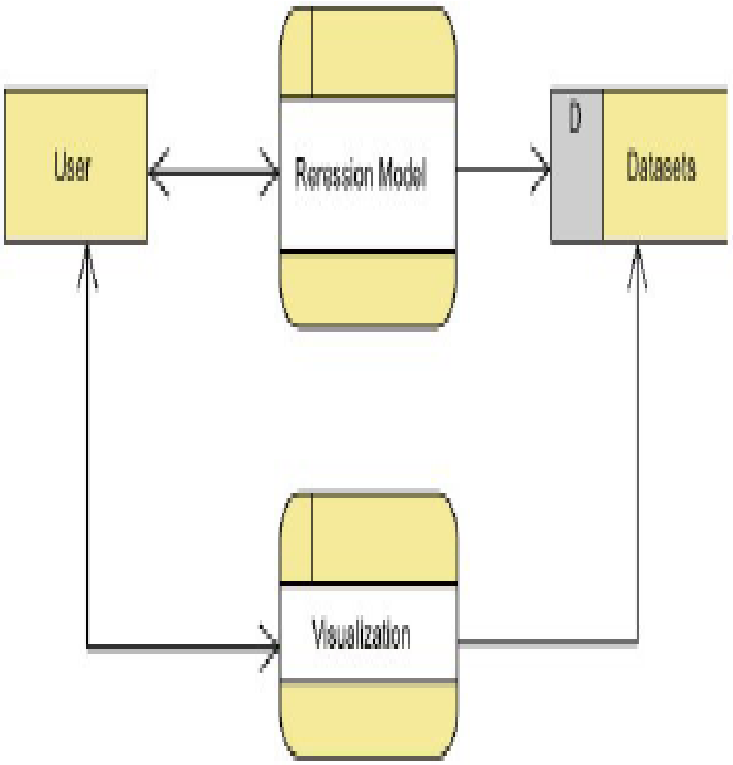

Figure 4.3: DFD 1 Diagram

4.3.3 DFD Level 2

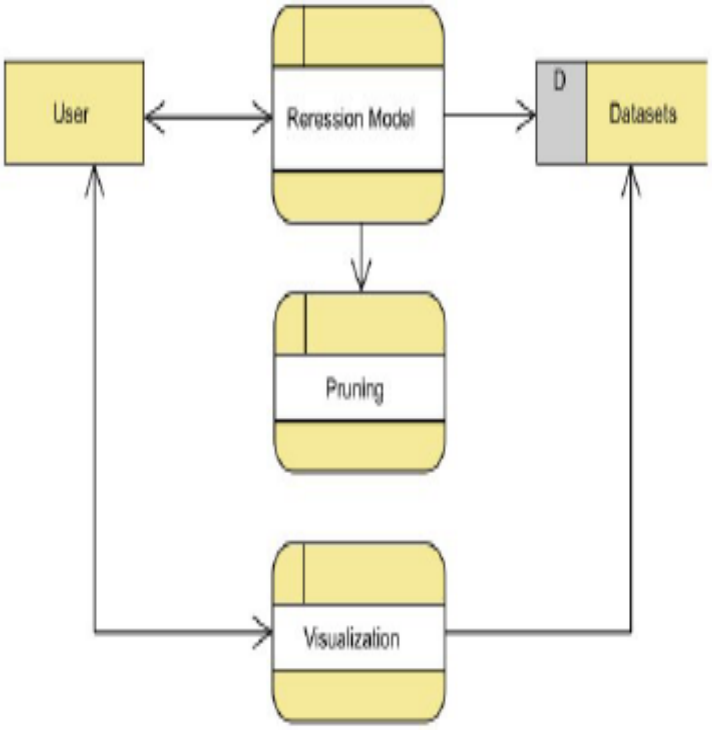

Figure 4.4: DFD 2 Diagram

4.3.4 Entity Relationship Diagram

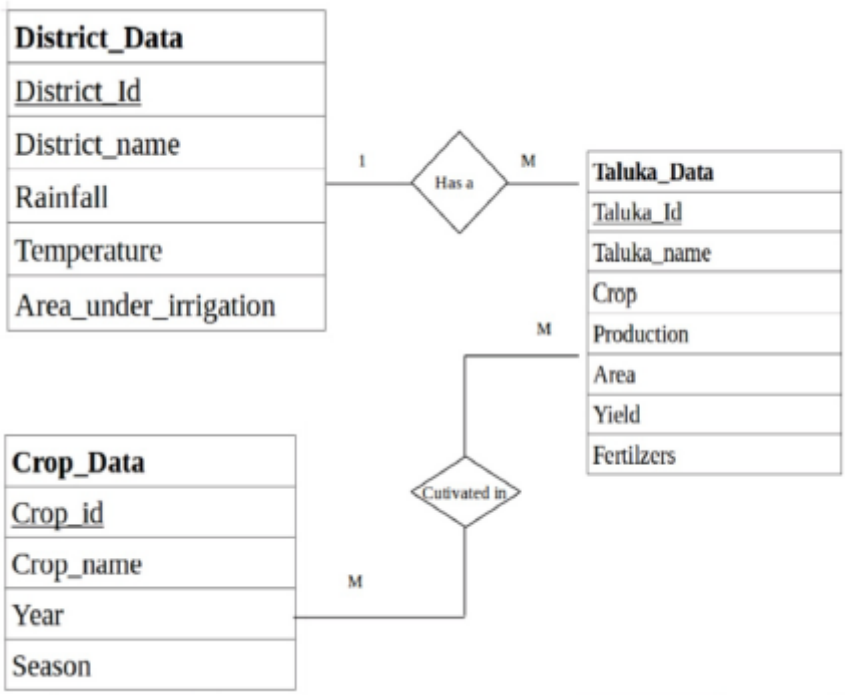

Figure 4.5: ER Diagram

4.4 UML Diagrams

4.4.1 UseCase Diagram

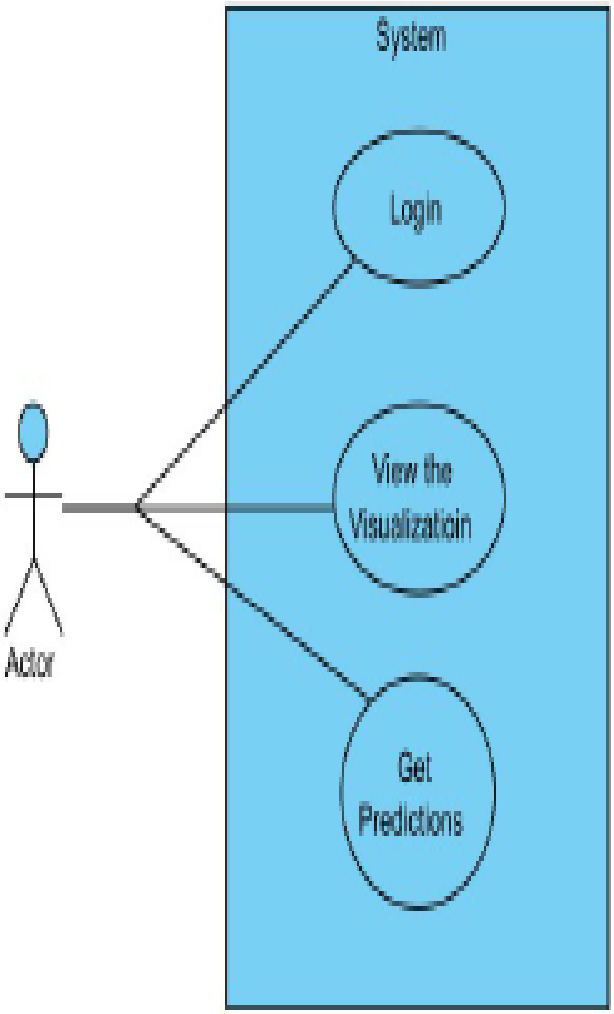

Figure 4.6: Use Case Diagram

4.4.2 Activity Diagram

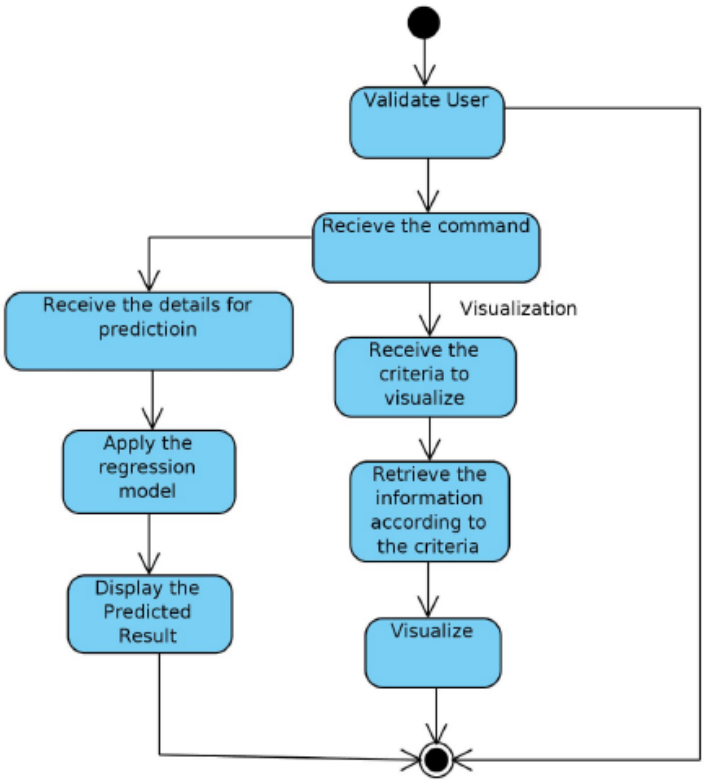

Figure 4.7: Activity Diagram

4.4.3 Sequence Diagram

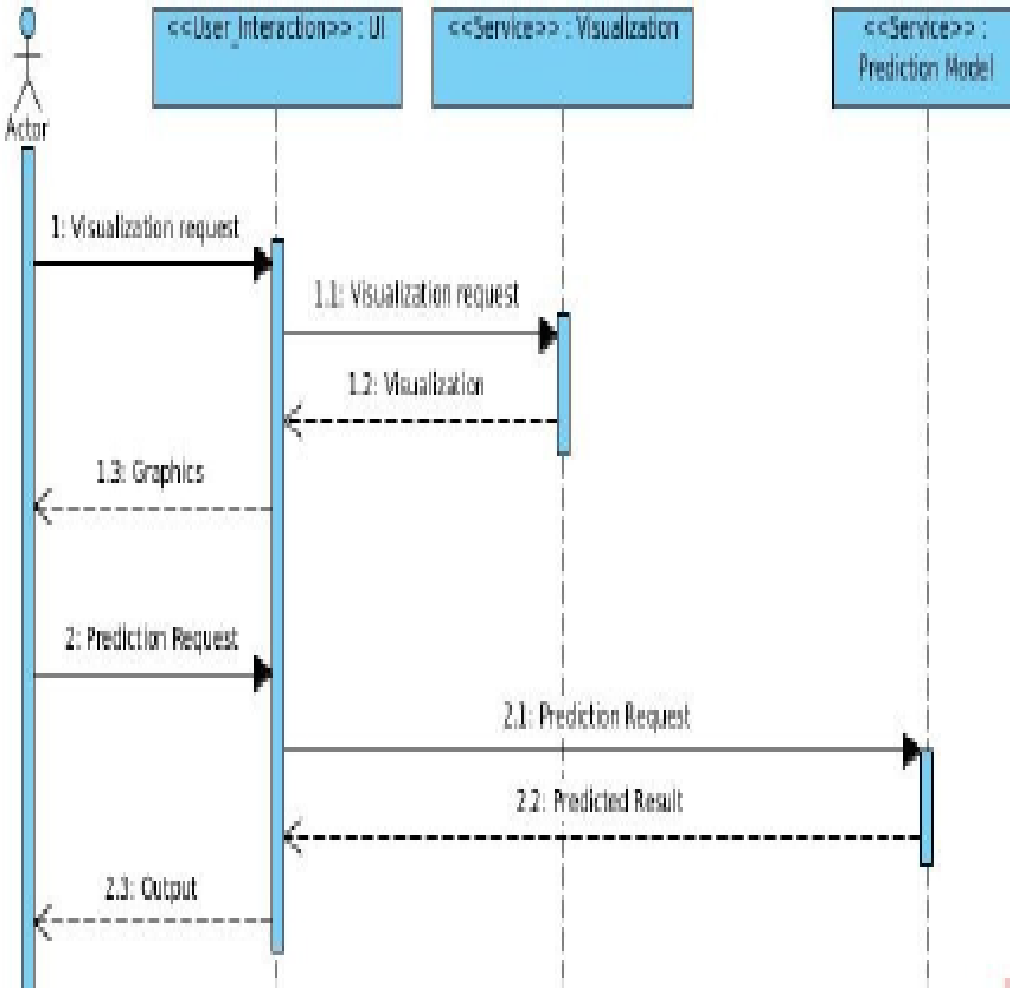

Figure 4.8: Sequence Diagram

4.4.4 Component Diagram

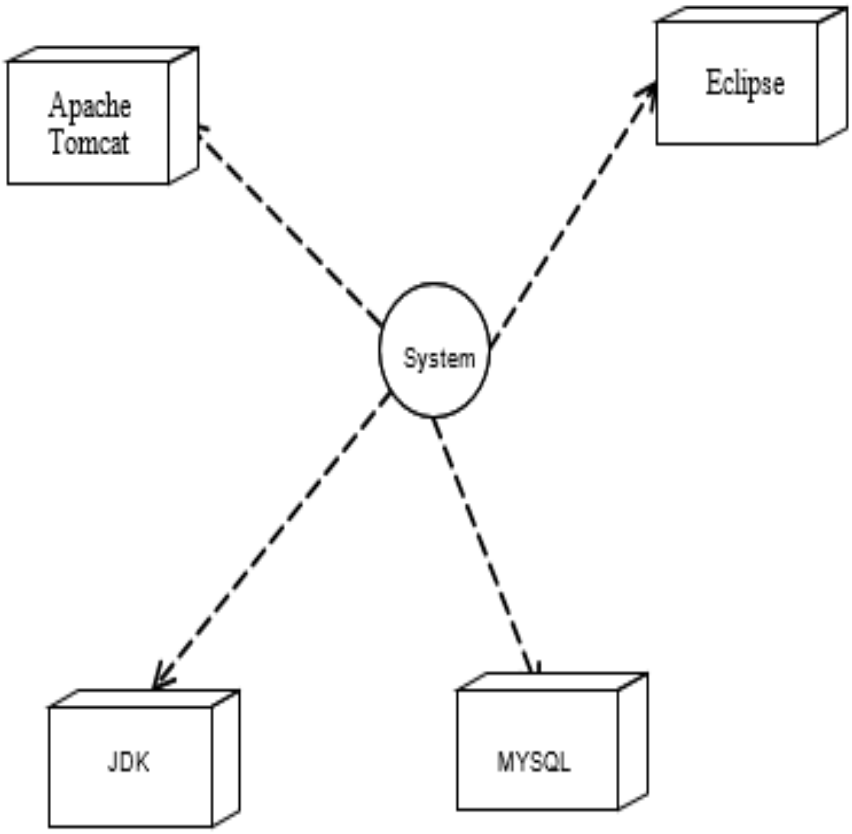

Figure 4.9: Component Diagram

4.4.5 Deployment Diagram

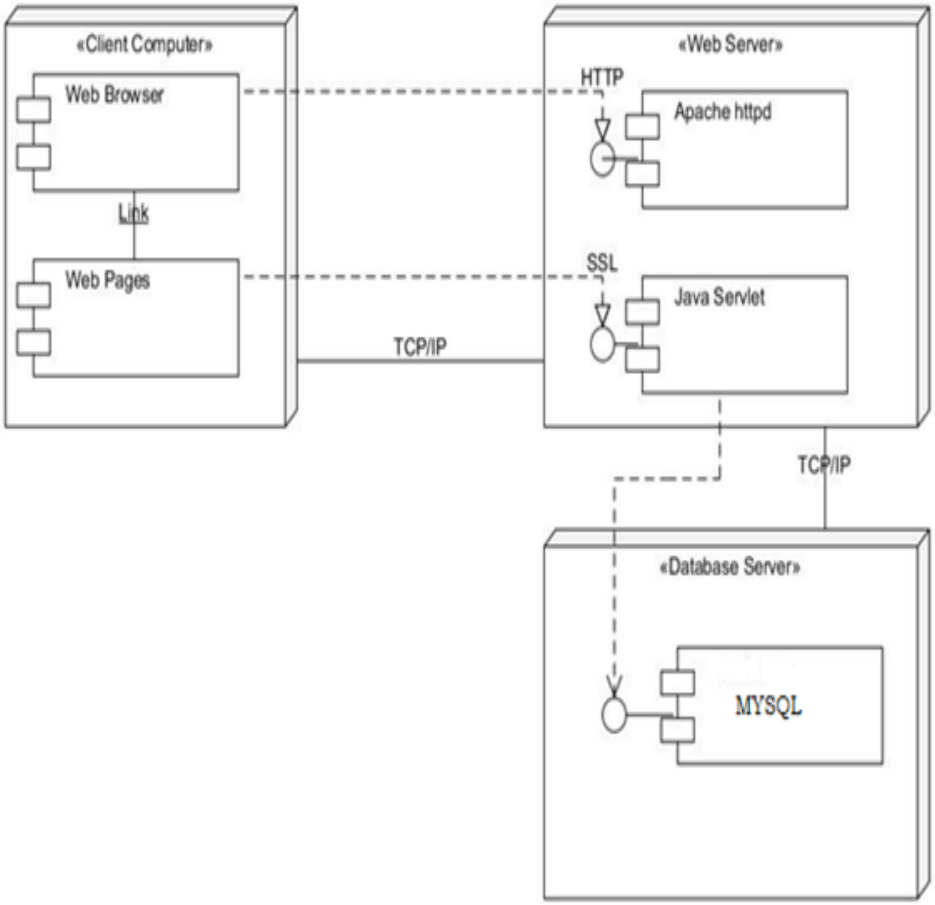

Figure 4.10: Deployment Diagram

CHAPTER 5

PROJECT PLAN

5.1 Project Estimates

5.1.1 Reconciled Estimates

5.1.1.1 Cost Estimate

Cost will estimate after completing the project that depend on time to complete the project. Also efforts required to complete.

5.1.1.2 Time Estimates

Time will depend on modules of project.Also project plan of execution.

5.1.2 Project Resources

1. Hardware Resources Required
   System: Pentium IV 2.4 GHz. Hard Disk: 40 GB. Floppy Drive: 44 Mb. Monitor: 15 VGA Color.
2. Software Resources Required
   Operating system: Windows. Coding Language: Java 1.8 Database: MySql 5 IDE: Eclipse

5.2 Risk Management

5.2.1 Risk Identification

For risks identification, review of scope document, requirements specifications and schedule is done. Answers to questionnaire revealed some risks. Each risk is categorized as per the categories mentioned

1. Have top software and customer managers formally committed to support the project?
Answer: Yes , Have top software and customer managers formally committed to support the project
2. Are end-users enthusiastically committed to the project and the system/product to be built?
Yse, end-users enthusiastically committed to the project and the system/product to be built
3. Are requirements fully understood by the software engineering team and

its customers?
Yes, Are requirements fully understood by the software engineering team and its customers
5. Have customers been involved fully in the definition of requirements?
Yes, customers been involved fully in the definition of requirements
6. Are project requirements stable?
Answer: all project requirements are stable
9. Is the number of people on the project team adequate to do the job?
Yse, the number of people on the project team adequate to do the job

5.2.2 Risk Analysis

DESCRIPTION	IOW	High
Login detail	no	yes
Internet connection slow	yes	no

Table 5.1: Risk Analysis

Following are the details for each risk.
Risk ID 1
Risk Description Description 1
When you login into the system, user should enter details properly considering the validation been there.
Risk ID 2
The user should be connected to the internet in order to get the registration done since the data is to be uploaded to the database. If there is no internet connection, registration will fail and give error.

5.3 Project Schedule

5.3.1 Project task set

ID	Task	Due Date
A	Problem Statement Decision	First week of July
B	Literature Survey	Fourth week of August
C	Revised Literature Survey	First week of September
D	Collection of dataset	Second week of September
E	Worked on image preprocessing techniques	Second week of October
F	Implemented basic algorithm as part of POC	Last week of October
G	Working on SRS of our project	Third week of November
H	Completed the UML diagrams	Last week of November
I	Completed the Preliminary Report	Second week of December
J	Preparation of High Level Design Document	Second week of January
K	Project Workstation Selection,Installation of H/W and S/W	Third week of January
L	Test-Tool selection and testing of various testcases	Third week of March
M	Demonstration of Project with results	Second week of June
N	Final Report Submission	First week of June

5.3.2 Timeline Chart

Activity	I week	II week	III week	IV week	V Week	VI week	VII week	VIII week	IX week
	Aug 4	Aug 11	Aug 18	Aug 25	Sept 1	Sept 8	Sept 15	Sept 22	Sept 29
Initiate the project									
Communication									
Literature survey									
Define scope									
Develop SRS									
Plan the project									
Design mathematical model									
Feasibility Analysis									
Develop work breakdown structure									
Planning project schedule									
Design UML and other diagrams									
Design test plan									
Design risk management plan									

Figure 5.1: Timeline Chart

5.3.3 Timeline Chart

Activity	XI week	XII week	XIII week	XIV week	XV week	XVI week	XVII week	XVIII week	XIX week	XX week	XXI week	XXII week
	Jan 5	Jan 15	Jan 19	Jan 26	Feb 2	Feb 9	Feb 16	Feb 23	Mar 2	Mar 9	Mar 16	April 25
Execute the project												
Build and test basic functional unit												
Build and test database with login and session maintenance facility												
Build and test Bluetooth mode												
Build and test security features												

Figure 5.2: Timeline Chart

5.4 Team Organization

Figure 5.3: Team structure

Chapter 6

Project Implementation

6.1 Overview of Project Modules

- Data Collection
- Data Preprocessing
- Feature Extraction
- Data classification
- Result

6.2 Tools and Technologies Used

6.2.1 Technology Description

The source code in Java is written in a plain text file having an extension .java which are then converted into .class files after compilation. The .class file contains bytecodes that is the machine language of Java Virtual Machine. With an instance of JVM, the java launcher tool executes the application

6.2.2 Hardware Specifications

• Processor - I3,I5
• Speed - 3.8 GHz
• RAM - 4GB

- Hard Disk - 1 TB
- Key Board - Standard Windows Keyboard
- Mouse - Two or Three Button Mouse
- Monitor - LCD(Liquid Crystal Display)

6.2.3 Software Specifications

- Operating System: Windows 10
- Programming Language: JAVA
- Backend: Mysql 5.0
- IDE : Eclipse Oxygen

Tool:Apache Framework

Chapter 7

Software Testing

7.1 Types Of Testings

7.1.1 Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. For Unit testing we perform elementary test at component level and test particular business processes, application or system configuration. Unit tests make certain that each distinctive path of a business process per- forms accurately to the documented specifications and contains certainly defined inputs and anticipated results

7.1.2 Integration testing

To check if the integrated software components run as single program, Integration tests are been designed and used. Testing is mostly concerned with the screen and field outcome since it is event driven. Unit testing successfully shows that the component is correct and persistent after the Intergration testing demonstrated that individually the components were satisfied. The problems that occur because of combination of components are exposed in Integration testing.

7.1.3 Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.
Functional testing is centered on the following items:
Valid Input : identified classes of valid input must be accepted.
Invalid Input : identified classes of invalid input must be rejected.
Functions : identified functions must be exercised.
Output : identified classes of application outputs must be exercised.
Systems/Procedures: interfacing systems or procedures must be invoked.
Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

7.1.4 System Test

System testing ensures that the requirement is met by the integrated software. To ensure the predictable results, System test, tests a configuration.Configuration oriented system integration test, is an example of system testing. It is based on flows and process descriptions, emphasizing pre driven process links and integration points.

7.1.5 White Box Testing

In Black Box Testing, the software developer knows nothing about the structure, language used and inner working of the software, or the purpose of the module. In general, on black box level the areas which cannot be reached are been tested using White Box Testing.

7.1.6 Black Box Testing

In White Box Testing, the software developer knows about the structure, language used and inner working of the software, or the purpose of the module. Specification or requirement documents are the source documents from which Black Box Test are written. In Black Box Testing, the software which is under the test is considered as back box and you cannot look through it. It doesnt consider the working of the software while responding to the output when provided with test inputs.

7.1.7 Unit Testing:

Unit testing is usually conducted as part of a combined code and unit test phase of the software life-cycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

7.1.8 Integration Testing

An incremental integration testing of more than one integrated software component on one platform to get failures which are caused by defects in the interface is Software integration testing. The motive or aim of the integration testing is to see if the software application or the components, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

7.1.9 Acceptance Testing

User Acceptance Testing is a critical stage of any system and requires significant participation by the end user. It also checks and ensures that functional requirements are met by the system. Test Results: All the mentioned test cases are passed and no defect is encountered.

7.2 Test cases and Test Results

Module-ID:-01
Modules to be tested:-Registration

Test Case_ID	Description	Test case I/P	Actual Result	Expected result	Test case criteria (P/F)
101	Enter the case insensitive Username click on Submit button.	Username	Error comes	Error Should come	P
102	Enter the case sensitive Username click on Submit button.	Username	Accept	Accept Username	P
201	Enter the case insensitive Password click on Submit button.	Password	Error comes	Error Should come	P
202	Enter the case sensitive Password click on Submit button	Password	Accept	Accept	P
301	Enter the case insensitive Mobile Number click on Submit button	Mobile Number	Error comes	Error Should come	P
302	Enter the case sensitive Mobile Number click on Submit button.	Mobile Number	Accept	Accept	P

Table 7.1: Test Cases

Module-ID:-2
Modules to be tested:- Login

Test Case_ID	Description	Test case I/P	Actual Result	Expected result	Test case criteria (P/F)
001	Enter the correct username and wrong password click on Login button.	Username Password	Error comes	Error Should come	P
002	Enter the wrong username and correct password click on Login button,	Username Password	Error comes	Error Should come	P
003	Enter the correct username and password and click on Login button.	Username Password	Accept	Accept	P

Table 7.2: Test Cases

Chapter 8

Results

Performance Analysis
The experimental result evaluation, we have notation as follows:
TP: True positive (correctly predicted number of instance)
FP: False positive (incorrectly predicted number of instance),
TN: True negative (correctly predicted the number of instances as not required)
FN false negative (incorrectly predicted the number of instances as not required),
On the basis of this parameter, we can calculate four measurements
Accuracy = TP+TN/TP+FP+TN+FN
Precision = TP/TP+FP
Recall= TP/TP+FN
F1-Measure = 2×Precision×Recall/Precision+ Recall.

8.1 Screen Shots

Figure 8.1: Home Page

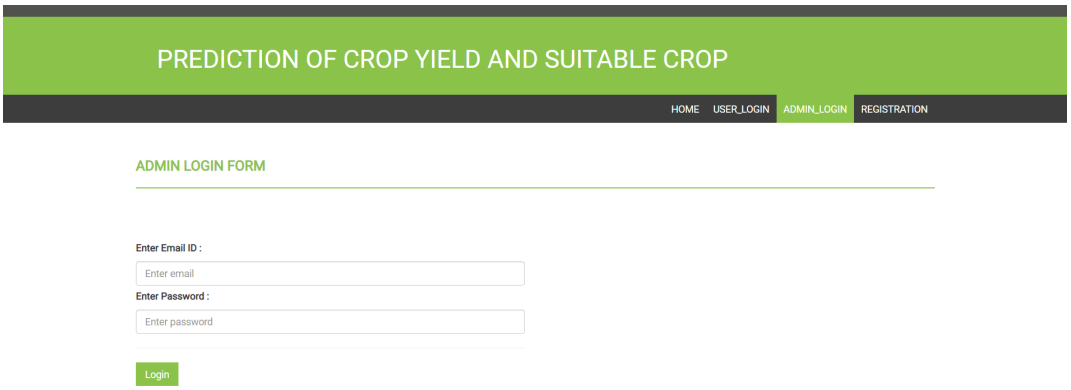

Figure 8.2: Admin Login Page

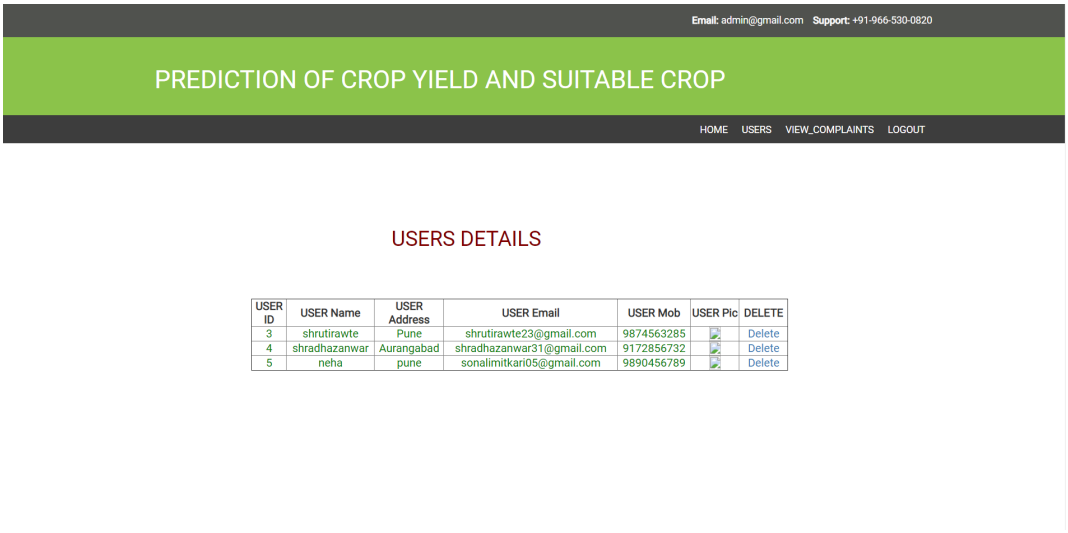

Figure 8.3: User List(Admin Side)

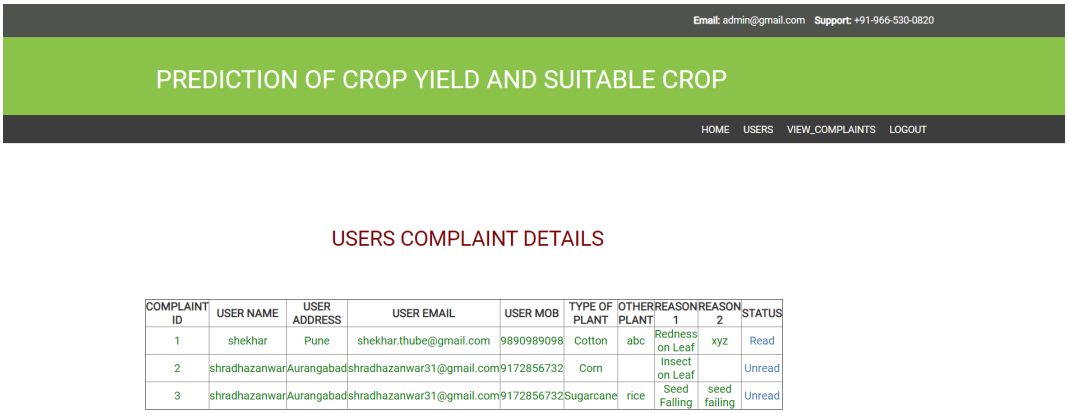

Figure 8.4: View Complaints(Admin Side)

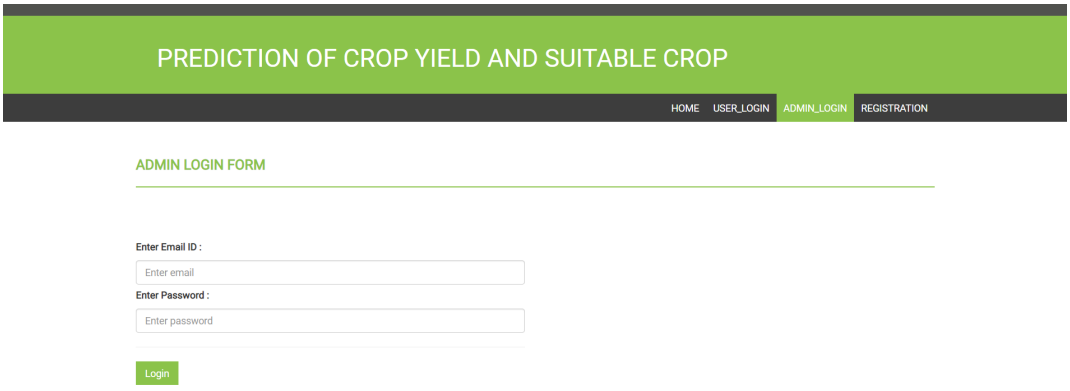

Figure 8.5: Admin Login Page

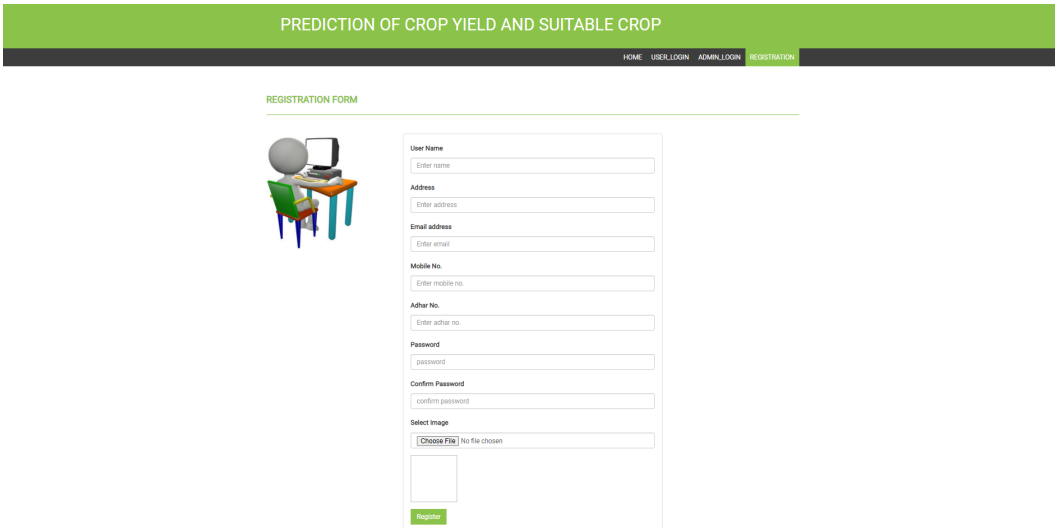

Figure 8.6: Registration Page

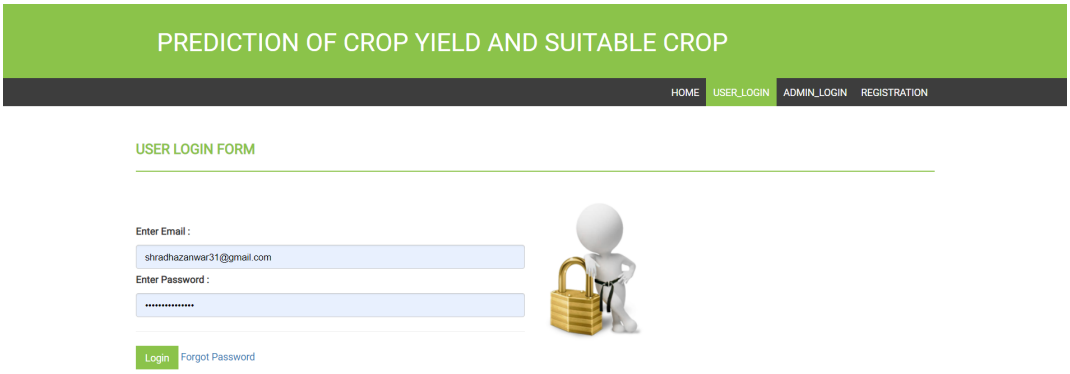

Figure 8.7: User Login Page

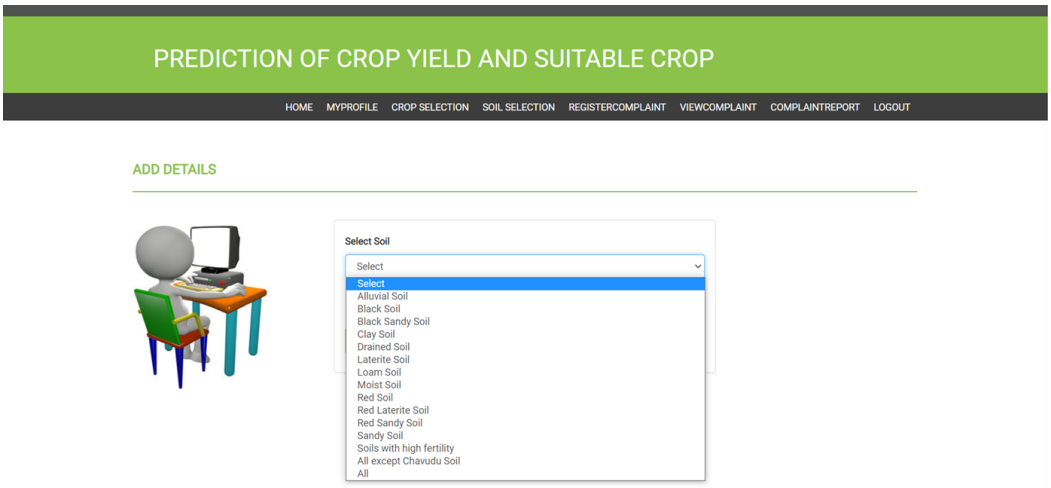

Figure 8.8: Soil selection for crop prediction

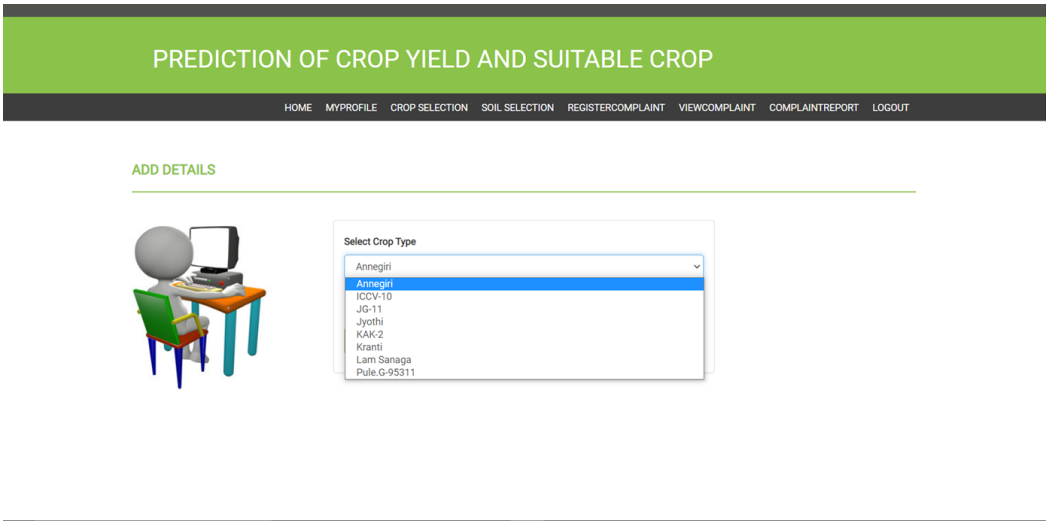

Figure 8.9: Crop type Selection

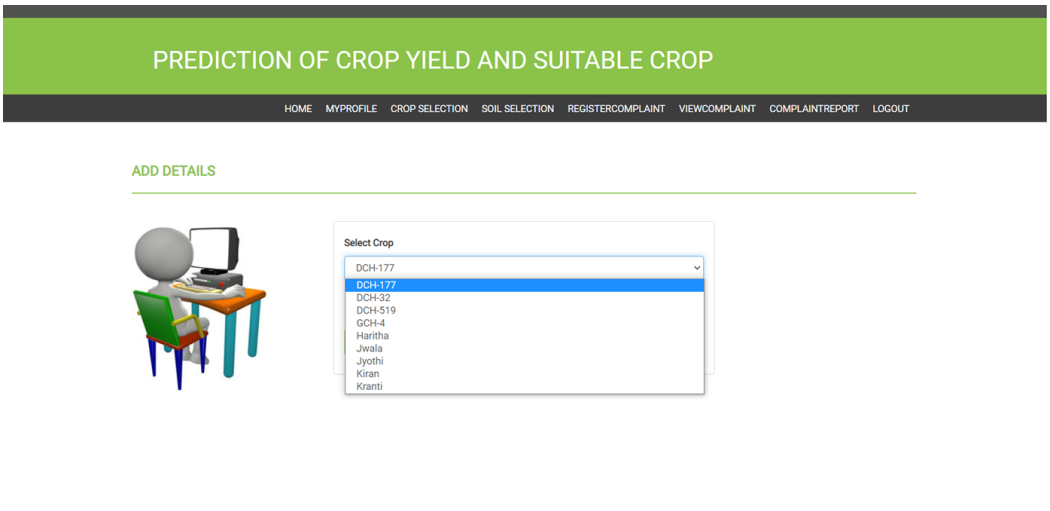

Figure 8.10: Sub crop selection

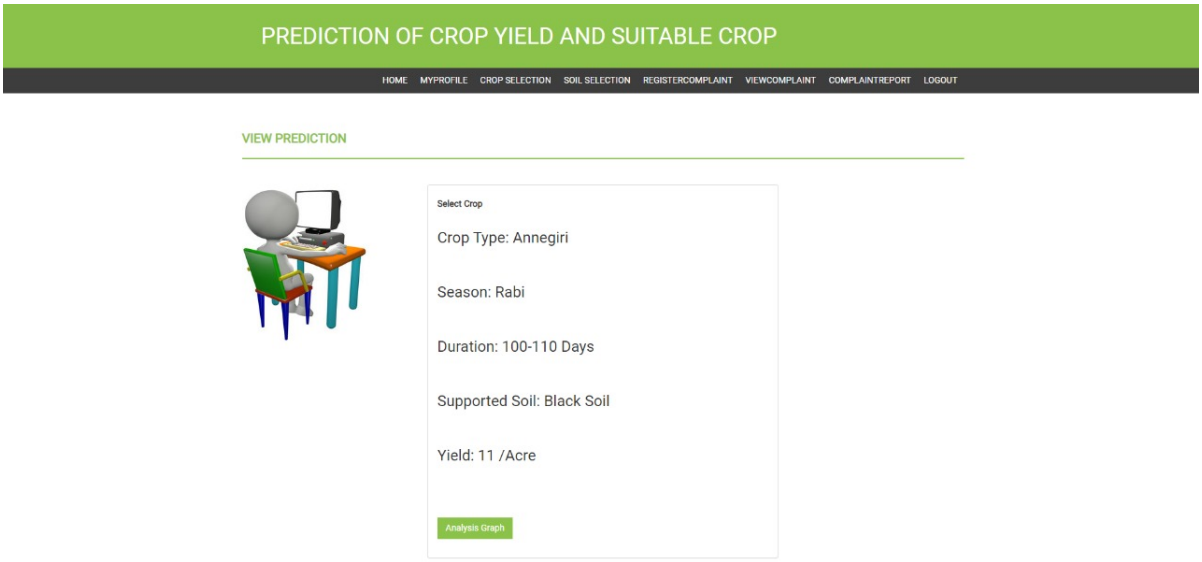

Figure 8.11: Prediction

Figure 8.12: Graphical analysis of Prediction

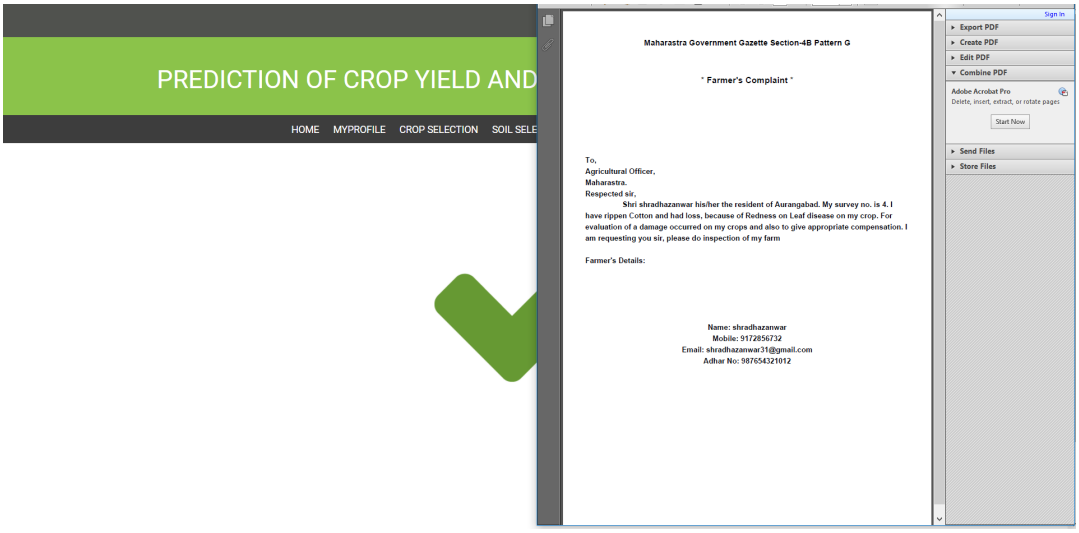

Figure 8.13: Complaint report(User Side)

Chapter 9

Conclusion and future scope

9.1 Conclusion

This model proposes a system which will predict the crop yield based on parameters like weather and area which is under cultivation. With the help of this model, farmers will be able to estimate the yield and accordingly decide whether or not to grow the crop.

9.2 Future Scope

In future, we can add few more points like
1. Detection of crop disease and pesticides to prevent it.
2. Prediction of estimated cost.
3. Loan, fertilizer and farming related legal information

Chapter 10

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