# SOIL MOISTURE ESTIMATION OF SUNFLOWER CROP BY USING REMOTE SENSING IMAGERY USING (UAV)

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# CERTIFICATE

This is to certify that "**Project/Thesis Report on, "SOIL MOISTURE ESTIMATION OF SUNFLOWER CROP BY USING REMOTE SENSING IMAGERY USING UAV"** is submitted in partial fulfillment of the requirement for the degree of Bachelor of Electronic Engineering by the following students:

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# DEDICATION

We are dedicating our whole efforts to our respected

## **"PARENTS & TEACHERS"**

Whom we are really inspired. Their pure love, devotion

Natural attitude and sincerity matter of great

Pleasure and pride for us.

Their encourage and simulating morally, socially and

academically based teachings have always been

Proved for us a

## **"PATH TOWARDS SUCCESS"**

They have given us name which caused our

Identification in society

# ACKNOWLEDGEMENT

It is enormous thanks to Almighty ALLAH who is Omniscient and Merciful who bestowed & enabled us to complete the task.

Always some people get a bigger share than other people not because they are better but because they arrive at the right time and right place to offer their services. So thanks to all those who helped us in completing the Project.

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**May ALLAH bless all these wonderful people.**

# ABSTRACT

The very fast and accurate estimation of crop coefficients at the farming scale is one of the most important and key prerequisites in precision agricultural. Soil measurement is one of the major factors to be considered in precision agriculture before doing any cultivation. Moisture content in a soil decides the strength of a soil. Conventionally farmers test their soil pH/Moisture and other properties, either in concerned laboratory, soil pH color chart or sometimes with the help of an expert. Those traditional methods consume more time and manual work. The use of aerial imaging with UAVs for monitoring and assessing crops has been growing steadily during the last decade. One of the most common advantages is that UAVs can provide high-quality data at the required scale and time. In this project, aerial imaging of crop is proposed for the estimation of soil moisture. The Soil Data was collected at Sindh Agriculture University TandoJam in a Sunflower field. Soil images are captured with the help of High Definition Image quality UAV and store all the images as soil dataset. This system mainly consists of UAV for image capturing on the field, image preprocessing, clustering, and classification.

The first step consists of image preprocessing to resize the images. Soil images are processed through image filtering, soil image segmentation, and soil image feature extraction. This study proposed the prediction of soil moisture and PH level which is done with the help of three methods Linear Regression, Artificial Neural Network and KNN Regression which are machine learning algorithm based on supervised learning. We used these three methods in order to get more accurate results. By training the artificial network with the known values from manual reading of soil moisture and pH, using Digital PH meter and Normal pH paper. Upon comparison of training and test data we obtained the results. Which gave us 89% accurate results.

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# List of Abbreviations

| | |
|---|---|
| UAV | Unmanned Aerial Vehicle |
| ACK | Acknowledge |
| GDP | Gross Domestic Product |
| PA | Precision Agriculture |
| PH | Power of hydrogen |
| ANN | Artificial Neural Network |
| KNN | K-Nearest Neighbor |
| RGB | Red Green Blue |
| HSV | Hue, Saturation and value |
| HTML | Hyper Text Markup Language |

# Chapter-1

# INTRODUCTION

## 1.1 INTRODUCTION

Pakistan is a country capable of producing large amounts of agriculture, and the economy of the nation is heavily reliant on agriculture. It meets the needs of the entire rural and urban population. Its required to improve the entire agricultural sector to meet the country's economic needs. According to domestic public opinion surveys conducted in 2019-2020, agriculture accounts for approximately 19.3% of Pakistan's annual GDP. This can be achieved by examining and improving the quality of yield, as well as methods used to improve crop growth rate and proper irrigation system. Due to shortage of water in some season's agriculture outcome could not be achieved as expected. The solution for this problem is providing only required water.

Soil moisture estimation is an important factor to be considered in precision agriculture before doing any cultivation. Precision agriculture (PA) is described as "a control strategy that uses generatedstatistical data to provide some declared data to take into account crop production decisions." Precision agriculture includes the use and consideration of all crops and regional control strategies in the surrounding environment. The strength of a soil is decided by its moisture content. Conventionally farmers used to find out the pH/moisture content of a soil manually using their old and traditional methods taught by their ancestors. Those methods lack in accuracy and require more man work and efforts. They were not much accurate, consume more time and results in wastage of unnecessary water supply.

As technology is introduced into various fields, whether it is military, industrial or office, why not use drone systems to introduce technology to farmland. The use of aerial imaging with Unmanned aerial vehicle for monitoring and assessing crops had been grown very fast during the recent decade. The Soil Data was collected at Sindh Agriculture University TandoJam in a Sunflower field. Soil images are captured with the help of High Definition

Image quality UAV and store all the images as soil dataset. Unmanned Aerial Vehicle (UAV) is a precise way to assist agricultural sector as they can measure the growth status of a crop with a High-Resolution ratio without giving harm to the crop. Digital cameras are usually deployed on UAVs for crop research as they benefit from low cost, light weight, practical operation, and straightforward data processing. Moreover, a drone can use a variety of camera filters to take photos of farmers crops, provide more than one type of spectral imaging, allow image processing and analysis, provide more information about crop health, and can also identify crops area. Machine learning is used to predict the soil different properties including soil pH. Total of 50 soil samples is collected from the fields. For all 50 samples, 5 fields are selected and 10 images per fields are collected. The distance separation of two samples is 100 meter in each field. Collecting samples are dragged out in depth of 0.5 feet in a vertical direction from the top position of the soil. All total of 50 soil samples is placed in white paper for image acquisition

## 1.2 PROBLEM STATEMENT

Soil moisture estimation is an important element to be considered for the growth of crop and maximum yield as well. Up till now the methods used were based on manual estimation of soil using sensors or typical knowledge of farmers gained from their ancestors. Those methods were time consuming and demand great number of farmers as well as efforts. Besides, water was being used more than it was required resulting in wastage of water as those procedures were done on the basis of prediction.

**1.3 AIM AND OBJECTIVES**

**Aim:**

The aim of this project is to find the parameters of soil like PH Level and Estimated Soil Moisture content of fields automatically through web app, which is designed using Machine Learning Algorithms and images processing techniques.

**Objectives:**

1) To survey the sunflower field at Sindh Agriculture University, Tandojam.
2) To plan UAV flight over the fields to collect imagery Data and perform pre-processing techniques on collected data.
3) To collect manual data of soil using sensors for comparing with digital data
4) To develop Soil moisture estimation model using machine Learning Algorithm (Linear Regression, KNN and ANN)
5) To design Web App for monitoring pH and moisture content of soil.

**1.4 THESIS LAYOUT**

Remaining thesis chapter are arranged as follows:

**CHAPTER 2:** This chapter describes the previous work done in the field of estimating soil moisture using image processing and other ways.

**CHAPTER 3:** This chapter describes the detailed description of each and every step done for the project which consist of Data collection, Labelling of images, Training of images and development of Software.

**CHAPTER 4:** This chapter demonstrate the results of training and testing data.

**CHAPTER 5:** This chapter demonstrate the conclusion and future recommendation that what additions can be added to this project in future to make it more advanc

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**Chapter-2**

**LITERATURE REVIEW**

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## 2.1 INTRODUCTION

The main objective of this literature review is to precise the agriculture with the help of the multiple technology we can collect the data to decide the crop production. It involves the development of techniques to estimate the soil moisture and pH of fields so a proper decision making could be possible to make. which is possible with the help of the unmanned aerial vehicles (UAVs) we can capture images by the RGB imagery.

## 2.2 LITERATURE REVIEW

Cardim Ferreira Lima et al., 2020 [1] The proposed pest identification and monitoring using automated traps brings a new approach to integrated pest management. Systems using image recognition technology and neural networks are the most studied due to their reliability for fully automated order identification and insect counting. However, it cannot discriminate to the species level as much as the proposed model. Other promising image-based systems that have been developed aim to transmit images of insects to experts, who can then remotely identify them and count them in real time. The idea is to identify pests using infrared, audio, and image-based categorization, and to study the many technologies that are already available, application examples, and ongoing research, such as machine learning and the Internet of Things. Also highlighted are upcoming developments in automated traps and decision support systems.

Claverie et al., 2012 [2] they introduced NDVI and SAFY index models, currently available high spatial and temporal resolution (HSTR) remote sensing data from Formosat-2 and upcoming Vens and Sentinel missions opens up new opportunities for crop monitoring. In this regard, we looked into the approach provided by a simple set of rules for yield estimate (SAFY) coupled with the Formosat-2 data to estimate agricultural production across large areas. The SAFY version enables the simulation of time collection of the green area index (GAI) and dry aboveground biomass with a limited number of input parameters (DAM). A 24 by 24 km2 area southwest of Toulouse, France, had 95 Formosat-

2 pictures (eight m, 1-day revisit) collected between 2006 and 2009. This study focused on two summer crops: sunflower and irrigated maize (Zea mays) (Helianthus annuus). Six key characteristics of the SAFY version were calibrated using the green region index (GAI) time collection that was derived from the Formosat-2 NDVI time collection.

Oleire-Oltmanns and et al. [3] This article affords an environmental far flung sensing software the use of a UAV this is especially aimed toward lowering the records hole among area scale and satellite tv for pc scale in soil erosion tracking in Morocco. A fixed-wing plane kind Sirius I (MAVinci, Germany) geared up with a virtual device camera (Panasonic) is employed. In order to provide both extremely high decision site-precise data and lower-decision overviews, UAV surveys are conducted over specific observational sites with a range of extents and flight heights, fully utilising the large capacity of the chosen UAV for multi-scale mapping purposes. For the purpose of monitoring soil erosion in Morocco, this research has developed the software for an unmanned aerial vehicle (UAV). With the chosen fixed-wing UAV, data collecting at many scales, including the interval between area scale and satellite television photograph scale, was successfully accomplished. Special photogrammetric procedures have been used for the image processing to deal with the extremely high decision of the acquired small-layout aerial photos (SFAPs). The initial procedure is applied to SFAPs that were received from lower flight altitudes (i.e., 70 m above ground). As a result, using just a few centimeters, the photograph decision could be quite enormous. Within the first procedure, precisely measured coordinate values from GCPs that were manually connected were employed. As a result, the photogrammetric image block's triangulation values are extremely accurate. The RMSE errors of the GCPs have horizontal values between 0.009 and 0.027 m.

Barbedo, 2019 [4] The methodologies that have been employed to extract the information from photographs captured during flights are highlighted in this paper's critical overview of the significant advancements in this field. A discussion is offered regarding the difficulties that have been solved and the significant research gaps that remain, along with some recommendations for future research, using data from more than 100 published articles and our own investigation. The optimistic test findings show that, regardless of the sensor type and implementation strategy, the practical adoption of image-based stress

monitoring remains delayed. The obvious solutions are based only on visual information because there are so many variables that might affect how physiological and morphological traits of plants behave in actual environments. This implies that current methods of stress monitoring have limited value but can be very useful as part of larger knowledge-based frameworks that use a system view that can combine various types of data, such as weather data, historical data on disease incidence, irrigation practices, pesticide applications, and more.

Zhang et al., 2019 [5] In this study, it is possible to use data from UAV multispectral snapshots taken from a distance to control irrigation water in rural areas. The main objective of the current study was to assess the appropriateness of calculating the Kc based entirely on VIs in comparison to on-site measured values for maize under exceptional tiers of deficit irrigation treatments on a farm size. Our findings demonstrated a strong connection between fc values generated from the NDVI equation and fc values principally based entirely on subject observations, with R2 = 0.93. The Ks retrieved the use of TCARI/RDVI higher meditated the real Kc, with R2 = 0.68-0. Eighty and RMSE = 0.140-0.232 compared to that the use of TCARI/SAVI. Briefly describing, this take a look at established that UAV-primarily based totally multispectral with a high temporal and spatial representation, snapshots can be utilized to map the maize crop coefficient Kc and indicate irrigation needs on the farm level. However, similarly research is appropriate to higher take a look at the technique for different crops, and multispectral snap shots may be mixed with statistics from different sensors set up on UAVs to offer extra records approximately water status, in particular thermal cameras

Zhang et al., 2019 [6] In their research it is found that Sustainable agriculture must use water resources wisely in order to protect the environment and achieve marketing goals. Monitoring soil moisture, salinity, and temperature is essential for current agricultural production because it involves intensive cultivation while also being environmentally friendly. The objective of the research was to identify agricultural and horticultural growers' needs for soil properties monitoring equipment and systems at the level of an individual farm in highly agriculturally developed regions. A questionnaire study with 1087 participants was carried out, as well as face-to-face interviews in Poland. According

to grower feedback, Despite the fact that only around 4% of the farmers in the study now have the tools necessary to measure soil moisture, salinity, and temperature, these factors are crucial to understand. According to them, cost is not the biggest barrier to purchasing the necessary probes. Most importantly, the system should be simple to install and operate, and the data gathering, processing, and transmission application should be simple to use.

Gałęzewski et al., 2021 [7] It has been concluded that their research has contributed to the development of high-yielding, disease- and stress-resistant commercial and field crops that are more resource-efficient when employing agricultural inputs insecticides, nutrition, water, etc). Until now, lack of high-throughput detection tools for quick and effective evaluation of phenotypes expressed in the field for data-driven decision making was a significant limitation in our study. In order to improve phenotypic profiling in the field, this review focuses on the technological elements of integrating drones with imaging systems. We analyzed cutting-edge drone technology for a variety of applications, including plant growth, vigor, and yield potential traits in field and row crops.
Prospects and developments were highlighted along with the possibilities of using aerial imagery to evaluate biotic and abiotic stress resistance/susceptibility for precision plant breeding and production management.

# Chapter-3

# BACKGROUND

## 3.1 INTRODUCTION:

This Chapter gives a brief background of this project and a detailed description of the Components, Software, Tools, Techniques and Methods which are used in this project.

## 3.2 ARTIFICIAL INTELLIGENCE:

Artificial Intelligence is the idea of making clever shrewd machines. The process of providing data, information, and human intelligence to machines is known as artificial intelligence, or AI. The main goal of artificial intelligence is to develop autonomous machines that can think and behave like people. These devices can behave in a manner like to that of people and fulfil tasks by getting to know and solving problems. To solve complex issues, the majority of AI architectures emulate herbal intelligence.

## 3.3 MACHINE LEARNING:

One can create applications based on artificial intelligence by using machine learning, which is a subset of AI. A subfield of computer science called machine learning employs analytics and computer algorithms to build predictive models that can resolve business issues. In order to make future predictions, machine learning analyses vast volumes of data (both structured and unstructured). It uses a variety of algorithms and methods to learn data. The figure below demonstrates how a computer learns from data.

## 3.4 DEEP LEARNING:

Deep learning is a branch of machine learning that trains a model with lots of data and sophisticated algorithms. A form of machine learning called "deep learning" uses algorithms to learn from the structure and operation of the human brain. Large volumes of both structured and unstructured data can be used by deep learning systems. Artificial neural networks, which enable machines to make judgments, are at the core of deep learning.

## 3.5 SOIL HISTOGRAM:

The graphic representation of data points arranged into user-specified ranges is called a histogram. A histogram, which resembles a bar chart in appearance, groups numerous data points into logical ranges or bins to condense a sequence of data into an understandable image.

**3.6 SONIKR SOIL PH METER (MS02)**

A 3-function digital meter that can measure soil moisture, soil pH, and soil light intensity. The 3-in-1 Soil Moisture Meter helps you better understand plant conditions, detects soil moisture, understands soil PH levels, and helps your plants get enough sunlight to grow healthier. It is designed to determine whether This is also called a 3-in-1 meter. It has two legs that are used to sense moisture and process the data to calculate soil pH and moisture level.

**3.6.1 Specifications include:**

1) Model: MS02
2) Moisture Range: 1–10 (1-3 Dry, 4–7 Dry, 8–10 Wet)
3) pH Range: 3.5-8 pH (3.5–6.5 Acidic, 7-8 Alkaline)
4) Copper and aluminum probes each have a 0.2-inch diameter.
5) 7.9-inch probe length; 1–10 scale for relative humidity (1st - 3 Dry, 4-7 Nor, 8-10 Wet)
6) The item is 11.5 x 2.0 x 1.5 inches in size.

**3.6.2 How to use the meter?**

Level 1: Switch to Moisture/pH/Light position as needed.

Step 2: Insert the probe approximately 6 to 7 inches into the soil.

Step 3: After 10 minutes pass, check the moisture/pH/light levels on the dial.

Step 4: After each usage, take the probe out of the soil and clean it with a cloth.

**3.7 VISUAL STUDIO CODE (VERSION 1.72.2)**

Microsoft's integrated development environment is called Visual Studio. It is employed in the creation of websites, web applications, web services, and mobile apps in addition to computer programs.

**3.8 PYTHON PROGRAMMING LANGUAGE**

Python is a high-level, object-oriented programming language that is very easy to learn for beginners. Also known as a general-purpose programming language. Python was written by Guido van Rossum and published in 1991.

**3.8.1 PYTHON IDE**

The Python IDE is an integrated development environment that lets you run code in the Python programming language. It enables code debugging, syntax error highlighting, and integration with online repositories. The Python IDE used to develop this system is Visual Studio Code.

The PYTHON Library The library is a pre-expressed scheme that you can use in your programs. Schemas are often called modules and are stored in objects.

### 3.8.2 FLASK

Flask is the Python library for this micro web framework. It's considered a micro-framework because it doesn't require any libraries or tools. It's simple, easy to learn, and easy to use, so you can create web applications in no time.



Figure 3.1: Flask library in a program to develop web framework

### 3.8.3 NumPy

Derived from Numerical Python, NumPy is a library used for manipulating arrays, Fourier transforms, linear algebra, and matrices. NumPy provides arrays of objects that are 50x faster than regular Python lists. Arrays are used when you have enough computing power where resources and speed are very important. NumPy works with locality of reference, where arrays are stored in contiguous regions that can be easily used and modified in a process/operation.

### 3.8.4 OpenCV

OpenCV is an open source machine learning and computer vision library. OpenCV has over 2500 improved algorithms. It features a combination of best-in-class, cutting-edge machine learning and computer vision algorithms. These algorithms are used to acquire 3D models, track camera movements, identify faces and objects, create his 3D point cloud from stereo cameras, identify human movements in a video, and stitch images together to form an entire scene. can be used to acquire and track high-resolution images of eye movements etc.



Figure 3.2: NumPy and OpenCV

### 3.9 HTML

HTML (Hyper Text Markup Language) is the code this is used to shape an internet web page and its content material. For example, content material might be dependent inside a hard and fast of paragraphs, a listing of bulleted points, or the usage of photographs and statistics tables.

### 3.10 SCIKIT IMAGE

It is a collection of algorithms which are used for image processing for some specific task.it is available and free of cost as well as free of restriction. Used when images are processed using python. From skimage import data, io, filters.

### 3.11 SKLEARN

The most user-friendly and reliable machine learning library in Python is called scikit-learn (Sklearn). Through Python's consistency interface, it offers a variety of effective machine learning and statistical modelling capabilities, including classification, regression, clustering, and dimensionality reduction. This library, which was primarily created in Python, is based on NumPy, SciPy, and Matplotlib.

### 3.12 REMOVING SHADOWS

The shadow removal process is widely used as a preprocessing operation in various video surveillance applications such as perimeter surveillance, motion detection and security surveillance. A simple Open CV technique can be used to remove image shadows. This is most useful for image preprocessing and his OCR text recognition. Here are the techniques I used:

- Dilate

- Mediun-blur

- Abs-diff

- Normalize

### 3.12.1 Dilate:

This operation includes convolving a picture A with a few kernel (B), that may have any form or size, generally a rectangular or circle. The kernel B has a described anchor factor, generally being the middle of the kernel. As the kernel B is scanned over the picture, we compute the maximal pixel cost overlapped via way of means of B and update the picture pixel with inside the anchor factor role with that maximal cost. As you could deduce, this maximizing operation reasons vibrant areas inside a picture to "grow" (consequently the call dilation).

### 3.12.2 Medium-blur:

Blur the image with a median filter. This function smooths the image using a median filter with an aperture of size k × k. Each channel of a multichannel image is processed separately. In-place operations are supported.

### 3.12.3 Abs-diff

Calculates the per-element absolute difference between two arrays or between an array and a scalar.

### 3.12.4 Normalize

Normalizes the norm or fee variety of an array. RGB (Red Green Blue) The satiation of a unpaired pixel is represented as a chain of 3 numbers among zero and 255. These values correspond to red, green, and blue respectively. Getting the RGB values of a photograph returns a tuple of the red, green, and blue values.

To determine the most prominent colors in an image, use these general three steps:

1. Extract RGB values into three lists.
2. Applying k-means clustering on measured through RGB values.
3. Show colors of cluster centers on display.

We employ Matplotlib's imread() function from the image class to extract RGB values. R, g, b has all been created as empty lists.

## 3.13 HSV (HUE, SATURATION AND VALUE)

Hue, saturation, and lightness are important color properties for differentiating different colors. Effective use of color is one of the most important aspects of photography. This is because color draws the viewer's attention to the composition and can affect the mood and emotional impact of the photo.

## 3.14 KNN MODEL

One of the most practical machine learning algorithms, K-Nearest Neighbor is completely based on the supervised learning method. The K-NN set of rules presume similarity between the new case/records and existing cases and places the new case into the category that is most similar to the existing categories. The K-NN set of rules stores all of the available data and categorizes a new data factor based only on similarity. This method, even though new data appear, may easily be classified into a class that fits it by using the K-NN set of rules. Although the K-NN set of rules can be used for both classification and regression, this is often where they are applied. Because K-NN is a non-parametric collection of rules, it no longer makes any assumptions about the underlying records. It is sometimes referred to as a lazy learner set of rules since it stores the dataset instead of learning from it right away and then performs an action on it when it comes time to classify. When new records are added, the KNN set of rules in the education portion simply stores the dataset and classifies the new records into a class that is quite similar to the newly added records.

## 3.15 EXECUTE MODEL

A programming language includes a grammar/syntax plus an execution version. The execution version specifies the conduct of factors of the language. By making use of the execution version, one could derive the conduct of a software that became written in phrases of that programming language. For example, whilst a programmer "reads" code, of their mind, they stroll via what every line of code does. In impact they simulate the conduct internal their mind. What the programmer is doing is making use of the execution version to the code, which ends withinside the conduct of the code.

## 3.16 FILTER

Filter() method is used to filter out the sequence with the help of function which tests the element in the given sequence which could be true or false.

## 3.17 SEGMENTATION

Image-based inspection and analysis technology realized by segmenting separately each parameter. steps of image segmentation

1. Import the libraries
2. Reading the sample image on which we will be performing all the operations.
3. Creating the function that will draw the bounding box.
4. Explaining the Grab cut algorithm.
5. The main function is to run the complete process all at once.

When more than one object is viewed in a scene at the same time, we need to determine to which object the pixels in the image belong. This process is called image segmentation". We perform image segmentation using the "connected pixels" algorithm to find an "object matrix", where the value of each pixel indicates which object the pixel belongs to.

## 3.18 K-MEAN CLUSTERING TECHNIQUE

The K-means algorithm establishes k centroids, then assigns each data point to the closest cluster while minimising the centroids. The data's mean, or the centre, is referred to as the "average" in K-means analysis.

## 3.19 MASKING

A smaller "image fragment" is defined and used to alter a bigger image as part of the image processing technique known as masking. Many types of image processing, such as edge detection, motion detection, and noise reduction, all depend on masking.

## 3.20 WERKZEUG

Tools is a comprehensive WSGI web application library. What started as a simple collection of miscellaneous utilities for WSGI applications has grown into one of the most advanced WSGI utility libraries.

It consists of the following:

1) An interactive debugger that allows you to inspect stack traces and source code in your browser using an interactive interpreter for each frame in the stack.

2) Complete request object including objects for interacting with headers, query arguments, form data, files, and cookies.

3) A response object that can wrap other WSGI applications and handle streaming data.

4) A routing system for mapping URLs to endpoints and generating endpoint URLs using an extensible system for capturing variables from URLs.

5) HTTP utilities that handle entity tags, cache control, dates, user agents, cookies, files, and more

6) His threaded WSGI server for use when developing applications locally.

7) A test client that simulates HTTP requests without running the server during testing.

## 3.21 WEB APP

Building Web Applications with Flask and Python 3 Flask is a lightweight Python web framework that provides useful tools and features for building web applications using the Python language. It provides flexibility for developers and is an accessible framework for new developers because you can quickly create a web application using a single Python file.

**Step 1 -** Installing Flask In this step, you will activate your Python environment and install Flask using the pip package installer. First, activate your programming environment if you don't already have it.

**Step 2 -** Create a simple application Now that your programming environment is set up, you will start using Flask. In this step, you will create a small Flask web application in a Python file, in which you will write HTML code to display in the browser. In the "Flask Applications" folder, open the file called "app.py" for editing, use nano or your favorite text editor.

**Step 3-** Run the app After creating the file contains a Flask application, you will run it using the Flask CLI to start the development server and display in the browser the HTML you wrote as the return value to the hello() display function in the previous step. First, in your flask_app folder with virtual environments enabled, tell Flask where to find the app (app.py in your case) using the Flask_App environment variable with the following command (on Windows, use use set instead of export()):

## 3.22 .NET 4 FRAMEWORK

proprietary software framework developed by Microsoft that primarily runs on Microsoft Windows. The .NET Framework (pronounced "dot net") is a proprietary software framework. rights developed by Microsoft mainly run on Microsoft Windows. It was the dominant Common Language Infrastructure (CLI) implementation until it was superseded by the .NET Cross Platform Project. It includes a large class library called the Framework Class Library (FCL) and provides language interoperability.

# Chapter-4
# DESIGN AND METHODOLOGY

## 4.1 INTRODUCTION

We have presented the relation of soil properties using ANN and regression. Machine learning approaches can be used to estimate and predict the different properties of soil including soil pH and soil moisture level. The presented model predicts the soil pH. In the study, valuable works are found for soil pH prediction. But, most of the tasks are not in the fever of rural farmers as images are captured using Drone Camera. In this study, samples are captured with the help of a Drone Camera which can reduce the cost of the system and determine the chemical characteristics of soil easily. But capturing soil samples using the Drone Camera is main challenging task for soil pH Prediction because the natural light can directly affect the quality of the soil sample. Taking all these factors, we develop our system in such a way that a rural farmer can easily capture a soil sample and use our system for actual soil classification Analyze and Prediction of soil pH is done using different machine learning Prediction algorithm including regression, ANN and KNN.

## 4.2 MATERIALS AND METHOD.
### 4.2.1 Study Site

The study site is located in the Tandojam at Sindh agriculture university, Sindh province, Pakistan (25∘4264j N, 68∘5434j E). The climate is variable according to seasons and months of the year. The Sindh province is located in a subtropical region; which is hot in the summer and very cold in winter. Temperatures frequently go above 46 °C (115 °F) in the months of May and August, and the minimum average temperature of 2 °C (36 °F) occurs in the months of December and January. February, the last month of the winter in Tandojam, is another warm month, with an average temperature fluctuating between 17°C (62.6°F) and 29.5°C (85.1°F). In February, the average high-temperature gradually increases from a warm 25.8°C (78.4°F) in January to a still moderately hot 29.5°C (85.1°F).The first month of the spring, March, is a sweltering month in Tandojam, Pakistan, with an average temperature varying between 22.2°C (72°F) and 35.8°C (96.4°F). In March, the average high-temperature increases from a warm 29.5°C (85.1°F) in February to a very hot 35.8°C (96.4°F). The study site is classified as fertile

land, where different types of crops are grown yearly like Sunflower, wheat, maize and cotton etc.

**4.2.2 Study Design**

We conducted a survey of field at Sindh agriculture university during 2 months February and march 2021-20122 to explore the weather and area of the land, the reason behind the selection of fields at Tando jam is because its land has high rate of fertility all over the Sindh and there are scientists who works on different type of soil properties.



Figure- 4.1 Survey of site

**4.2.3   UAV FLIGHT MISSION**

The DJI spark drone (UAV) is included in the hardware part for soil data collection. It is operated through an android app known as DJI GO 4. DJI Spark drones equipped with cameras will be used to take photos for data collection and real-time detection, allowing us to easily capture the images at a certain height so we can cover wide area of the field, simply by flying the UAV over the area. This UAV drone has a built-in camera, obstacle avoidance, vision system and 3D sensing system, and can take 12-megapixel photos at a height of up to 30 meters, DJI spark drone is shown in (Fig: 4.4).

Figure 4.4: DJI Spark Drone

**Methods of UAV Flight:**

1) Remote control device.

2) Use "DJI GO 4 APP".

The specifications of the drone used are as follows, with a total weight of 300 grams. This drone is powered by a LiPo 3S battery with a capacity of 1480mAh. The charger is used to charge 5v drones with a rated current of 3amp. Its maximum flight time is approximately 16 minutes. It can fly at a maximum altitude of about 30 meters and can be controlled within a range of about 50 meters. In S mode, the highest rated and descending speed of the drone is 3 meters per second. In order to fly the drone safely, a temperature range of 32 degrees to 104 degrees is given; below or above this threshold, DJI Spark's behavior will be different. The attached camera uses a 1/2.3" CMOS sensor with an effective pixel of 12 megapixels, a lens of 81.9 FOV, a size of about 25 mm, and a shooting range of 2 meters to infinity. The sensitivity of the camera sensor is referred to as ISO, which is used to control exposure F/stop and shutter speed. For photos, DJI Spark's camera range is 100- 1600, and for movies, its range is 100-3200. It can capture images at a maximum resolution of 3968x2976 pixels.

The format in which pictures have been captured is JPEG. In this drone the gimbal has been attached to stabilize the image during flight mode and the controllable range was -

85 to 0 degree. The flight of drone was totally controlled by the mobile app DJI GO 4 in which many controllers have been given to capturing the images, recording the videos and control the flight of drone.



Figure 4.2: DJI GO 4 App Icon



Figure 4.3: Operating Drone Through App

These are the camera parameter values of DJI spark drone, which are shown in (Table 4.1: RGB Camera Specifications)

Table 4.1: RGB Camera Specifications

| Parameter | Value | Parameter | Value |
|-----------|-------|-----------|-------|
| Sensor | 1/2.3" CMOS | Aperture | f/2.8 |
| Lens angle | 81.9 FOV 25 mm | ISO | 200 |
| Photo size | 3968x2976 pixels | Shutter Speed | 1/320 sec |

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### 4.2.3.1 Sample Setting and Data Collection

Soil sample collection is a big challenge, we collected total of 500 soil samples from the fields. For all 500 samples, 5 fields are selected and 100 images per fields are collected. The distance separation of two samples is 10 meter in each field. Collecting samples are dragged out in depth of 0.5 feet in a vertical direction from the top position of the soil. All total of 50 soil samples is placed in white paper for image acquisition. Images are captured with the help of UAV and then soil samples are processed for pH and soil moisture calculation. To understand and unifying the solar altitude angle, the UAV visible images are captured from 12:00 to 13:00 local noon time. A UAV Drone is a good device to capture the agriculture image.

Soil photo acquisition is a method for shooting extraordinary pics with the assist of virtual photo shooting devices. In maximum of the agriculture study, a virtual digital digicam is used to seize the pattern pics however Drone is likewise used captured the agriculture pics. Since the aim of doing this technique is to expect the soil pH in a low-value manner, a Drone is used to seize the soil pics and saved it as soil dataset. The precautions in the purchase segment of the UAV seen pics have been as follows:

**(1)** The brightness of the UAV seen pics turned into tormented by the mild depth, flight velocity of the UAV, and the seen digital digicam parameters (model, lens perspective, ISO, aperture, and shutter velocity). Among those influencing factors, the flight velocity of the UAV and seen digital digicam parameters (model, lens perspective, ISO, aperture, and shutter velocity) have been controllable, so suitable UAV parameters have been set and no extrude turned into made for the duration of the entire test. As an uncontrollable impact factor, the mild depth turned into tormented by the sun altitude perspective and the atmospheric transparency. The mistakes because of the atmospheric transparency might be corrected with inside the later period.

**(2)** To suit the soil moisture in time and space, the UAV seen pics have been taken synchronously with the dimension of the soil moisture of the 0–10, 10–20, and 20–30 cm layers. In the case of wet climate at noon, the taking of the UAV seen pics might be postponed accordingly. Every UAV seen photo need to cowl 2 m × 2 m quadrat place containing all of the information, consequently we set the insurance place be three m × three m, after which calculated that the peak turned into 1.4 m consistent with the lens angel of the digital digicam and the insurance place. 2.five m consistent with the lens angel of the digital digicam and the insurance place (Figure 4.4).

Combining the above aspects, the UAV flight

mode turned into a velocity of three m/s, a peak of 2 five m, vertical taking pictures on each point, and an insurance place of three m × three m for every photo. In the rotational grazing land, we used the identical flight mode via way of means of the DJI spark to take seen pics for verification quadrats.
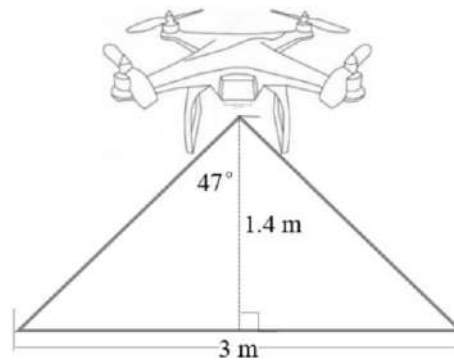


Figure 4.4: Schematic diagram of the flight height

To edit the test's individual images, the "Mosaic" flight mode was also used to obtain aerial images. During each flight, the drone automatically takes a picture every 3 seconds. Aerial photographs of the quadrilateral have been reduced to the minimum size necessary to cover the study area and control points.



Figure 4.5: Arial image of the study area.

Figure 4.6: Soil Dataset

### 4.2.4   MANUAL METHOD

We used a premade soil pH/Moisture and light content sensor. With this method, we measured the soil sample values for 7 days, during a favorable light -conditions, in the open. where we took the soil sample, by digging half feet into the soil and creating a square plate for the soil to settle in. then we started by moisturizing it by giving a certain amount of water, so that soil get completely moisturized. And placed the sample set in an open environment, so that we can collect readings for all the days, and during different daily intervals.



Figure 4.7: Digital pH meter

**4.2.4.1 DETERMINATION OF SOIL PH USING SOIL PH METER**

The soil pH can be calculated using digital soil pH meter or soil pH color chart. But, soil pH chart is not an adequate process as it requires human perception during the time of color analysis. The actual soil pH value of 120 soil samples are done in the laboratory test, a digital soil pH meter is used to determine the soil pH. The calibration of soil pH meter is done using a buffer solution with 7 pH value. A 20grms of soil sample is weighted and transferred it to a 100 ml glass beaker. 40 ml distilled water is mixed with the soil solution and stir with a glass rod. The solution stands for half an hour. Finally, the electrode of soil pH meter is immersed in the solution and determined the soil pH. The pH of the soil sample is displayed in the digital display of the digital soil pH meter and then, all the pH values are tabulated.

Table 4.2: pH value of digital pH meter

| Sample No: | Field-1 | Field-2 | Field-3 | Field-4 | Field-5 |
|---|---|---|---|---|---|
| 1 | 8.25 | 8.24 | 8.01 | 7.11 | 7.12 |
| 2 | 8.23 | 8.21 | 7.90 | 7.69 | 7.15 |
| 3 | 8.31 | 8.26 | 7.85 | 7.08 | 7.25 |
| 4 | 8.25 | 8.15 | 7.95 | 7.09 | 7.09 |
| 5 | 8.29 | 8.16 | 7.98 | 7.07 | 7.08 |
| 6 | 8.24 | 8.00 | 7.99 | 7.11 | 7.91 |
| 7 | 8.19 | 8.10 | 7.95 | 7.09 | 7.92 |
| 8 | 8.17 | 8.15 | 7.82 | 7.09 | 7.85 |
| 9 | 8.16 | 8.17 | 7.89 | 7.15 | 7.98 |
| 10 | 8.21 | 8.19 | 7.84 | 7.16 | 7.97 |
| Mean | 8.23 | 8.163 | 7.918 | 7.164 | 7.532 |

## 4.3 CONTROLLING OF EFFECTING FACTORS

As a studies index of UAV seen pix, the brightness relies upon on twin modifications with inside the plants and soil, and is tormented by a chain of influencing elements. Among those elements, controllable elements were managed in the purchase segment of UAV seen pix. The uncontrollable element is the mild intensity, and the atmospheric transparency is the primary element affecting the mild intensity. The cause is that seen mild-electromagnetic radiation is transmitted with inside the sun-floor-sensor (UAV) route, and the transmission system is tormented by the absorption and scattering of atmospheric molecules, water vapor, aerosol, and different atmospheric components. The seen mild-electromagnetic radiation eventually conventional through UAV now no longer simplest consists of the floor mirrored image data, however additionally information the interference of the environment with inside the floor mirrored image data. To accurate the mistake resulting from atmospheric transparency amongst distinct take a look at dates, the UAV seen pix have been taken on sunny dates with much less than 10% cloud cowl in line with meteorological data and real observation. On this basis, we had decided on a comparative quadrat as a general quadrat. As a simplest uncontrollable affect element, the alternate with inside the brightness of the same old quadrat with the alternate with inside the atmospheric transparency become fixed, consequently we elevated or reduced the brightness of the watered quadrats and comparative quadrats in line with the same old quadrat.
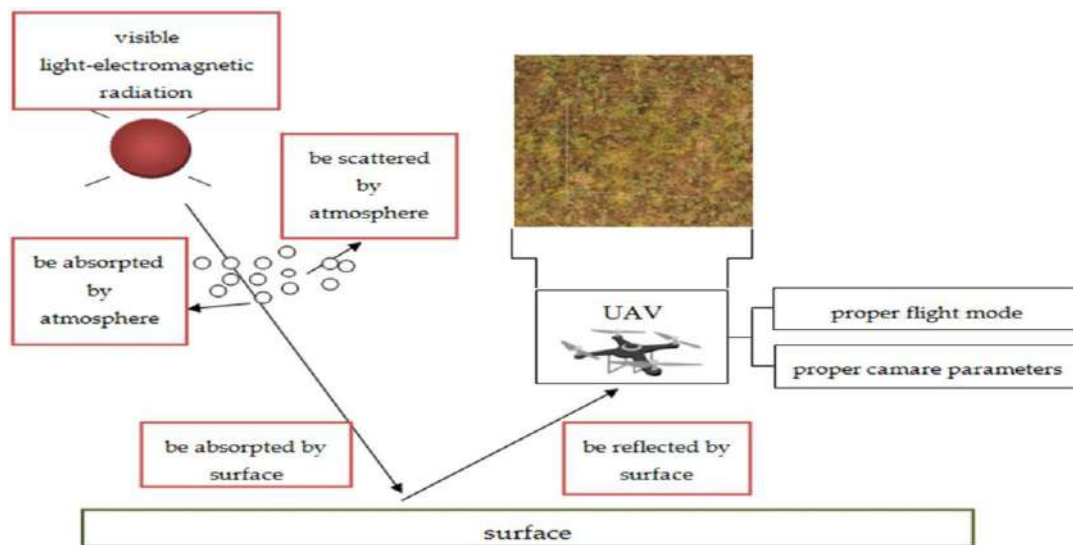


Figure 4.8: UAV Soil Monitoring Model
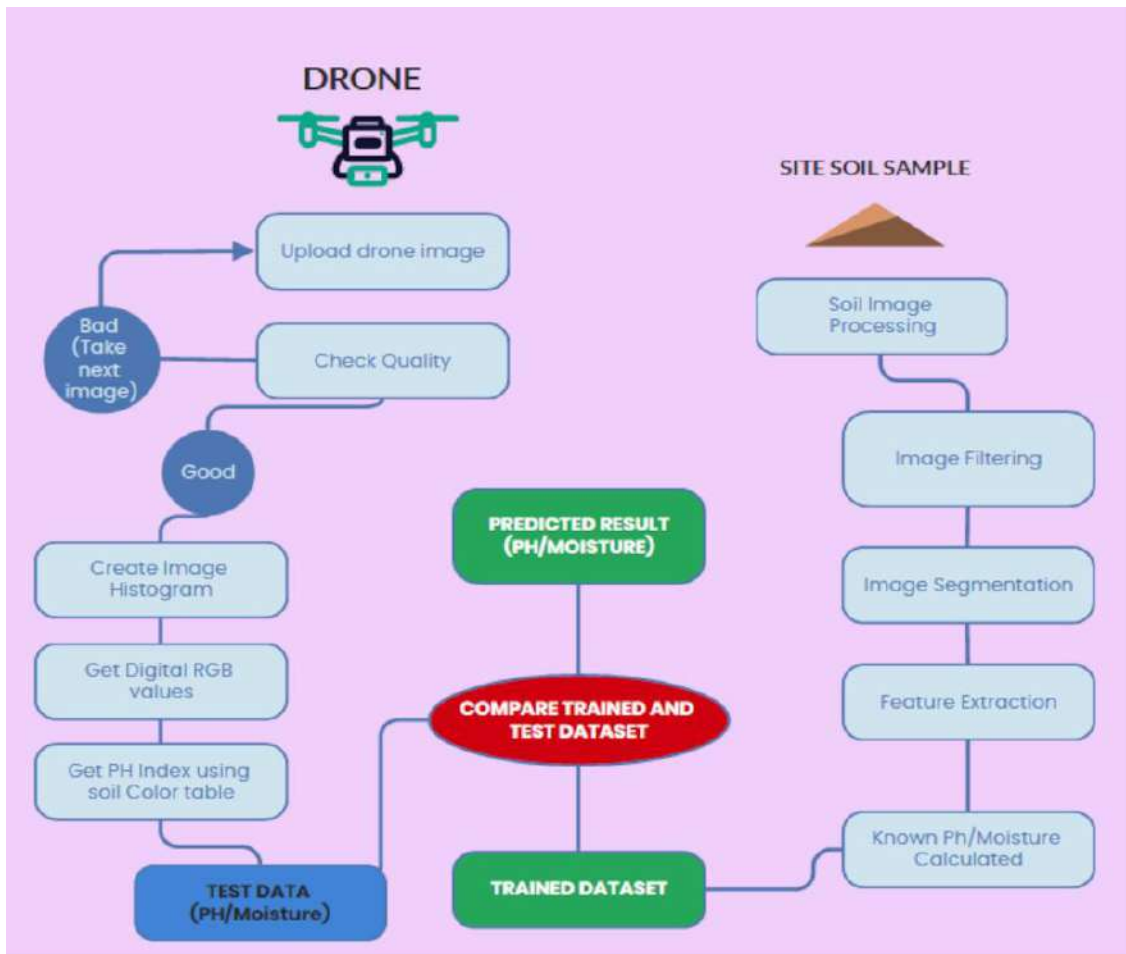
4.4 **WORKING METHODOLOGY**



Figure 4.9: Working Methodology Block Diagram

**4.4.1 SOIL IMAGE PREPROCESSING, SEGMENTATION AND FEATURE EXTRACTION:**

Soil captured images are in 8-bit RGB mode and saved in jpeg format. All the images are in 4160 x 2340 dimensions with 72 dpi. After this, images are processed through the different image processing steps including image filtering, image segmentation, and feature extraction.
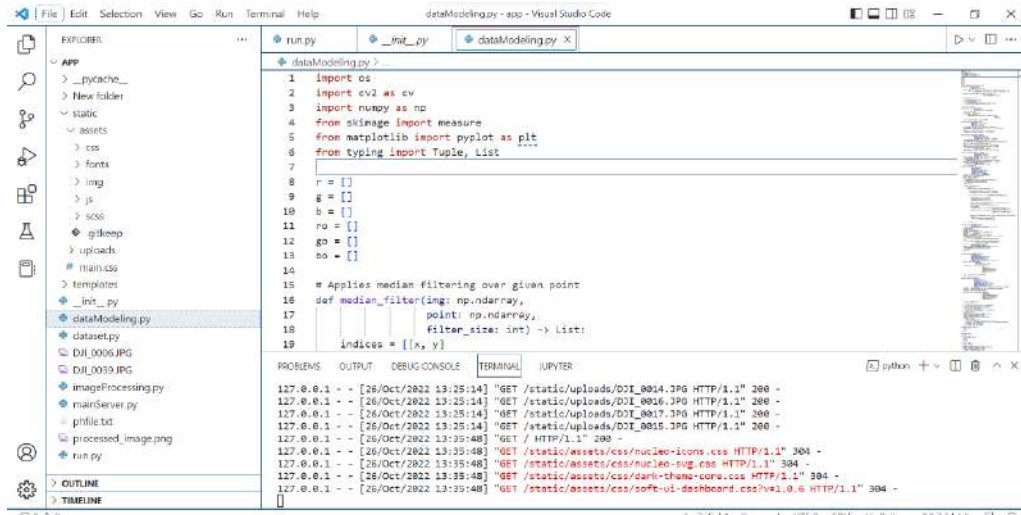
Figure 4.10: visual studio code

**IMAGE FILTERING:**

As all the captured images are in high in dimension, images are resized to 300 x 400 dimensions. After that, Image filtering is used to filter the images. Image filtering is the process of enhancing the quality of soil images using filtering and other image enhancement techniques.

**DRONE IMAGES**



Figure 4.11: sample (a)    Figure 4.11: sample (b)    Figure 4.11: sample (c)

**Segmentation using K-Mean and masking:**

Image segmentation is the process of segmenting the original image or filter image into different small segment so that the features of the images can be easily calculated. In this paper, K-Mean clustering is used to segment the filter image into 2 clusters. K mean is **unsupervised** clustering technique which is used for image segmentation. It divides the images into different cluster or Segment.

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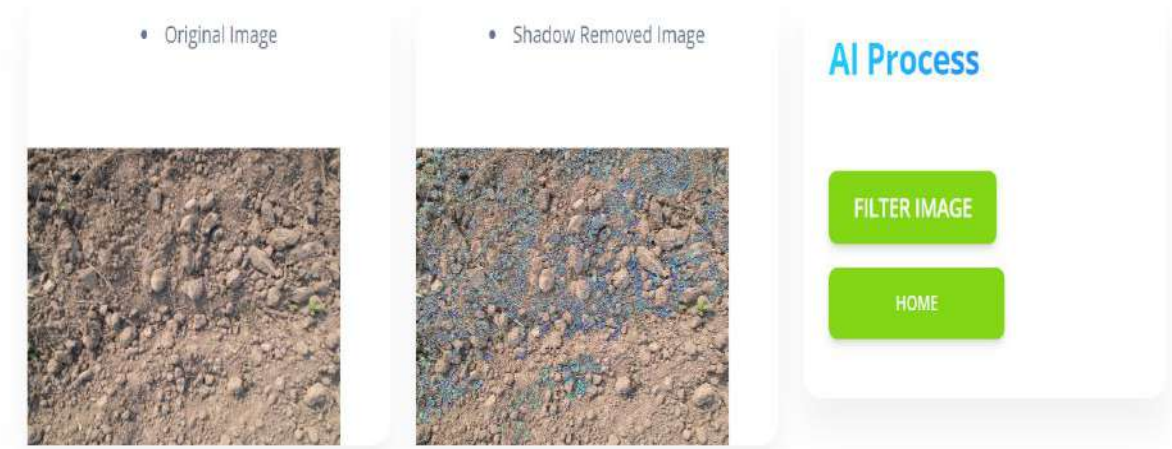
Figure 4.11: Removing shadow

## FEATURE EXTRACTION OF SOIL IMAGES:

Feature extraction is the process of extracting different image features like color, texture, and shape. In this paper, the color image

of soil is considered for feature extraction. Color is an important feature of an image and human can recognize any images using color. A human can determine the soil pH through naked eyes using soil pH chart but the process is not reliable as it is

based on the color analysis of the soil images by a human

### 4.4.2 SOIL PH PREDICTION USING LINEAR REGRESSION

Linear regression is a good tool of machine learning to predict the unknown data in agriculture field and presented with the help of fitted line. Regression coefficient (R) gives the performance of the regression. The regression results showing an accuracy of 0.8-0.99 is accepted or highly correlated, otherwise, it is not accepted. We used **Mean_Hue + Mean_Saturation** method. Which gives a high correlation with the soil pH Values.These Values are then given to ANN algorithm, for further processing

### 4.4.3 SOIL pH PREDICTION USING ANN

Different properties of soil can be estimated using Artificial Neural network. In paper we already used ANN for soil pH prediction with an accuracy of 80%. Paper used ANN for the Prediction of compaction parameter of soil. In this paper, an

ANN model is developed to predict the soil pH using **Mean_Hue** + **Mean_Saturation** as the input data. **Mean_Hue** + **Mean_Saturation** is used in input as these two features of soil already give a high correlation with the actual soil pH values. The used ANN model for this paper is a feedforward neural network. The model consists of an input layer, one hidden layer, and an output layer. These are different Backpropagation algorithm is present in Neural Network Toolbox including Levenberg-Marquardt and Scaled Conjugate Gradient Backpropagation Algorithm. In this paper, both Levenberg-Marquardt and Scaled Conjugate Gradient Backpropagation Algorithms are used to train the model. Levenberg–Marquardt Backpropagation (LMBP) algorithm is the fastest neural network training and it uses less memory for the training set. Again, Scaled Conjugate Gradient Backpropagation algorithm (SCGBP) is a general-purpose training algorithm which requires no line search.

The model is programmed in **Python**. The model is evaluated by considering 500 samples of soil. For the evaluation, 50 samples are divided into three categories of Training Set, Validation Set, and Testing Set.

The proportions of different sets are 70%-15%-15%. It means that the training set contains the 70% of the data and it is 30-35 samples. Validation set contains 15% of the data and it is 6-10 samples. Again, testing set contains 15% of the data and it is 10 samples. The performances of both the models are assessed using mean square error and coefficient of regression (R). Mean Square error (MSE) is the mean square error in between the actual values of soil pH and the predicted values.
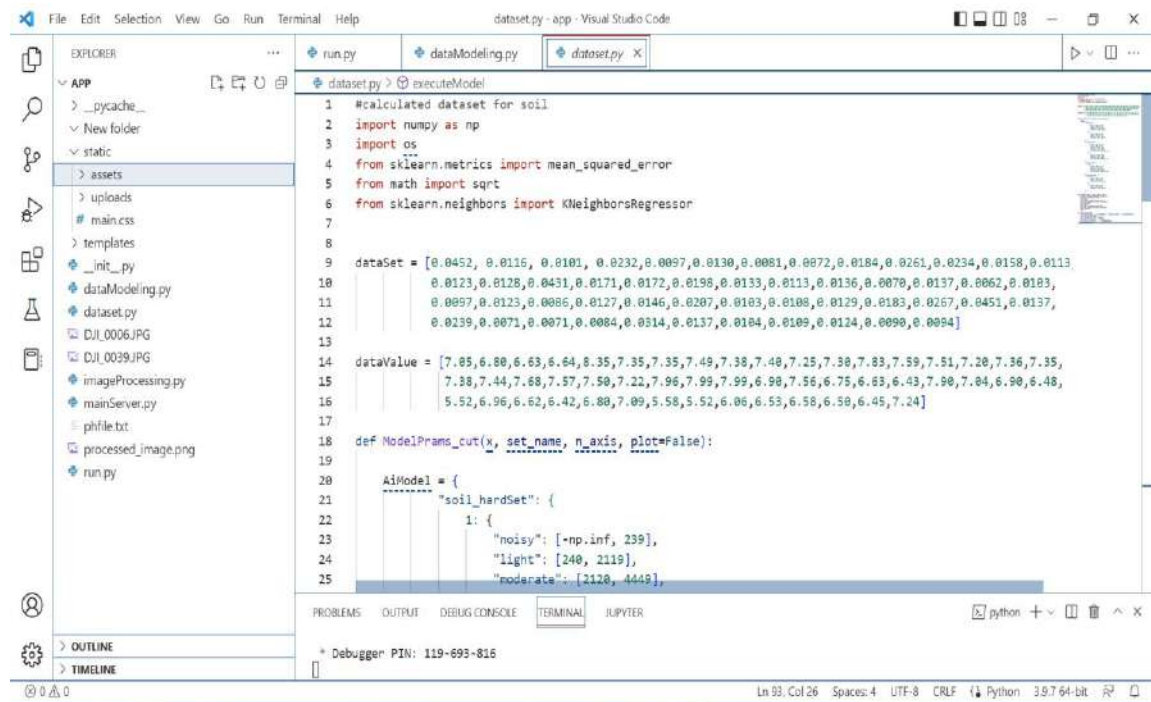
### 4.4.4 SOIL PH PREDICTION USING KNN

K nearest neighbor is a very popular algorithm which stores all the values of the training set and predicts the testing value based on the similarity measure. Various methods are present to calculate the distance between the training and testing set including Euclidian distance, Manhattan distance, Minkowski distance etc. The prediction of soil pH using KNN depends on the following steps. Division of entire dataset in between training and

testing set. I. Determine the value of K.

- Compute the distance between training and testing set using any distance algorithm

- Sort all the training values as per the computed distance.

- Based on the RMSE value, find the appropriate K.

For KNN, the entire 500 values of saturation color space of the soil image and **Mean_Hue + Mean_Saturation** of the soil image are considered as soil data. Soil data are divided into training and testing set. The ration of the division is 70:30. The training the similarity measurement of the model is performed using the Minkowski distance.
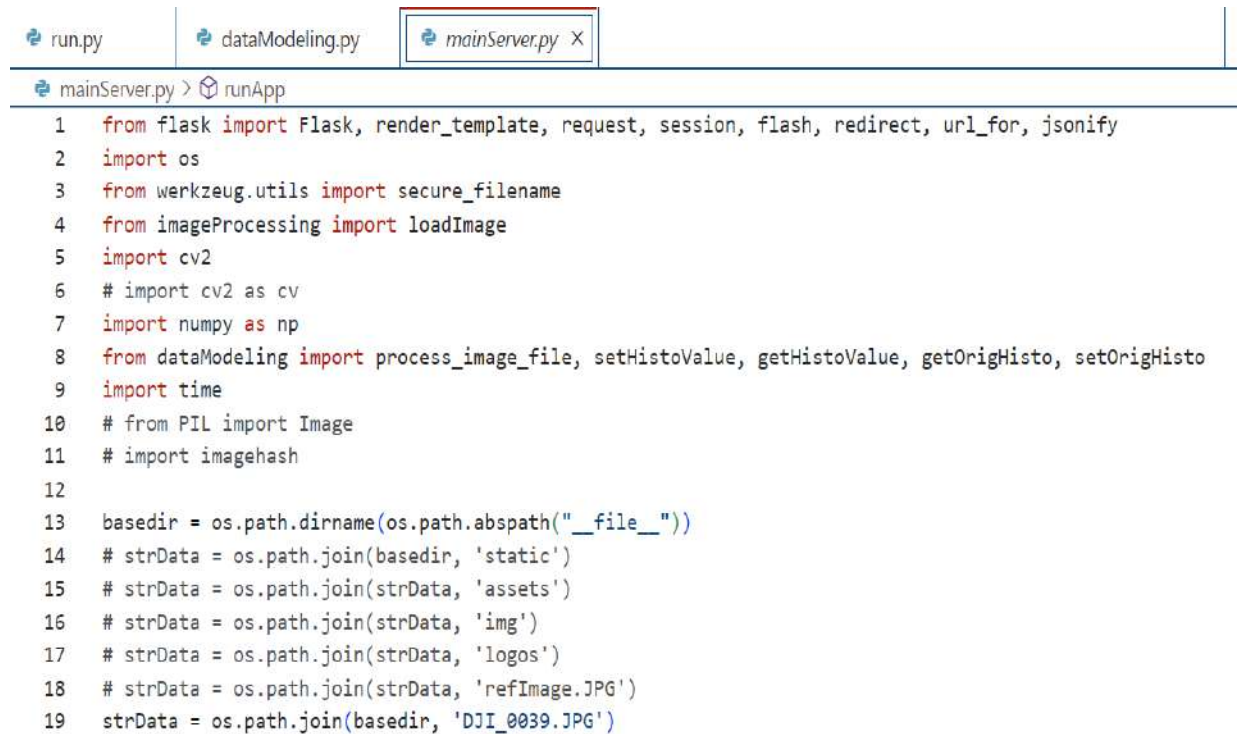
Different values of Red, Green, Blue, Hue, Saturation and Values are calculated for the entire soil samples. All the extracted values of RGB and HSV are stored in a (.mat) or (.csv) file for the Prediction. prediction of soil pH is done with the help of different Prediction algorithm including Regression, ANN and KNN.



Figure 4.13: Training of dataset

### 4.4.3    WEB APP DEVELOPMENT



```
1   from flask import Flask, render_template, request, session, flash, redirect, url_for, jsonify
2   import os
3   from werkzeug.utils import secure_filename
4   from imageProcessing import loadImage
5   import cv2
6   # import cv2 as cv
7   import numpy as np
8   from dataModeling import process_image_file, setHistoValue, getHistoValue, getOrigHisto, setOrigHisto
9   import time
10  # from PIL import Image
11  # import imagehash
12
13  basedir = os.path.dirname(os.path.abspath("__file__"))
14  # strData = os.path.join(basedir, 'static')
15  # strData = os.path.join(strData, 'assets')
16  # strData = os.path.join(strData, 'img')
17  # strData = os.path.join(strData, 'logos')
18  # strData = os.path.join(strData, 'refImage.JPG')
19  strData = os.path.join(basedir, 'DJI_0039.JPG')
```

Figure 4.14:   Main Server of Web APP

Figure 4.15: Interface of web app

**Chapter-5**

## RESULTS AND DISCUSSION

### 5.1 INTRODUCTION

This chapter presents the result of the project. After the application finished its work, a series of tests were performed on the model. The images stored in the phone are also used to compare the accuracy of the models. In order to meet the criteria for using drones to calculate PH and Soil moisture, soil pH prediction is done using linear regression, ANN and KNN regression. In the process, it is finding that soil saturation color is highly correlated with the actual value of the soil pH. it is found that Mean_Hue + Mean_Saturation is also highly correlated with the actual value of the soil pH. Both the correlations are positive correlation and their coefficient of best fit is respectively 0.859 and 0.823. For KNN, Levenberg-Marquardt and Scaled Conjugate Gradient Backpropagation.

### 5.2 ANALYSIS OF RESULTS

Algorithms are used as training algorithm. Levenberg-Marquardt model is used with 4 hidden neurons at the hidden layer and the R-value of the model is 0.94064. But the R value of the training set, validation and testing set is presented. The accuracy of the training model is less comparing to the testing and validation and gets the best validation result at epoch 6.

The best validation is 0.0083895. Like Levenberg Marquardt, Scaled Conjugate Gradient Backpropagation Algorithm also gives very good accuracy in the testing and validation set as compared to the training set and gets the KNN algorithm is widely used in the classification problem rather than regression.

The performance of the KNN is depended on the optimum value of the K and optimum of K can be found by using the grid search. But in this paper, the KNN regression is implemented for the different value of K and finds the RMSE and MSE value of the model to find the optimum value of the K.

The optimum value of the K is 5. The RMSE and MSE of the testing set of the KNN model are respectively 0.131168255 and 0.01592665. It is the less RMSE and MSE value among all the K values of RMSE and MSE of the testing set. At K =5, the accuracy of the testing and training is almost the same from our analysis it is analyzed that the soil pH prediction can be possible with the different prediction algorithm but

ANN always gives a better result as compare to other one.

The grayscale images, a spectral clear out out changed into introduced to the grayscale images, and thereby we divided the 256 degrees of brightness into seven colorations roughly.   The definition from darkish to vibrant changed into red, inexperienced and blue. The brightness regularly multiplied from left to right. The brightness of the plant life is decrease than that of the soil, and the decrease the 0–four cm soil moisture changed into, the greater apparent the brightness comparison changed into. Finally, the histograms have been output. In those histograms, "Mean" refers back to the brightness that we talked about.
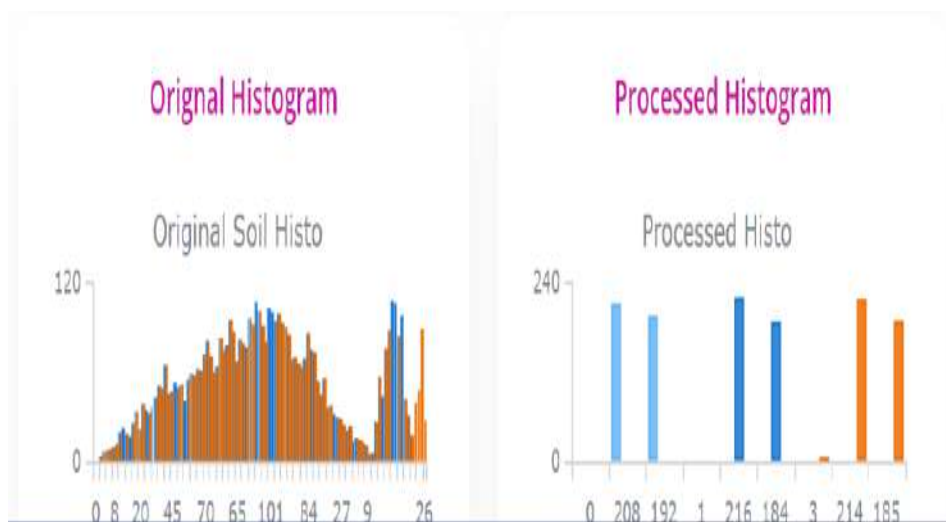


Figure 5.1: Soil Histogram

## 5.3    CALCULATION OF SOIL MOISTURE AND PH

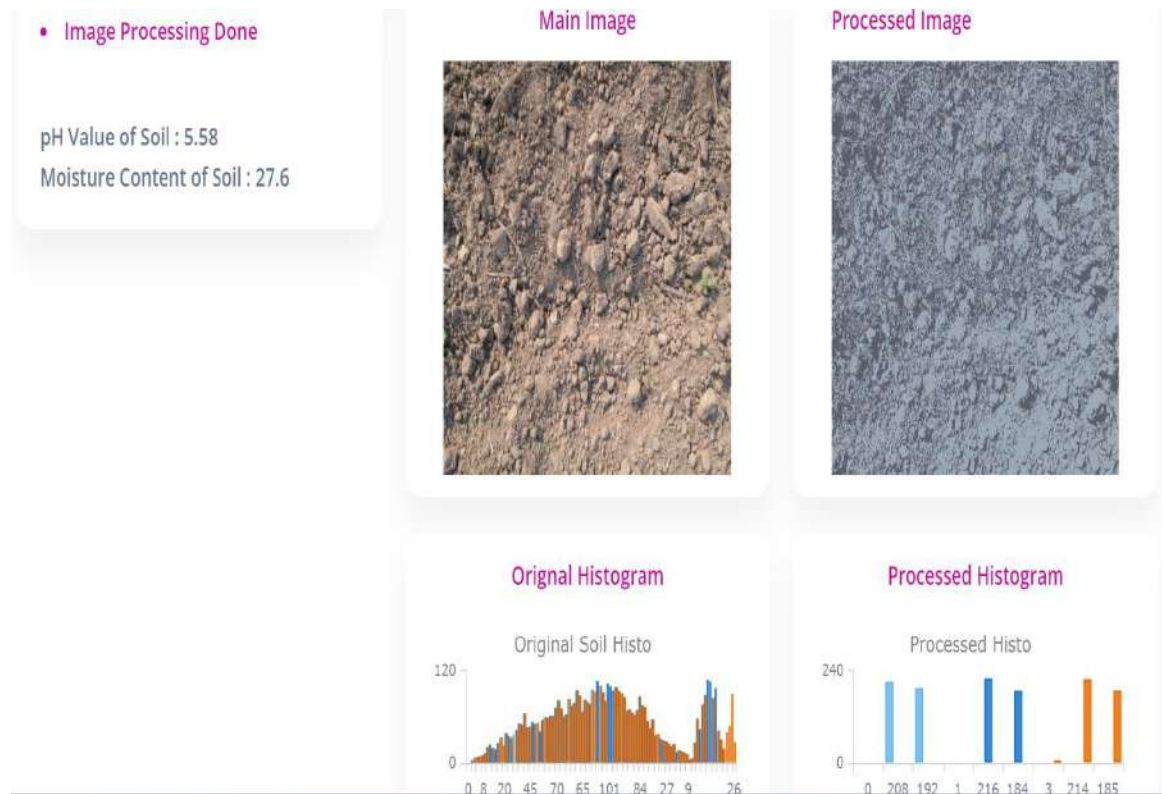Result contain 90% of accuracy, when compared with manual data.



Figure 5.2:  Soil pH and Moisture content

# Chapter-6
# CONCLUSION AND FUTURE RECOMMENDATIONS

## 6.1  INTRODUCTION

Soil estimation model will be developed to estimate/monitor the moisture of soil in easy way and without using lab equipment. This could be helpful for farmers to judge the soil estimation at farmland. In conventional method, farmers used their expertise to estimate the moisture of soil and took decision on that basis which results in excessive usage of water required for field and excessive use of fertilizers also. Using advanced technologies, Unmanned Aerial Vehicle (UAV) is used in this project for high resolution images on shorter time which is good for model development. After acquired aerial images, three machine learning methods were used to get better model for soil estimation. Estimation technology using drones can solve these problems. Firstly, the resolution of aeronautical remote sensing images is higher than that of satellite remote sensing images, so the accuracy of interpretation and classification is higher. Second, aerial remote sensing images can be interpreted in stereo, while satellite remote sensing images can only be interpreted in the plan. Third, compared to aerial remote sensing images, satellite remote sensing images are larger in scale and more difficult to interpret than aerial remote sensing images. In this study, Soil image color is a good indicator of soil pH. Previously farmers used soil color chart to predict the soil pH and this method is fully based on human perception. An Expert can also help farmers during this process but getting expert views in all time is not possible. Sometimes farmers used soil testing laboratory or soil pH digital meter to calculate the soil pH but these methods are very time and cost consuming. This paper gives a camera based low-cost soil prediction model which will detect the soil PH easily. In this paper, different prediction algorithm is implemented for better accuracy for the prediction using linear regression, ANN with SCGBP and KNN regression. And best approach is selected, which gives more accurate results. Hence it is seen that camera-based technique for estimating the soil pH content is very helpful for rural farmers rather than other methods.

## 6.2    ADVANTAGES

- We can use the UAV virtual system to simply collect field data, which can save farmer's time and energy, and enable more accurate results.

- The conventional oven-dry approach and time-green instrumental approach are appropriate for a factor scale to degree soil moisture and feature apparent boundaries for large- or medium-scale use. The majority of current far flung sensing era concentrates on non-unmarried seen bands; maximum of them rely upon multiband operations to degree soil moisture, inclusive of infrared digital digicam drones and high-value and complicated virtual picture processing.

## 6.3    LIMITATIONS AND FUTURE WORK

- In this project, we had only determined 2 parameter of soil that is its pH value and moisture content.
- This project is limited to access only 15 photos at a time.
- This project can't be use in northern areas because of infertility and texture of soil.
- It is does not process images in real time.
- More soil parameters could be found in future like electrical conductivity, and nutrients.

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