iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** I **Month of publication:** January 2022

DOI: https://doi.org/10.22214/ijraset.2022.39655

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue I Jan 2022- Available at www.ijraset.com

CropsIT- A Portable Soil Analysis and Crop Suggestion System

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Abstract: ***Many farmers, especially ones from underdeveloped and developing countries, rely on agriculture for their family's livelihood. Agriculture is the most useful and noble employment of man. Yet on the contrary agriculture industry holds a record for the highest death rate by profession. This fatality is a result of many reasons. One such reason is when the farmer does not get the proper yield due to a lack of knowledge regarding the soil quality and fertilizers to be used. The solution to this is an easily operable device that senses the soil nutrient components and analyses the values obtained to provide a detailed report, along with crop suggestions suitable for the soil, instantaneously through a message or web service. The device will collect information regarding the NPK percentages present in the soil on a regular basis. The Technologies involved in the device are Colorimetry, Python, Deep Learning, Flask, and Heroku. The analysis made by the device will suggest the farmer with a variety of crops that are suitable for their land. The farmer can then get the required seeds and fertilizers to get a greater yield.***
Keywords: fatality, colorimetry, reagents

I. INTRODUCTION

"Agriculture is the most healthful, most useful and most noble employment of man". — George Washington. Yet 23.66% of agricultural land is being unutilized in India. Contrary to it agriculture industry holds a record for the highest death rate by profession. This fatality is a result of many reasons. One such reason is when the farmer does not get the proper yield due to a lack of knowledge regarding the soil quality and fertilizers. How might we help the farmers to access the soil quality instantaneously in advance of the cultivation process to increase crop productivity?

Soil testing laboratories take time to give the analysis report. Farmers are unable to decipher the scientific and technical information provided in the report and this process is not instantaneous, therefore ineffective for day-to-day analysis. Crop yield is not up to the mark due to a lack of knowledge on the soil quality

There are around 4000 soil testing labs all over India. Since the soil testing laboratories take time in giving the analyzed report, farmers do not prefer that method. Most of the farmers admit that they lack knowledge on the right amount and type of fertilizer that is to be used and may end up making the soil infertile. They are looking forward to a device that can give a complete report on the soil quality instantaneously. The device should be easily operable with simple steps

Our solution is an easily operable device that senses the nutrients present in the soil and analyses the values obtained to provide a detailed analysis report instantaneously through a messaging or web service. The device primarily measures the number of macronutrients present in the soil and collects information regarding various parameters that affect the soil quality. It analyses the collected information using appropriate data science techniques, suggests the farmer with the crop varieties suitable for that land, provides information regarding the right fertilizer that is to be used, and conveys the data to the farmer using a message and web service platform.

II. LITERATURE SURVEY

Agriculture is an industry with almost 70% of the country's workforce that requires a lot of attention in terms of advancements in technology. This device provides assistance to the users of the agricultural industry.

Furthermore, this device also benefits the horticulture industry.

The main objective of the device is to provide the soil analysis report instantaneously. Traditional soil laboratories consume 1 to 2 weeks of time to provide the farmers with a complete analysis of the soil quality.

This concept mainly focuses on filling this gap by providing the farmers with a device that functions automatically. The user has to place a significant amount of soil required as per the experiment, into the device. The device has three phases which include preparation of soil solution, the addition of required reagents, and colorimetry to analyze the samples. Every phase in the process is executed automatically.

The device is easily operable as it needs a minimal manual operation. It senses the nutrient components present in the soil on the basis of colorimetry. The reagents include extraction solutions for the preparation of soil solution and reagents for respective macronutrients. The device aims at providing a quantitative analysis of soil nutrients.

The output generated by the colorimeter is collected, processed, and analyzed through various machine learning algorithms. The response of the algorithms is various kinds of crops that can be grown in that particular soil and various fertilizer options to increase the yield of the suitable crops. This analysis report is communicated to the user through a messaging or web service. The user can purchase the required crop seeds and fertilizer according to the generated receipt.

The team aims at providing the user with an appropriate and automatic device that helps the farmer to utilize the services and to cultivate healthy crops that are rich in nutrients. The idea also includes the provision of various fertilizer suggestions to increase the crop yield and enhance the soil nutrient content suitable for their land. The idea, pertaining to the Indian market is solely a new concept. The soil testing in the country is done manually, in the soil testing laboratories

III. METHOD

The hardware device collects the soil nutrient readings (Nitrogen, Phosphorous, Potassium, Temperature, Moisture, and Humidity) These values are given as input to the website by the farmer.

Fig: Block Diagram

Then, these values are passed to the database. The collected data from the database is passed to the server and output is shown on the device and website

The farmer can also see his previous and current logs along with the timestamps. Based on this the farmer can make a decision in harvesting and cultivating the crop.

The farmer can search for details like harvesting, soil preparation, climatic conditions of growing a crop which makes the agricultural practice much simpler.

IV. HARDWARE IMPLEMENTATION

A. *Hardware Specifications*

1) *Arduino Uno:* The Arduino UNO includes 6 Analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. This device can run on both online and offline platforms. The main purpose is to integrate all the activities done by the sensors and to perform the required operations.
2) *Light Dependent Resistor:* A Light Dependent Resistor (also known as a photoresistor or LDR) is a device for which the resistivity is a function of the incident electromagnetic transmission. They are also known as photoconductors and also photocells.
3) *Colour Sensor:* Colour sensor is used to determine the Soil's pH ranging Between 1-14. By determining the pH of the soil, the crops can be segregated for a basic, acidic, and neutral type of soil.
4) *DHT11:* DHT11 is a sensor used for measuring the Temperature and Humidity of the surroundings. It consists of a capacitive humidity sensing element for Humidity and a thermistor for sensing temperature. The temperature and Humidity of the Surroundings can be determined by using the DHT11 Sensor.
5) *LCD Display with Integrated I2C:* Working with the embedded system requires a reliable output device with the help of which the required information is known, now this problem is solved with the introduction of 16 characters by 2 LCD Display with IIC/I2C interface The main purpose of LCD is to display the Obtained code from the performed Operations done by the Arduino

6) *Vibration Motor:* For the proper mixing of the soil with the liquid, a decent jerk or shake must be applied. Thus, by attaching a vibration motor this action can be done.
7) *LEDs:* Used for a light source light-emitting diodes are used as the main components. LEDs constitute different wavelengths. These are used for determining the N, P, K values along with the LDRs.

Nutrient	Absorption Wavelength(n m	LED Type	Wavelength (n m)
Nitrogen (N)	438-490	LED 1	460-485
Phosphorous (P)	528-579	LED 2	500-574
Potassium(K)	605-650	LED 3	635-660

B. Implementation

Initially, all four compartments are filled with the Soil along with the respective solution. Once the soil is filled, a power supply is given to the device. The power supplied is distributed among all the sensors by the Arduino UNO the sensors get the appropriate commands from the Arduino. The first sensor that gets activated is the vibration motor. It helps in the proper mixing of the soil with the solution. After this process, the LDR's calculate the percentage of macronutrients in the soil by using the method colorimetry. The Color sensor gets the command for finding the pH of the soil. After all the operations are executed the obtained 12-digit code is shown on the LCD Display. This Code helps the farmer to find the appropriate crops and fertilizers suitable for the soil. Once the code is collected by the server, the software takes over to suggest the crops.

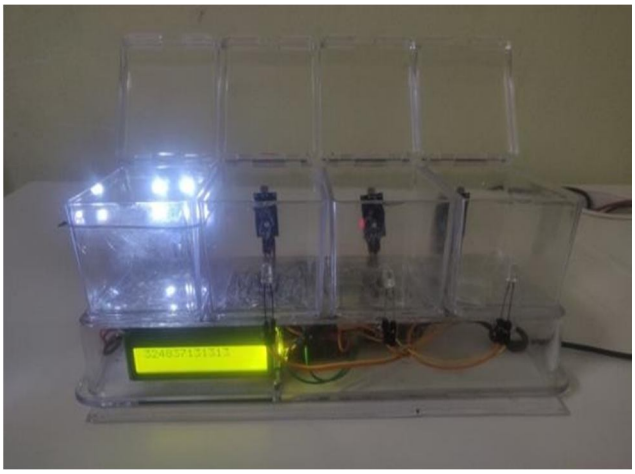

Fig: 12-digit code on the LCD module

V. SOFTWARE IMPLEMENTATION

A. Software Specifications

1) *Python:* Support language for build control and management, testing, etc.
2) *Machine Learning:* To identify patterns and make decisions with minimal human intervention.
3) *Flask:* It is a third-party Python library used for developing web applications.
4) *Heroku:* It is a container-based cloud Platform as a Service (PaaS). To deploy, manage and scale applications

B. Implementation

1) Dataset: The Following Dataset has been considered to train the data which was taken from Kaggle and Data world

Temparatı	Humidity	Moisture	Soil Type	Crop Type	Nitrogen	Potassium	Phosphorous	Fertilizer Name
26	52	38	Sandy	Maize	37	0	0	Urea
29	52	45	Loamy	Sugarcane	12	0	36	DAP
34	65	62	Black	Cotton	7	9	30	14-35-14
32	62	34	Red	Tobacco	22	0	20	28-28
28	54	46	Clayey	Paddy	35	0	0	Urea
26	52	35	Sandy	Barley	12	10	13	17-17-17
25	50	64	Red	Cotton	9	0	10	20-20
33	64	50	Loamy	Wheat	41	0	0	Urea
30	60	42	Sandy	Millets	21	0	18	28-28
29	58	33	Black	Oil seeds	9	7	30	14-35-14
27	54	28	Clayey	Pulses	13	0	40	DAP
31	62	48	Sandy	Maize	14	15	12	17-17-17
25	50	65	Loamy	Cotton	36	0	0	Urea
32	62	41	Clayey	Paddy	24	0	22	28-28
26	52	31	Red	Ground Nuts	14	0	41	DAP
31	62	49	Black	Sugarcane	10	13	14	17-17-17
33	64	34	Clayey	Pulses	38	0	0	Urea
25	50	39	Sandy	Barley	21	0	19	28-28
28	54	65	Black	Cotton	39	0	0	Urea

The Dataset contains the values of Temperature, Humidity, Moisture, Soil Type, Crop Type, Nitrogen, Potassium, Phosphorous, Fertilizer Name.

The farmer has to enter the 12-digit code (values of temperature, humidity, moisture, nitrogen, phosphorus, potassium) which is displayed on the device and soil type on the website.

2) Training: To train the data XGBoost has been used. XGBoost is a choice tree-based outfit AI calculation that uses an inclination boosting system. In expectation issues including unstructured information (pictures, text, and so on) Counterfeit neural organizations will in general beat any remaining calculations.

```
from numpy import loadtxt
from xgboost import XGBClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
# fit model no training data
model = XGBClassifier()
model.fit(X_train, y_train)
y_pred = model.predict(X_test)
predictions = [round(value) for value in y_pred]

accuracy = accuracy_score(y_test, predictions)
print("Accuracy: %.2f%%" % ((accuracy)* 100.0))
```

```
[22:50:43] WARNING: C:/Users/Administrator/workspace/xgboost-win64_release_1.4.0/src/learne
0, the default evaluation metric used with the objective 'multi:softprob' was changed from
et eval_metric if you'd like to restore the old behavior.
Accuracy: 98.56%
```

VI. RESULTS

The device primarily measures the number of macronutrients present in the soil. It Collects information regarding various parameters that affect the soil quality. It generates the 12-digit code.

As soon as the farmer enters the 12-digit code on the website, suggestions regarding the crop name and fertilizer details that are suitable for the land are displayed instantaneously

It Provides information regarding the right fertilizer that is to be used. And also conveys the required data to the farmer using a message service platform.

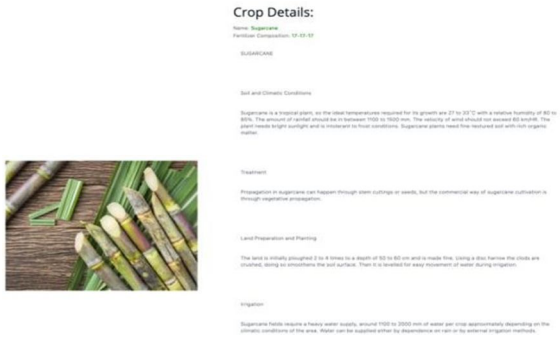

Fig: Crop Details

VII. CONCLUSION

Agriculture provides employment to about 70% of the countries workforce. Hence increasing the crop yield results in increasing the country's economy.

In agriculture, crop yield is not up to the mark due to a lack of knowledge on soil quality.

Farmers are looking forward to a device that can give a complete report on the soil quality instantaneously and provide some basic details about where they can find the fertilizers and how to use the land.

This device provides a solution by collecting the information regarding various parameters that affect the soil quality when required thus suggesting the farmer with the crop varieties suitable for that land.

This device solves the problem of lack of knowledge about soil quality, crop rotation, fertilizer usage, and low yield. Hence testing of the soil quality instantaneous can help in the cultivation process thereby improving crop yield.

Enhancing production is the need and demand of farmers and this device surely can contribute to the agricultural sector by improving farming productivity.

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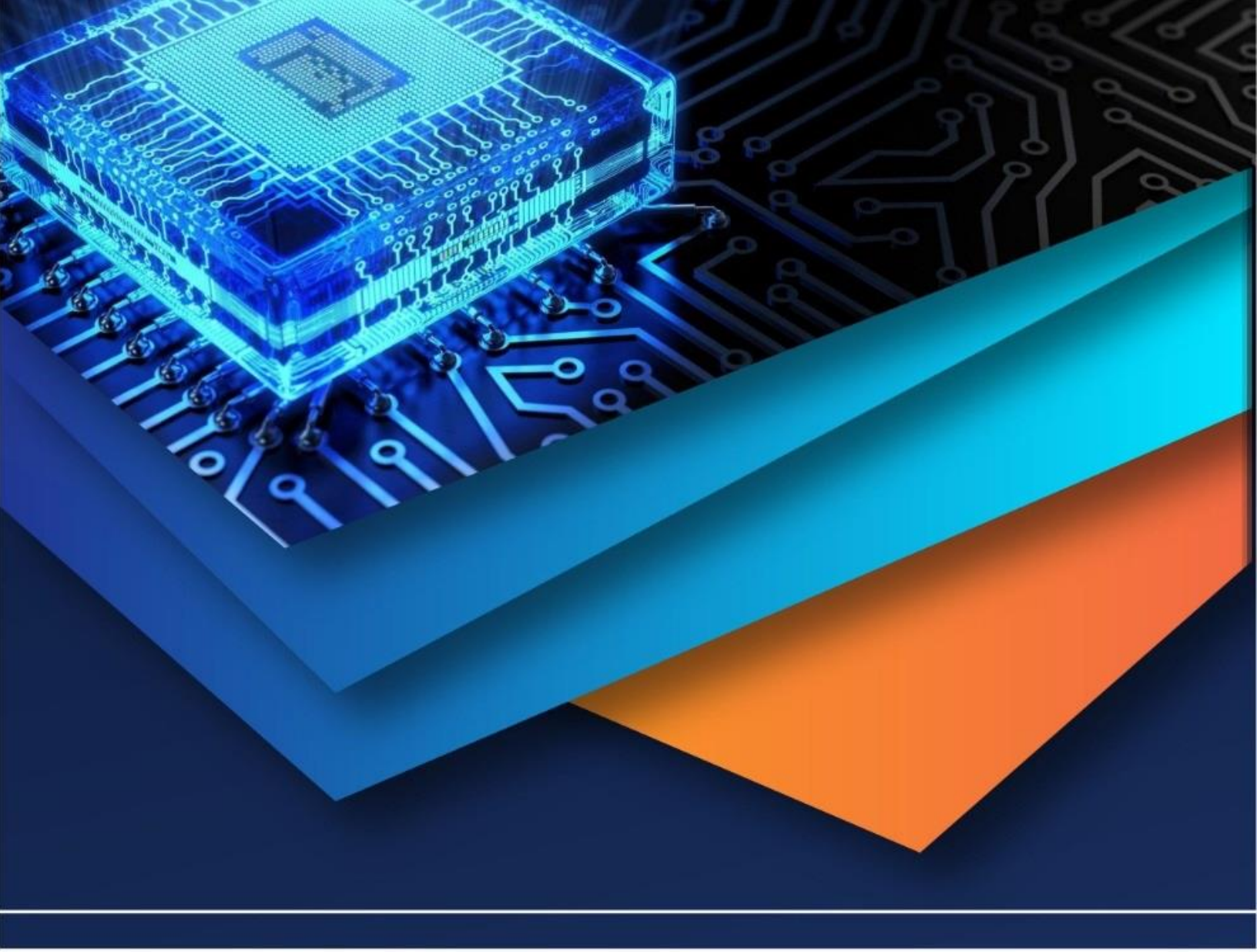

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