DESIGN AND IMPLEMENTATION OF AN AUTOMATED AGRICULTURE MONITORINGAND CONTROL

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***Abstract*—Machine learning techniques are highly appeared in the field of agricultural research the agricultural factors of weather, rain, soil, pesticides, and fertilisers are the number one factors accountable for yield production. The fundamental part of agriculture is developing fertile soil. Soil examination is an essential aspect of soil asset management in horticulture. Soil inquiry is beneficial for cultivators in determining the type of harvests that need to be created in a specific soil condition. The number one objective of this is to observe soil supplements through the usage of machine learning and categorization techniques. The department of Agriculture and Farmers Welfare furnished a huge records set on soil nutrient repute. This work analyses the soil nutrients and helps in reducing the usage of pesticides and fertilizers by predicting the appropriate organic and inorganic fertilizers that are to be used in the soil for the specific crop.The pesticides can be avoided by the usage of ultrasonic pest repeller. The soil of different sorts consists of a large array of nutrients. The nutrients N, P, K, Ca, Zn, Al are used in this paper to investigate soil supplements using a hybrid neural network approach. The class algorithms' performance is evaluated using two metrics: accuracy and execution time. Furthermore, we are avoiding the usage of pesticides by using DHT11 and an ultrasonic pest repeller. This system consists of number of modules that are intended to solve the problem faced by the cultivators.**

***Index Terms*—Data Mining, Agriculture, Soil Nutrients, Classification, Hybrid neural network.**

I. INTRODUCTION

Horticulture is the part that brings out the lack of dietary supplements present within the soil. It calls for spotting strategies to be able to reduce the disposal of supplements and furthermore will restore the desired dietary supplements with the soil, so that we are getting excessive quality and extremely good quantity of crop productions.

[1] discussed about a disclosure which is made regarding an apparatus to identify any toxic material contaminating into any drinkable liquid consumed by the humans or animals. A drop of any form of liquid can be taken and can be dripped onto the sensor of the keychain so as to identify whether the liquid has any unwanted formulation which is not safe to consume. The Keychain is programmed with color changing indication system to notify the purity of the liquid or otherwise any contamination if identified. Soil is very essential for plant life. It is composed of solids (minerals and natural topics), liquid (water and dissolved materials), and gases (usually oxygen and carbon dioxide) and carries residing organisms. These types of components offer their bodily and chemical properties.

Dealing with the soil properly is vital on the way to preserve its fertility, attain better yield and appreciate the surroundings. Testing the soil on the opposite hand can be a must so that you can control it properly.

A soil test is the research of a soil instance to discover supplement substance, composition, and exceptional attributes. Soil exams are typically done to determine richness and display insufficiencies that should be cured. Soil vitamins examination is precious for the agriculturist to determine which type of yields to be evolved in a selected soil situation. In this system machine learning classification techniques are applied to analyze the soil nutrients. Machine learning is a process of extracting facts from a statistics set and converts it into a comprehensible shape for similarly use. Distinct statistics research strategies are accessible for farming exploration area. Category is one of the machine mastering strategies that mechanically create a model of training from a fixed of records that includes class labels. Famous category strategies consist of choice trees, neural networks, k-nearest neighbor, SVM, and Na¨ıve Bayesian classifier, and so on.

The soil has three forms of traits: physical, chemical, and biological. This paper specially makes a speciality of chemical characteristics. Chemical properties of soil contain the management of soil nutrients at the most basic stage. Mineral nutrients in the soil have both positive or a negative charge. [3] brought out present disclosure which provides a system for monitoring and controlling farming using drone technology comprising a drone system for monitoring the farm and transmitting information and a ground control system for controlling the drone system and receiving the information. The nutrients and their plant's available forms are

- Nitrate, Ammonium Phosphorus, and Potassium
- Calcium and Magnesium as Secondary Nutrients
- Micronutrients containing sulphur include iron, manganese, boron,molybdenum, copper, zinc, chlorine, nickel, and cobalt

This paper specializes in the classification of the soil nutrients analysis based on the selected nutrients.

II. OBJECTIVES

The transitional duration for new natural operations can be the most stressful in terms of soil fertility management. Cultivators are benefitted at the transitional period, and as the soil organic matter builds, its benefits are meditated in increased soil fertility. [18] discussed about diabetic retinopathy from retinal pictures utilizing cooperation and information on state of the art sign dealing with and picture preparing. The Pre-Processing stage remedies the lopsided lighting in fundus pictures and furthermore kills the fight in the picture. Although the Disease Classifier step was used to identify arising wounds and other data, the Division stage divides the image into two distinct classes.

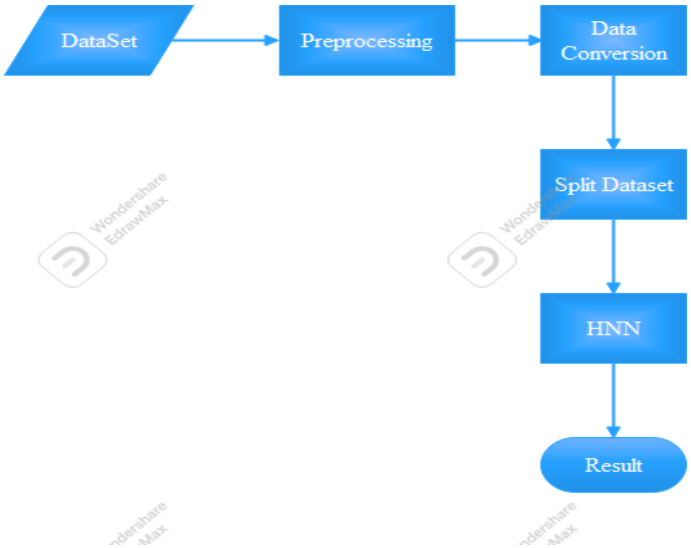

Fig. 1. Proposed Work Flow

III. RELATED WORK

Baskar et al.,[4] Examine soil information through utilising unique formulas as well as declaration methods. A record exists that utilises a selection of category techniques, consisting of Naive Bayes, J48 (C4.5), as well as JRip, with the help of the Device Knowing WEKA.

Jay Gholap [5] Anticipates the plant formula for soil splendor exploitation. [6] Examined soil data exploitation category methods as well as forecasted soil residential or commercial homes. Category formulas like Naive Bayes, J48, as well as JRip were actually to categorize soil specifications like pH worth, Electric Conductivity (EC), Potassium, Iron, as well as Copper. Suman et alia. [7] Evaluate soil data utilizing KNN, Naive Bayes, as well as J48. This examine suggests a fertiliser based upon the nutrients spotted in the soil examination collection.

Bhuyar [2] Concentrates on soil splendor price classification utilising J48, Naive Bayes, as well as Arbitrary woodland formulas. The J48 formula creates a much more preferable outcome compared to various other formulas.

Hemageetha et alia.,[8] Utilize Device Knowing category methods to identify if the Salem area soil is actually beneficial for plant manufacturing or otherwise. The outcome unveils that J48 is actually more precise compared to Naive Bayes, Jrip, as well as BayesNet. Furthermore, it shows that most of the Salem area soil appropriates for the advancement of various crops.

Bhargavi et alia.,[9] Suggested for using GATree, fuzzy

category regulations, as well as the fuzzy C-Means formula to categorise soil surface areas in horticulture . Category along with fuzzy regulations outperforms GATree. [10] contrasts the Naive Bayes, JRip, as well as J48 formulas. In contrast to the various other 2, the JRip category technique creates an exceptional outcome as well as effectively classifies the greatest variety of situations.

Ramesh et alia., [11] Show exactly how contrasting various classifiers can easily assist improve soil individual administration as well as bodies throughout a wide variety of areas, consisting of agricultural, horticulture, ecological, as well as property that utilize administration.

Dildarkhan et alia.,[12] Examine soil information with using a number of category formulas as well as projecting methods. Soil screening research study labs analyze the soil as well as offer example . By hand characterising the soil documents will certainly get a considerable quantity of your time.

Shivnath et alia.,[13] Carried out a rear proliferation system examination of soil qualities. The gradient descent formula is actually utilized to educate the information within this particular examine. The Rear Proliferation formula yields one of the absolute most precise outcome.

IV. PROPOSED WORK

The proposed work consists of multiple components they are

- Node Mcu
- Temperature sensor
- Ultra Sonic Wave radiator

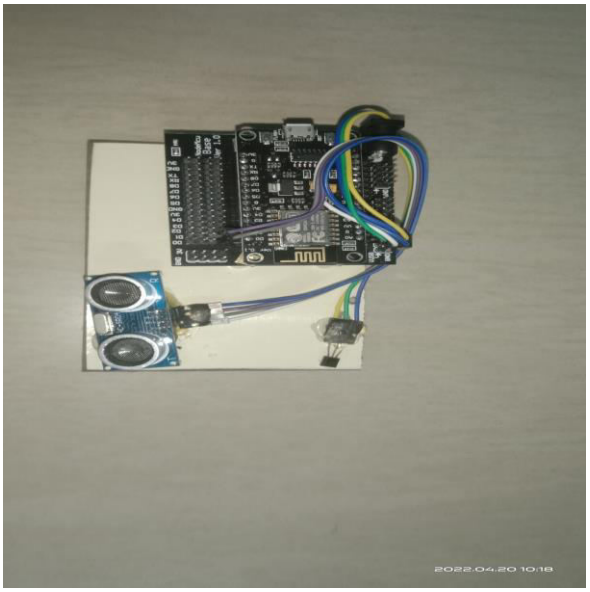

Fig. 2. Proposed device

A. Node Mcu

NodeMCU is actually a visible resource firmware for which available resource prototyping panel layouts are actually on call. The title NodeMCU integrates ”node” and also ”MCU” (micro-controller system).[8] The condition ”NodeMCU” stringently communicating describes the firmware instead of the linked progression sets.

The firmware makes use of the Lua scripting foreign language. The firmware is actually based upon the eLua venture, and also improved the Espressif Non-OS SDK for ESP8266. It makes use of a lot of available resource tasks, including lua-cjson[9] and also SPIFFS.[10] Because of information restraints, customers should pick the components applicable for their venture and also develop a firmware adapted to their demands. Sustain for the 32-bit ESP32 has actually additionally been carried out.

The prototyping equipment generally utilized is a motherboard performance as a double in-line package deal (DIP) which integrates a USB operator along with a smaller sized surface-mounted panel consisting of the MCU and aerial. The option of the DIP layout enables very effortless prototyping on breadboards. The concept was actually in the beginning based upon the ESP-12 component of the ESP8266, which is a Wi-Fi SoC incorporated along with a Tensilica Xtensa LX106 primary, commonly utilized in IoT treatments.

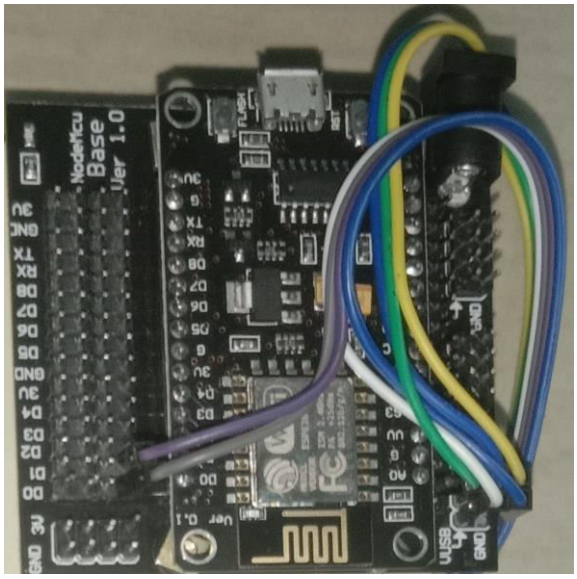

Fig. 3. NodeMCU DEVKIT

NodeMCU provides access to the GPIO (General Purpose Input/Output) and a pin mapping table is given below

I/O index	ESP8266 pin
0 [*]	GPIO16
1	GPIO5
2	GPIO4
3	GPIO0
4	GPIO2
5	GPIO14
6	GPIO12
7	GPIO13
8	GPIO15
9	GPIO3
10	GPIO1
11	GPIO9
12	GPIO10

B. Temperature sensor

The measurement of the temperature level sensing unit concerns the coolness or hotness of a body. The operation of the sensing unit is the voltage that review all over to the diode. If there is increment in voltage, after that the temperature level enhances and also there's a voltage decrement in between the transistors, terminals of emitter & bottom. That information spared due to the sensing unit.

If the variation in voltage is magnified, the analog sign is created due to the tool, and it is straight corresponding to the temperature level. [16] analyzed that the reason that every family member will be employed and busy, the health monitoring of elderly people and patients has become very crucial. In the proposed methodology caretakers can get the information of the temperature and the pulse rate of the people being monitored at home.

C. Ultra Sonic Wave radiator

Ultrasound is actually applied in various areas. Ultrasonic devices are absolutely applied to spot objects in addition to decide ranges. Ultrasound imaging or even sonography is regularly utilized in medication. in the nondestructive screening of items in addition to frameworks, ultrasound is surely utilized to identify unnoticeable defects. Industrially, ultrasound is certainly utilized for cleansing, mixing, as well as rushing up chemical tactics. Pets like bats as well as tortoises make use of ultrasound for situating sufferer in addition to challenges.

Fig. 4. Ultra Sonic wave radiator

V. ANALYSIS

Machine learning is crucial to decide the agricultural related data including soil fertility, yield prediction and soil vitamins analysis. This segment analysis soil properties and nutrients primarily based on hybrid type algorithm 1. Shows the architecture of proposed work.

A. Dataset Overview

To start with any Machine Learning problem, initially bring all the data together. The data set contains 13 attributes. The attributes are District, pH, EC, OC, N, P, K, S, Zn, Fe, Cu, Mn, B. 5 Shows the description of attributes.

Fig. 5. Example Image for soil

B. Techniques

The proposed work starts with the preprocessing step. In this step the collected data was pre-processed. Some records have missing attribute values, those records were removed from the dataset. In the data conversion step, the pre-processed data was converted based on the nutrients values.

Attribute	Description
District	The data was collected from six district of Tamil Nadu in India.
pH	pH value of Soil Data
EC	Electrical Conductivity
OC	Organic Carbon
N	Nitrogen
P	Phosphorus
K	Potassium
S	Sulfur
Zn	Zinc
Fe	Iron
Cu	Copper
Mn	Manganese
B	Boron

Level / Attribute	Low | Deficient	Medium | Moderate	High | Sufficient
pH	< 6.5 (Acidic)	6.5 – 7.5 (Neutral)	> 7.5 (Alkaline)
EC	< 1.0 (Non Saline)	1.0 – 3.0 (Slightly Saline)	> 3.0 (Saline)
OC	< 0.5	0.5 – 0.75	> 0.75
N	< 280	280 – 450	450
P	< 11	11 – 22	> 22
K	< 118	118 – 280	> 280
S	< 10	10-15	> 15
Zn	< 1.2	1.2 – 1.8	> 1.8
Fe	< 3.7	3.7 – 8.0	> 8.0
Cu	< 1.2	1.2 – 1.8	> 1.8
Mn	< 2.0	2.0 – 4.0	> 4.0
B	< 0.46	0.46- 1.0	> 1.0

Fig. 6. Nutrients Levels

Table 2 shows the value for three levels of nutrients. After data conversion, the macro and micro nutrients are split into three types. The type-1 contains pH, EC, OC, N attributes. Type-2 contains P, K, S, and Zn. And Type-3 contains Fe, Cu, Mn, B attributes. Convolutional Neural Network in deep learning, is an undemanding probabilistic classification technique is CNN classification. It depends on the Bayes theorem with independence attributes [10]. The class labels are predicted based on the probability. For classification, a small amount of training data is expected to predict the class labels. [14].

1) ALGORITHMS

CNN

Convolutional Neural Networks are a unique kind of feed-forward synthetic neural system through which the connection style in between its own neuron that is influenced due to the aesthetic peridium.The Convolutional levels include a collection of learnable filterings system, such that each filter accepts a certain size of elevation in addition to deepness as that of the offered input intensity (if the picture is actually the input level after that most likely it will be actually 3). Presume that our team wish to operate the convolution over account that consists of $34 \times 34 \times 3$ measurement, such that the measurements of a filter might be actually $a \times a \times 3$. Right below it might be actually any one of the over 3, 5, 7, and so on. It should be less in contrast to the measurement of the photo. It moves gradually, contacting every private tip as a stride that functions an expense of 2 or even 3 or even 4 for higher-dimensional photos. It'll lead to 2-Dimensional outcome for each strain as as well as whilst our team move our filters accompanied using piling all of them jointly that enables you to accomplish an outcome intensity to have a similar strength charge as that of the variety of filters. Finally, the neighborhood will certainly evaluate every one of the filters.

RNN

Recurrent Neural network(RNN) are a kind of Neural system through which the outcome coming from preceding step are supplied as input to the present step. In traditional neural systems, all of the inputs as well as outcomes are impartial of one another, nevertheless in circumstances like when it is much needed to anticipate the following expression of a paragraph, the previous expressions are actually needed as well as consequently there might be a wish to bear in mind the previous expressions. For that reason RNN obtained right below into way of lives, which refixed this problem along with the help of a Covert Level. [17] discussed that Liver tumor division in restorative pictures has been generally considered as of late, of which the Level set models show an uncommon potential with the advantage of overall optima and functional effectiveness.

HNN

Hopfield Neural network (HNN) is a neural network with cyclic and recursive characteristics, combined with storage space and binary frameworks. Created by John Hopfield in 1982. For a Hopfield neural network, the trick is to choose its weight listed below in steady circumstances . Hopfield neural networks are split into distinct and constant kinds. The concept distinction depends on the activation that is in particular.The Hopfield Neural neighborhood (HNN) manages a variation that mimics human memory. It has a wide range of programs in synthetic knowledge, along with device grasping,

associative memory, example appeal, enhanced computation, VLSI and identical awareness of optical gadgets

VI. EXPERIMENTAL RESULT

The accrued data set were pre-processed. After preprocessing step, the facts set transformed into Low, Medium and excessive based on nutrients stage cited in desk 2.The converted data set is shown in table four. Apply CNN, RNN and Hybrid classification algorithm to categorise the soil nutrients as Very excessive, high, Medium, Low and really Low. The comparative evaluation of classifiers is given in table five. Fig 3 shows the execution time of type algorithms with 3 sorts of vitamins. Fig 2 shows the accuracy rate of classification algorithms with 3 kinds of nutrients. it is found from Fig 3 and Fig 2 that the Hybrid set of rules is capable of classify the dataset in less time with better classification accuracy rate.The ultra sonic radiator is used to remove the unhealthy outcomes of using pesticides in the crops that humans consume. Harmful pesticides usage may cause various health problems in a healthy person.

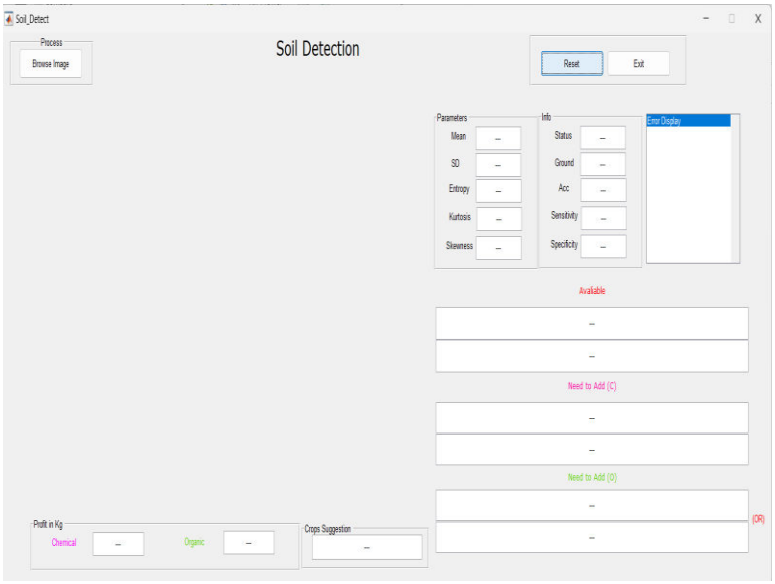

Fig. 8. Output UI

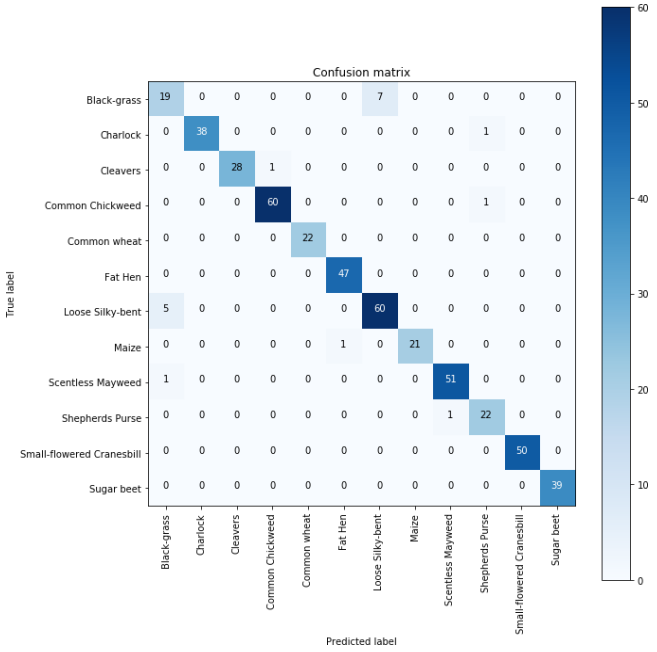

Fig. 7. Accuracy for classifiers

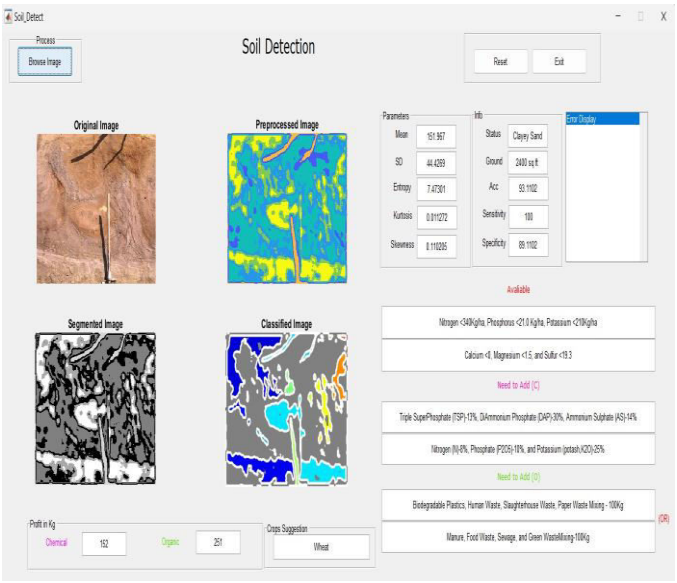

Fig. 9. Output UI with Image classification

Algorithm	Correctly Classified Instance	Incorrectly Classified Instance	Accuracy	Execution Time in ms(Milli sec)
CNN	2067	26	93%	1200
RNN	2667	29	91.5%	1600
HNN	2987	1	99.02%	700

TABLE I
COMPARATIVE ANALYSIS OF CLASSIFIERS BASED ON PH, EC, OC, N

	Actual - Soil analysis	Actual - Not a Soil analysis	Total
Soil analysis are predicted	894	2	896
Not a Soil analysis, as predicted	3	697	700
Total	898	698	1596

TABLE II
CONFUSION MATRIX FOR A CLASSIFICATION

The matlab output is the below 8

$$Accuracy = \frac{(TP + TN)}{(TP + FN + FP)} \times 100\%$$

$$Accuracy = (894 + 697)/(894 + 3 + 2 + 697) * 100\%$$

$$Accuracy = \frac{1591}{1596} \times 100$$

$$Accuracy = 99.686716792$$

CONCLUSION

Machine learning techniques in cultivation will assist the agriculturist to enhance the crop productivity. The yield production is mainly based on the soil nutrients. The research of soil nutrients present whether which kind of crop can be delicate in a specific soil. This paper proposed a research of soil nutrients using distinct algorithms. The comparative examination of three classification algorithms like Na¨ıve Bayes, decision and hybrid algorithm were anticipated. Hybrid classification algorithm gives enhanced end result for this dataset and is correctly classified into maximum quantity of instances evaluating with the alternative . Hybrid set of rules may be counseled to dissect the soil vitamins like vegetables, plants, seeds, inexperienced manure and Vermicomposting. The usage of pesticides can be avoided by the usage of ultrasonic wave radiator. Futhermore, the temperature and humidity data of the soil can be used to predict the appropriate type of crop to be planted for a particular soil.

REFERENCES

[1] Christo Ananth,D. R. Denslin Brabin,D. R. Denslin Braja, "Keychain Based Liquid Testing System", Application number: 320650-001, Cbr number: 15403, Journal No.: 41/2019 , Journal Date: 11/10/2019, Indian Patents, Design & Trademark Office, 11th October 2019

[2] . Bhuyar V. (2014)," Comparative analysis of classification techniques on soil data to predict fertility rate for Aurangabad District", International Journal of Emerging Trends and Technology in Computer Science. 2014 MarApr; 3(2):200–3.

[3] Christo Ananth, Narasimman P, Priya N, Aaron James S, Anupama Prasanth, Densy John Vadakkan, Vinothkumar C, Thangam C, Electa Alice Jayarani. A, Stalin Jacob, Parashiva Murthy B M, R.Uma Maheshwari, "A SYSTEM MONITORING FOR HARVESTING OF FARMING USING DRONE TECHNOLOGY", Patent number: 2020101843, Australian Patent, 9th September 2020

[4] S.S.Baskar L.Arockiam S.Charles (2013), "Applying Machine Learning Techniques on Soil Fertility Prediction", International Journal of Computer Applications Technology and Research Volume 2–Issue 6, 660 -662, 2013

[5] Jay Gholap (2012), "Performance Tuning of J48 Algorithm for Soil Fertility" ,2012. Asian Journal of Computer Science and Information Technology 2: 8 (2012) 251– 252

[6] Gholap J, Lngole A, Gohil J, Shailesh, Attar V.(2012), "Soil data analysis using classification techniques and soil attribute prediction", 2012 Jun; 9(3):1–4

[7] Suman, Bharat Bhushan Naib (2013), "Soil Classification and Fertilizer Recommendation using WEKA" ,IJCSMS International Journal of Computer Science & Management Studies, Vol. 13, Issue 05, July 2013

[8] Hemageetha, G.M. Nasira (2016), "Analysis of Soil condition Based on pH value Using Classification Techniques", IOSR Journal of Computer Engineering (IOSR-JCE), Volume 18, Issue 6, Ver. III (Nov.-Dec. 2016), PP 50-54

[10] Rajeswari V, Arunesh K. (2016), "Analysing soil data using Machine Learning classification techniques", Indian Journal of Science and Technology. 2016 May; 9(19).

[11] V.Ramesh and K. Ramar,(2011) "Classification of Agricultural Land Soils: A Machine Learning approach",Volume:6, Issue: 3,Sep. 2011

[12] Dildarkhan T. Pathan, Pushkar D. Joshi, Prof. S. U. Balvir,(2014), "Prediction of soil Quality for Agriculture", IRJSSE International Research Journals of sustainable Science & engineering, Vol. 2, Issues 3, 2014.

[13] Shivnath Ghosh, santanu koley,(2014), "Machine Learning for Soil fertility and Plant Nutrients Management using Back Propagation Neural Networks", International Journal on Recent and Innovation Trends in Computing and Communication, Vol. 2, Issues 2, 2014.

[14] Narain B. (2011), "Study for Machine Learning techniques in classification of agricultural land soils", Journal of Advanced Research in Computer Engineering. 2011 JanJun; 5(1):35–7.

[15] Ponmani S, Vidhu Priya P (2017), "Classification Algorithms in Machine Learning –A Survey", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 6, Issue 1, January 2017

[16] Christo Ananth, Anand Nayyar, Bandana Mahapatra, "Analysis of IoT Based Weather Monitoring using Fuzzy Logic", Patent number: 1189027, Canadian Patent, 4th January 2022

[17] Christo Ananth, M Kameswari, Densy John Vadakkan, Dr. Niha.K., "Enhancing Segmentation Approaches from Fuzzy-MPSO Based Liver Tumor Segmentation to Gaussian Mixture Model and Expected Maximization", Journal Of Algebraic Statistics, Volume 13, Issue 2, June 2022,pp. 788-797

[18] Christo Ananth, D.R. Denslin Brabin, Jenifer Darling Rosita, "A Deep Learning Approach To Evaluation Of Augmented Evidence Of Diabetic Retinopathy", Turkish Journal of Physiotherapy and Rehabilitation, Volume 32,Issue 3, December 2021,pp. 11813-11817