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GreensWorth: A Step Towards Smart Cultivation

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Abstract – *It has been observed that plants influence us human being not only reduce the amount of Carbon dioxide in the atmosphere but also help us to improve our health. We as a team of three have made an app which will help crop lovers to plant more and will encourage others also to do so. Our app has following features: Disease detection, Weather prediction, Crops Guide, Global Community. We have used CNN for Disease detection and Decision Tree Regression for Weather prediction. The details on how we have implemented above features is given in methodology section of this paper.*

Key Words: CNN: Convolutional Neural Network, Decision Tree Regression, Plant Disease Detection, Machine Learning.

1. INTRODUCTION

Plants are the very precious part of our earth. Earth is called a green planet because of the presence of plants. They are also most essential part of the life of all the organisms living on the earth. Plant diseases have always been a challenge to plant growth and crop production in several parts of the world. Plant diseases can affect plants by interfering with several processes such as the absorbance and translocation of water and nutrients, photosynthesis, flower and fruit development, plant growth and development. Plant diseases are well known to reduce the food available to humans by ultimately interfering with crop yields. This can result in inadequate food to humans or lead to starvation and death in the worst cases.

Plant diseases affect a significant yield and quality constraint for growers of broad acre crops, gardeners and nature enthusiasts sometimes they don't know how to deal with these issues. For dealing with plant issues and their healthy nourishment there must the something that will offer fast and free help to the community. Here we are presenting Green'sWorth the adequate solution for such problems. Whether they grow tomatoes, bananas or rice - Green'sWorth is the interactive plant doctor. The only thing they need is an internet-enabled smartphone with a built-in camera. Wherever the problem lies, a smartphone picture is enough and in seconds you will receive a diagnosis and the appropriate treatment tips. In a way this app is a key to all the problems of crop lovers.

2. LITERATURE SURVEY

1. Mirwaes Wahabzada, Anne-Katrin Mahlein, Christian Bauckhage, Ulrike Steiner, Erich Christian Oerke, Kristian Kersting, "Plant Phenotyping using Probabilistic Topic Models: Uncovering the Hyperspectral Language of Plants," Scientific Reports 6,2016. proposed, an approach to plant phenotyping was presented that integrates non-invasive sensors, computer vision, as well as data mining techniques and allows for monitoring how plants respond to changing environment. Images then turned into corpus text documents. Then the Probabilistic topic model is applied which identifies the content and topic of documents and thereby identifies the plant disease [1].

2.Macedo-Cruz A, Pajares G, Santos M, Villegas-Romero I., "Digital image sensor-based assessment of the status of oat (Avena sativa L.) crops after frost damage," Sensors 11(6), 2011 [2]. Presented a system to classify the land covered with oat crops, and the quantification of frost damage on oats, while plants are still in the flowering stage. The images are taken by a digital color camera CCD-based sensor. Unsupervised classification methods are applied because the plants present different spectral signatures, depending on two main factors: illumination and the affected state. The color space used in this application is CIELab, based on the decomposition of the color in three channels, because it is the closest to human color perception. The histogram of each channel is successively split into regions by thresholding. The best threshold to be applied is automatically obtained as a combination of three thresholding strategies: (a) Otsu's method, (b) Isodata algorithm, and (c) Fuzzy thresholding. The fusion of these automatic thresholding techniques and the design of the classification strategy are some of the main findings of the paper, which allows an estimation of the damages and a prediction of the oat production. [2]

3. Phadikar S, Sil J, "'Rice disease identification using pattern recognition techniques," IEEE, Khulna, 2008 [3] Presented a method that detects and differentiates two diseases affecting rice crops by converting the image to the HSI color space, an entropy-based thresholding is used for segmentation. An edge detector is applied to the segmented image, and then spots are detected by using the intensity of the green components. The paper describes a software prototype system for rice disease detection based on the infected images of various rice plants. Images of the infected rice plants are captured by digital camera and processed using image growing, image segmentation

techniques to detect infected parts of the plants. Then the infected part of the leaf has been used for the classification purpose using neural network. The methods evolved in this system are both image processing and soft computing technique applied on number of diseased rice plants.

3. Plantix

Plantix is an android app specializing in agricultural crops that feed the world plantix empowers farmers to make a living by providing comprehensive support on all issues that are important to farmers like health check in which they claim to detect disease in a blink of eye, community where users can take advice from experts, crop advisory which provides continued support to users and a disease library which is a database for plant problems and their treatments.

3. METHODOLOGY

3.1 Weather Prediction Module:

Users will use the disease detection feature of our android application and get to know what disease has affected their crops; solutions to these diseases can easily be found in the disease library. But many a times the right time to apply the solution is weather dependent. For example if the disease detection module has identified that "xyz" disease was caused and can be cured by applying "abc" pesticide provided that water is given to the plants at a specific time which is weather dependent then in that case (which is very often) this module will prove to be useful.

We have used a dataset that we got from [2] this data is from march 1 2019 to march 16 2019 in an hourly basis. It has in all seven attributes the screenshot of the same is given in figure below. When we used decision tree algorithm on this data, results have given an accuracy of 85%. The reason for using decision tree was that weather is influenced by a plethora of different attributes (temperature, humidity, wind speed etc.) and each time a different kind of attribute pattern is followed and this logic is followed in decision tree algorithm. We have also given a sample screenshot of the decision tree that our model made in figure below.

	A	B	C	D	E	F	G	H	I
1	wind	Temperat	Dew point	Humidity	Wind spe	pressure	precipitat	Preci accu	Condition
2	NE	79	48	0.34	9	29.8	0	0	Smoke
3	NNE	77	48	0.36	5	29.8	0	0	Smoke
4	CALM	75	50	0.41	0	29.8	0	0	Smoke
5	CALM	75	50	0.41	0	29.8	0	0	Smoke
6	CALM	73	50	0.44	0	29.8	0	0	Smoke
7	CALM	73	50	0.44	0	29.8	0	0	Smoke
8	NW	75	50	0.41	3	29.8	0	0	Smoke
9	NE	73	50	0.44	3	29.8	0	0	Smoke
10	CALM	73	50	0.44	0	29.8	0	0	Smoke
11	CALM	72	52	0.5	0	29.8	0	0	Smoke
12	ESE	73	52	0.47	5	29.8	0	0	Smoke
13	S	73	55	0.53	5	29.8	0	0	Smoke
14	SE	72	54	0.53	5	29.8	0	0	Smoke
15	E	72	52	0.5	3	29.8	0	0	Smoke
16	CALM	72	50	0.46	0	29.8	0	0	Smoke
17	SE	73	50	0.44	5	29.9	0	0	Smoke
18	CALM	73	52	0.47	0	29.9	0	0	Smoke
19	CALM	75	50	0.41	0	29.9	0	0	Smoke
20	CALM	77	52	0.41	0	29.9	0	0	Smoke
21	ENE	79	50	0.36	6	29.9	0	0	Smoke
22	SE	81	52	0.37	6	29.9	0	0	Smoke
23	SSE	82	52	0.35	7	29.9	0	0	Smoke
24	CALM	84	52	0.33	0	29.9	0	0	Smoke
25	VAR	86	48	0.27	3	29.9	0	0	Smoke
26	CALM	88	45	0.22	0	29.9	0	0	Smoke
27	W	86	54	0.33	9	29.8	0	0	Smoke
28	W	86	55	0.35	13	29.8	0	0	Smoke
29	W	86	55	0.35	12	29.8	0	0	Smoke
30	W	84	55	0.37	12	29.8	0	0	Smoke
31	WSW	86	55	0.35	13	29.8	0	0	Smoke
32	WSW	84	55	0.37	10	29.8	0	0	Smoke

Fig: Screenshot of Weather data

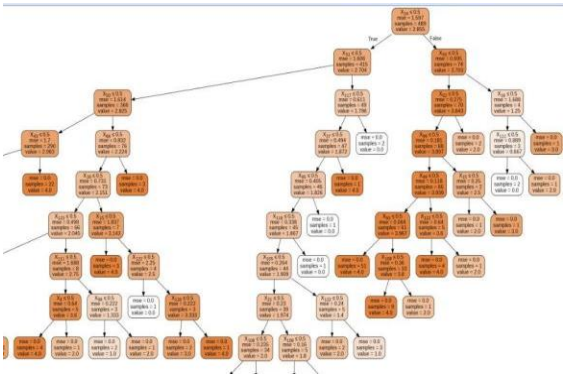

Fig: Screenshot of Decision Tree

Here's how decision tree algorithm works:

Decision tree regression works by finding out the dependent variable using the independent attributes. The sample of data considered below for prediction of dependent variable considers only two attributes (for simplicity purpose since scatter plot would be confusing if all the variables are considered) temperature and humidity but the data that we used for our app considers total seven attributes such as wind direction, Temperature, Dew point, wind pressure and precipitation levels.

Coming back to the example considering only humidity and temperature:

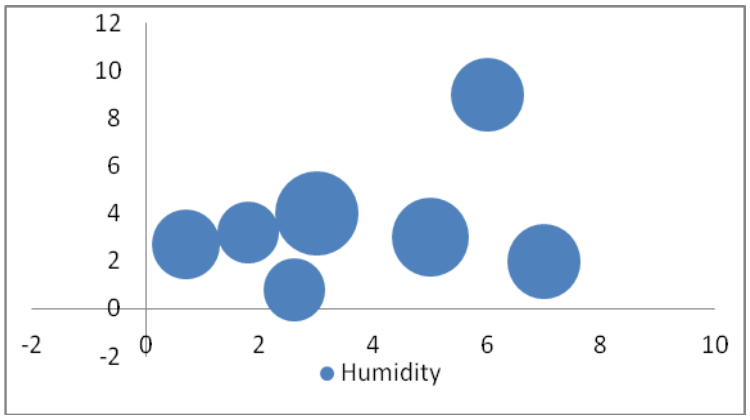

Fig : Temperature in celsius and humidity in percentage

Here Y-axis represents the temperature and X-axis represents humidity. Our dependent variable that is the output prediction which we are looking for in this model will be along the Z axis that is why we are not considering other variables since explanation will not be comprehensible, since each attributes needs to be represented on a separate axis.

The decision tree algorithm starts by making a tree out of this data and in doing so it will divide the above graph in several regions as shown below:

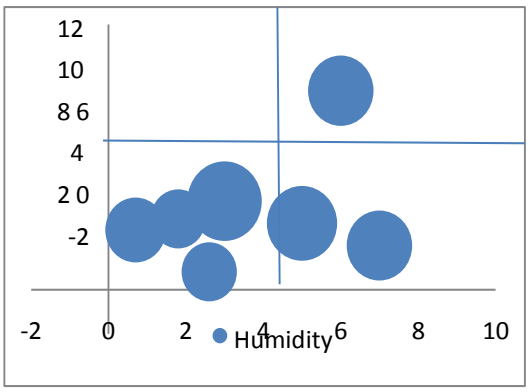

Fig : Temperature in celsius and humidity in percentage

And for each area newly found it will calculate the dependent variable. In terms of our tree every sliced portion acts as a non-leaf node and values calculated of dependent variables act as leaf nodes. So for example if the model needs to find the value of dependent variable for humidity equals 5 and temperature equals 4 the model will look into quadrant four's dependent variable calculated before.

3.2 Disease Detection Module:

Our motto behind this app is to encourage crop lovers to do what they are doing by providing them all they need at one place. The plethora of diseases that affect crops make it difficult to identify which disease has occurred. Here disease detection module comes to help only thing the user has to do is click an image of the effected part of the crop and the app with the help of CNN will detect the disease.

The reason CNN is for image classification is because of its high accuracy which is the result of four steps through which the image is processed before finally feeding it to the neural network. We are using AlexNet CNN model this model consists of 5 convolution layers 2 fully connected layers and a softmax layer. In the AlexNet CNN the first, second and fifth layer have max pooling. A simple implementation of AlexNet is as given below:

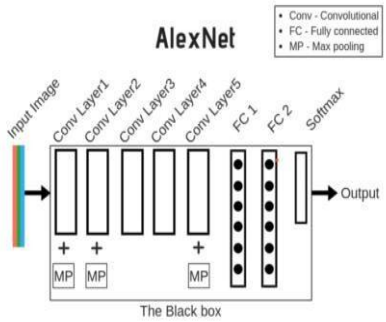

Fig AlexNet architecture

The working of each layer is as explained below:

Convolution equation:

$(f*g)(t) = \int f(\tau)\, g(t-\tau)\, d\tau$ [4]

Broadly considering convolution operation is performed by putting a feature detector on the input image and performing multiplication followed by addition of each pixel of the input image with the feature detector this operation is described in fig(1). The output of the operation so performed is called as Feature Map. The convolution operation is performed so that the size of the image is reduced and most important feature of the image are highlighted. In our example given in fig(1). The same can be noticed in the feature map where some specific cells have higher values like 4 and 2. The convolution operation is performed many times and many feature Maps are calculated so that the most important feature does not miss out.

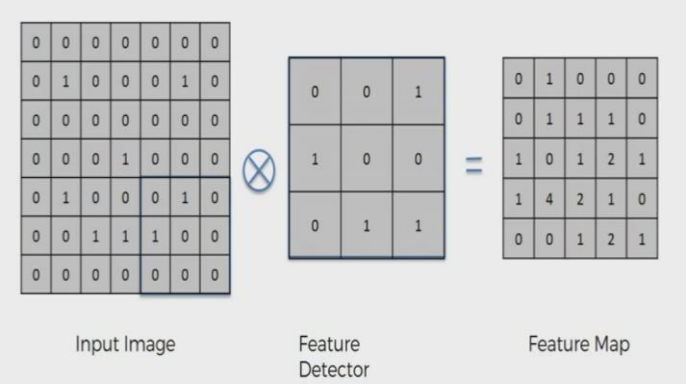

Fig: Feature Map [5]

One more step which is a sub step of convolution is also performed in which the image is passed through a rectifier and then the rectifier removes linearity of the image. This step is important since when we perform convolution operation and create many versions of the original image we risk the non-linearity of our image.

The pooling step in CNN this step is performed so that when the model comes across many different images of the same kind but slightly distorted for example if the same image is rotated or squashed the model will still be able to correctly identify the image. Pooling occurs as shown below:

In the pooling step the pixel matrix obtained from step 1 i.e. from convolution step is used and an operation shown in figure below is performed.

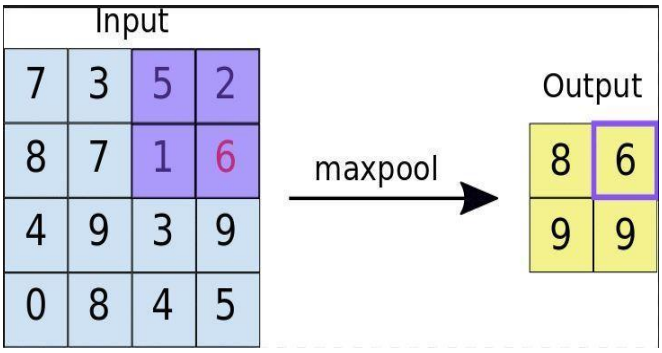

Fig: Maxpooling [6]

The small box (in this case is a 2 X 2 empty matrix) is rotated over the bigger matrix which is our image from step one and maximum of pixels covered by the smaller box is calculated to get the output matrix. The advantage of max pooling is that the size of image is reduced and problem of over fitting is removed.

In the image above max poling is depicted but there are other types of pooling too like average pooling, min pooling.

The Flattening step in CNN is in which the image obtained after first two (This step is always applied at last that is after convolution, max polling) steps is converted in to an array and is fed to Artificial Neural network which carries out final classification

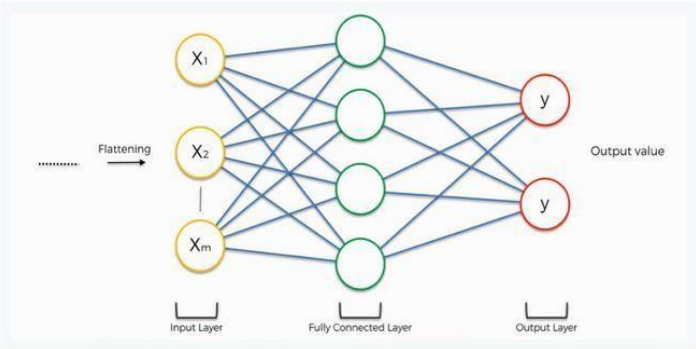

Fig: Neural Network [7]

The ANN performs back propagation in order to reduce the error in classification and find the correct results. In back propagation step weights associated with respective neurons are updated.

SoftMax:

The softmax here calculates the loss percentage.

3.3. Crops Guide:

This is fourth pillar for multiplying user's cultivation expertise. The crop guide is the holistic tool that reminds you about all the steps necessary for highest yields and best quality of harvest. It makes user to become more productive by planning and supervising entire harvest cycle from sowing to harvest. Reduce unnecessary operating cost and working hours. This crop guide tells user exactly what next steps to take and how to use each input along the way. Away from mono-cropping user can now react to market requirements with ease, growing new crop at any time and without great risk or prior experience

3.4 Global community

This feature enable user to get in touch with the global community of scientists, farmers, plant experts, nature enthusiasts to exchange information about plant issues on local and global level. This community provides plenty of advantages to farmers, experts and plant lovers around the world and is the ideal place to get in touch with other like-minded people. This will provide more detailed explanation and advice to the user specific field challenges. along with it the community offers them tailor-made solutions for all aspects of their crop cycle. This is an endless space for ideas and discussions where user can dig deep into all relevant farming experiences and exchange insights.

4. CONCLUSIONS

Greenswoth's prime aim is to provide comprehensive guidance and knowledge it will help users to develop more interest in the gardening and agricultural field ad that will lead nation to become greener, greater and healthier in the world.

Our prime features include "PlantsPedia", which provides information about different gardening ideas and suggests plant's that would help user to embellish their gardens and to maintain them further. Secondly Global community which helps users to share their ideas with other nature enthusiasts. Our plant disease detection which uses modern artificial intelligence-based approach for plant disease prediction just from its leaf images and plan disease library which contains information about thousands of plants diseases.

5. REFERENCES

1. 1. Mirwaes Wahabzada, Anne-Katrin Mahlein, Christian Bauckhage, Ulrike Steiner, Erich Christian Oerke, Kristian Kersting, "Plant Phenotyping using Probabilistic Topic.

2. 2. Macedo-Cruz A, Pajares G, Santos M, VillegasRomero I., "Digital image sensor-based assessment of the status of oat (Avena sativa L.) crops after frost damage," Sensors 11(6), 2011

3. 3. Phadikar S, Sil J, "'Rice disease identification using pattern recognition techniques," IEEE, Khulna, 2008