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## Determine the Ph. of Soil by Using Neural Network Based on Soil's Colour

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**Abstract**— *Soil pH plays an important role in many chemical and biochemical processes in soil, including adsorption and desorption of the ions, nutrient transformations, and nutrients' availability to plants. This paper suggested method to determine the PH of the soil by using Artificial Neural Network (ANN). The database that suggested for this neural network, store the value of the soil colour (RGB) and the PH value of each sample. The neural network that has been designed depended on secondary data that have been already collected by some of the researchers in 2014.*

**Keywords**— *soil ph , image processing , neural network , soil colour ,soil properties*

### I. INTRODUCTION

Soil pH is probably the most important test performed by a soil-test laboratory to help advice producers on how to maximize crop production. Soil pH, along with some indicator of the pH buffering capacity of the soil, provides information on how much lime should be applied to achieve a target pH level. The pH buffering capacity of the soil is usually assessed by measuring pH of a buffer solution after reacting with soil acidity, while some laboratories use soil texture Soil ph. plays important roles in many chemical and biochemical process in soil Measurement of soil pH is most commonly conducted with a glass electrode manually placed into a 1:1 mixture of soil/water. [1]. The PH of the soil is a measure of mix of factors that affect the soil some of these factors are chemical or physical [2] The several of PH values have affected the crops growing for different stages of growth [3]. The pH. told how the environment is affecting the soil. These days the technology is used in every field of science. Now it's important and necessary to find new methods that can estimate the values of ph. and this method can be used in agriculture to determine which crop is suitable for the soil. And these methods can cover a wide area of land. And can deal with the satellite image. The neural network is one of the new models that used in different fields and gave a good results in this research, neural network is suggested to be used to estimate the pH value of soil.

The Artificial Neural Network (ANN) is a type of mathematical model for information processing through interconnecting structures, similar to brain synapses. Also, ANN is highly appropriate for the modeling of nonlinear systems among which the back-propagation (BP) network is the most popular and classical, having been applied in various of fields. A one-hidden-layer neural network can approximate a complicated nonlinear function with arbitrary precision, with widespread use in practical applications .The most common ANN architecture consists of three layers, i.e., the input layer where the data are introduced to the model, the hidden/intermediate layer where the data are processed, and the output layer where the results of given inputs are obtained [4].

The concept of ANN is basically introduced from the subject of biology where neural network plays a important and key role in human body. In human body work is done with the help of neural network. Neural Network is just a web of inter connected neurons which are millions and millions in number. With the help of this interconnected neurons all the parallel processing is done in human body and the human body is the best example of Parallel Processing. [5]. ANN have been used in different filed and gave a well results [6], [7], [8] [9], [10]

### II. LITERATURES REVIEW

In the last two decades the soil image analysis has been used to find different content and some of the chemical physical and biological effects of soil. The researcher's use some statistical models are some of the software with image analysis and they used the new technology to find some of the soil properties. [11] Used the image analysis to determine the organic matter content by using the statistical measurement and found there is a strong positive correlation between SOC concertinas and basic colour value of the digital image red, green and blue. (The value of  $r = 0.93$ ). [15] estimated the water content of soil by using two colour spaces of digital image (RGB) and (HSV). He discovered that the soil became darker when the water content increase and the soil wetted up, but this will be in a limited range. The regression analysis has been used to find the relation between the colour of the soil and the water content of the soil. He found there is a strong relation between soil colour and water content of soil, light colour of the soil refers to that the soil has poor organic matter. [12] Determined the solute concentration of soil by developing model based on digital image. Chemical analysis and soil sampling were used to find the relation between the dye content of soil and the value of digital image

colour (red , blue and green). The pre-processing is used to detect some of the error that in digital image. Before image analysis to determine the soil colour at sampling point in profiles. The polynomial regression is used to build the model with a primary colour (RGB) validation of the technique with independent data showed the methods estimated the concentration of the dye well. [16] used image analysis to determine some of the physical change of the soil to determine the shape and the size of the macroporosity of the soil by using Aphelion image analysis to approach have been used in this methodology, geometrical radius and hydraulic radius. The first approach gave better result that the second. [13] found the soil pH. value by using digital image processing technique. 50 samples of soil have been chosen for this study during sunlight, captured the image by using digital camera. These images converted to their multispectral by using TNT Maps spatial. In this research, the researchers are used both RGB and grey level values to find the pH. of the soil. The result showed that the values of the pH in dark brown soil are in the range of 7.30 to 7.50 in light yellowish soil the pH. The range of the was between 6.8 and 7.04. the pH in the range of 5.58-6.58 in greenish colour. The variety of pH values belong to the variety of soil content.

### III. METHODS AND MATERIALS

The idea of this study to find the pH value of soil, according to the soil colour by using neural network. The sample of soil is taken from many lands and its pH value was estimated according to the sample colour. That mean database is needed for this purpose to compare the current soil sample with, and find its pH value. The colour values (RBG) of the soil will compare with the colour values of the samples that already store in database and find the minimum error to determine the pH. value of the current sample. That means the value that need to store in the database is the basic colour value (RBG) and the pH value of each sample that already collected. And the data needed for the sample that we want to find its pH. are (RBG). The two RGB values of the sample and database will compare to find the value of pH..

In this study, we used secondary data that already collected by another study. These data include 50 samples of soil with different colour. Each sample of these samples is analyzed to its basic colour values, RGB and found the pH. value for each one, then we have the colour values of soil and its pH. value. This data is used to store in a database to use in our research. The table below shows the values of RGB and the pH that collected by [13]. The training is done with known value of these data to train the neural network. Now these data will cover the requirements that we need to build database to be ready to use for compering with the soil sample that we need to find its pH value. And these data have the RGB values that need to compare and the pH values. These data can classify in three classes, dark brown, light yellowish and greenish. And have the pH. values from 5.5 to 8.3.

SOIL SAMPLE	RGB VALUE	pH	SOIL SAMPLE	RGB VALUE	pH	SOIL SAMPLE	RGB VALUE	pH	SOIL SAMPLE	RGB VALUE	pH
1	133 98 30	7.05	13	203 155 115	7.83	25	227 209 173	7.96	37	182 136 50	5.52
2	172 139 106	6.80	14	169 136 96	7.59	26	187 155 117	7.99	38	128 105 27	6.96
3	176 152 114	6.63	15	175 134 102	7.51	27	226 186 125	7.99	39	185 155 91	6.62
4	158 132 51	6.64	16	162 128 88	7.20	28	196 146 109	6.90	40	152 122 52	6.42
5	197 164 123	8.35	17	162 131 72	7.36	29	203 168 140	7.56	41	229 210 152	6.80
6	190 147 99	7.35	18	168 128 76	7.35	30	155 137 89	6.75	42	255 220 162	7.09
7	191 162 145	7.35	19	156 119 66	7.38	31	157 134 80	6.63	43	176 169 123	5.58
8	167 151 153	7.49	20	163 131 93	7.44	32	179 129 67	6.43	44	173 128 43	6.52
9	152 121 68	7.38	21	182 146 110	7.68	33	230 181 123	7.90	45	169 145 85	6.06
10	148 118 48	7.40	22	175 138 93	7.57	34	208 161 119	7.04	46	189 164 110	5.53
11	133 103 55	7.25	23	207 186 157	7.50	35	196 150 101	6.90	47	167 154 99	6.58
12	176 137 81	7.30	24	186 144 94	7.22	36	176 139 69	6.48	48	186 154 97	6.50
									49	164 160 113	6.45
									50	158 150 111	7.24

Fig 1: The data that used for research [13]

### Proposed Neural Network

The Architecture of the neural network consists of three main layers, the first is the input layer the second is the hidden layer and the third is the output layer. In this proposed network the input layer consists of three nodes use for input and one hidden layer with 10 neurons and one node for the output layer. The three input nodes will use to input the three basic colours of soil (RGB) and these inputs will process in hidden layer to give the output. One output node uses to give the value of pH for the selected sample.

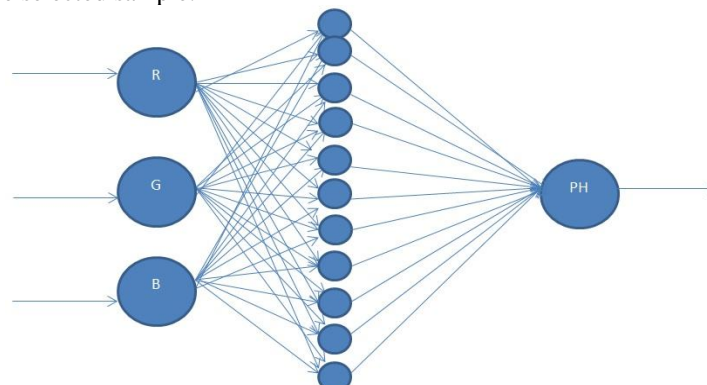


Fig 2: The proposed Neural Network

In this network 70% (34 samples) of data is used for training , 15%( 8 samples) is used for validation and 15%(8 samples) used for testing.

### Model performance evaluation

The following four statistical indicators were selected in the performance evaluation of ANN models [4] [14]

- 1) Mean absolute error (MAE)

$$MAE = \frac{1}{n} \sum_{i=1}^n |M_i - E_i|$$

- 2) Mean absolute percentage error (MAPE)

$$MAPE = \frac{1}{n} \sum_{i=1}^n \left| \frac{M_i - E_i}{M_i} \right| * 100\%$$

- 3) Root mean square error (RMSE)

$$RMSE = \sqrt{\frac{\sum_{i=1}^n (M_i - E_i)^2}{n}}$$

- 4) Determination coefficient ( $R^2$ )

$$R^2 = \frac{[\sum_{i=1}^n (E_i - \bar{E}_i) \cdot (M_i - \bar{M}_i)]^2}{\sum_{i=1}^n (E_i - \bar{E}_i) \cdot \sum_{i=1}^n (M_i - \bar{M}_i)}$$

where n is sample size,  $E_i$  is estimated Ph value,  $M_i$  is the Ph value from collected data.

## IV. RESULTS

After used this neural network for our system to the data we calculated the statistical indicators were selected in the performance evaluation of ANN models . the table below shows the values of the measurement.

Table 1: Values of Neural Network Performance Measurement

MAE	MAPE	RMSE	$R^2$
0.8	0.2	0.18	0.8

The table showed the result that indicates to the good performance of the model in this range of colour. And the error here is small and the estimate result is close to the real values that already collected. The table shows the two values of pH when ph1 is represented the pH value that collect from the data and ph2 is representing the pH value that the estimate of the model.

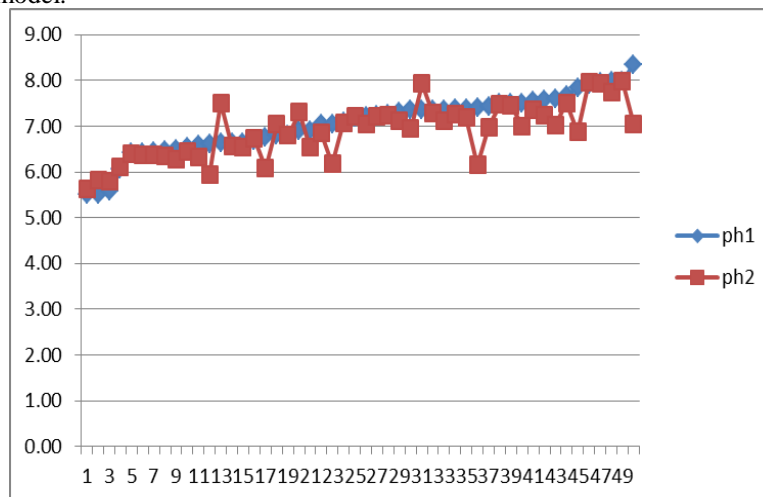


Fig 3 : The two Phs values are there the value of Ph1 that get from lab and ph2 the value get from Model

## V. CONCLUSIONS

This model showed a good performance and it can be used to estimate the pH. values of soil in this range (5.5 to 8) and the value of error evaluated refers to the small error value of the model. The results of this study support the conclusion that the use of neural network to forecast the. values would be a useful tool. Analysis of comparisons between real values of pH calculated using the chemical analysis and pH. A value estimated by using neural network correlated very well ( $R^2$  between 0.8) and had low RMSE values (0.18), low MAE value (0.8) and low MAPE value 20%. These errors also can be reduced by increasing the numbers of sample data that can use for training to cover more soil colour and more ph. values and if the amount of data that use in neural network increase this will lead to better performance.

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