Decision Support System for Agricultural Management using Prediction Algorithm

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Abstract— **Currently climate change is one of the major problems encountered due to the climatic controls interacting in various intensities and in different combinations. The proposed system includes mechanism that accepts/processes gathered data from Agricultural Research Center. The system uses Time Series Analysis; the collection of observations of well-defined data items obtained through repeated measurements over time which utilizes algorithm that is capable of formulating the trend. Upon prediction, the system displays table and graphs along with the recommended crops. The system had successfully determined the trend of rainfall and evaporation using prediction algorithm together with the recommended crops. It was able to display the result of prediction in graphical form and crop classification in tabular form.**

Keywords-Prediction Algorithm; Agricultural Management; Rainfall-Evaporation Prediction; Trend;

I. INTRODUCTION

It is a fact that agriculture is one of the most important sectors for human beings all over the world. The credit of the increased production of agriculture products in the past could be given to the efforts of farmers. When production is stagnated it becomes essential that farmers collect important and updated information about any of the crop.

The major problem experienced by the farmers and the Department of Agriculture is climate change. It includes global warming, extreme temperature and when rainfall is not distributed throughout the month. The weather today is not as it was. It is unpredictable and that affects the normal development of crops which leads to the loss of farmers' production.

With the details from previous study, the researchers have come up with the new system that predicts the possible weather condition for every quarter throughout the year using the information gathered from agricultural research center. The factors are rainfall and evaporation for five years from 2007-2011.

This study aimed to develop a decision support system using prediction algorithm that will assist farmers in agricultural management. The rainfall and evaporation data gathered from the measuring device will be used in the process of prediction. Through prediction per quarter, the system displays the trend along with the recommended crops. The trend will be used by farmers for their plant scheduling.

II. RELATED STUDIES

In the study about Decision Support System for Farm Management [1], the emergence of information technology has resulted in an ever-increasing demand to use computers for the efficient management and dissemination of information. Keeping in view the strong need of farmers to collect important and updated information for interactive, flexible and quick decision-making, a model of Decision Support System for Farm Management is developed [1] [3]. The paper discusses the use of Internet technology for the farmers to take decisions. A model is developed for the farmers to access online interactive and flexible information for their farm management. The workflow of the model is presented, highlighting the information transfer between different modules.

On the other hand, a paper on Prediction Algorithm Based on Fuzzy Logic Using Time Series Data Mining Method [2], focused on a prediction of an event at a time series which is quite important for engineering and economy problems. Time series data mining combines the fields of time series analysis and data mining techniques [5], [6], [7]. This method creates a set of methods that reveals hidden temporal patterns that are characteristic and predictive of time series events. Time series data mining examines the time series in a phase space. In this paper, a prediction algorithm using time series data

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mining based on fuzzy logic is proposed. Earthquake prediction has been done from a synthetic earthquake time series by using investigating method at first step ago. Time series has been transformed to phase space by using nonlinear time series analysis and then fuzzy logic has been used to predicting optimal values of important parameters characterizing the time series events. Truth of prediction algorithm based fuzzy logic has been proved by application results [2] [5].

III. SYSTEMS ARCHITECTURE

A. *Architectural Design*

In this system using a computer with internet or local connection, the administrative user will log in to the system using an admin account. Upon the accessing the home page, the user will input daily record of rainfall and evaporation data. Using the Time Series Analysis as the algorithm, the system will execute it and will come up to the prediction together with the recommended crops and will automatically update the graphical representation of the prediction. Additional features of the interface are adding, updating and deleting of user accounts, types of crops and rainfall/evaporation data. Moreover, viewing the graphical presentation of the trend and also printing a yearly summary report.

IV. PROPOSED SYSTEM

This paper includes is a web-based application system which serves as the interface that is managed by the user. The system has two main components: First, the Rainfall/Evaporation and second is the Crop Management. The interface includes fields wherein the user will input all data per day of the rainfall and evaporation data.

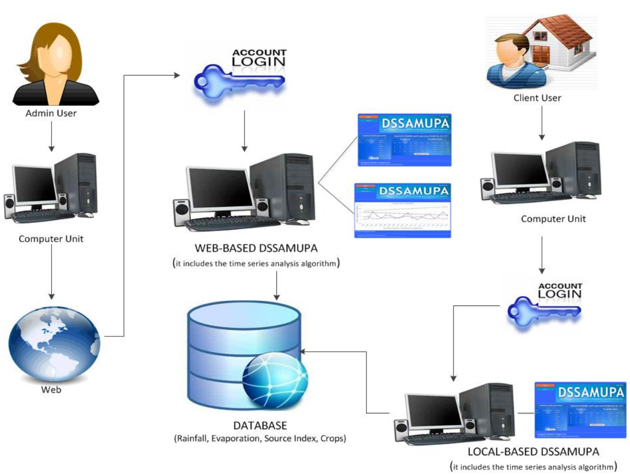

Figure 1. Architectural Design of the Proposed System

The system will automatically predict and recommend crops for the next years' first quarter even if the user has just inputted one day of rainfall or evaporation data, but this prediction is considered incomplete, unless the user has finished filling up the first quarter of the present year. Afterwards, it will update the database that previously contains the list of crops and the water data.

The proposed system uses a Time Series Analysis as a Prediction Algorithm. Table 1 shows the Real Data Computation using Time Series Analysis. The table contain fields such as the year, the "t" or the "x" variable, the "y" which is the average rainfall per quarter, the "ty": product of "t" and "y" variables, the "t^2": the square of the "t" variable, the "T": trend and the "S" which is the seasonal effect on the trend. Table 1 also contains the summations and means of some variables.

Table 2 illustrates the result and the predictions obtained from the algorithm. The table contains the fields such as the "y_p", the predicted rainfall and the "SI" or the seasonal effect to the trend, obtained by solving the average of all the values of "S" field in table 1 by quarters.

Table1. *Real Data Computation Using Time Series Analysis*

Year	t	Y	ty	t^2	T	S
2007	1	29.2	29.17	1	160.905	0.181287
	2	77.2	154.4	4	164.8495	0.468306
	3	446.2	1338.72	9	168.7941	2.643695
	4	222.47	889.88	16	172.7386	1.2879
2008	5	100.6	503.0667	25	176.6831	0.569456
	6	264.49	1586.94	36	180.6276	1.464283
	7	234.9	1644.3	49	184.5722	1.272673
	8	126.89	1015.12	64	188.5167	0.673097
2009	9	105.6	950.4	81	192.4612	0.548682
	10	215.4133	2154.133	100	196.4057	1.096777
	11	368.3	4051.3	121	200.3503	1.838281
	12	164.1333	1969.6	144	204.2948	0.803414
2010	13	13.3	173.3333	169	208.2393	0.064029
	14	106.2333	1487.267	196	212.1838	0.500666
	15	242.5	3637.9	225	216.1284	1.122142
	16	308.43	4934.88	256	220.0729	1.40149
2011	17	73.8	1254.6	289	224.0174	0.329439
	18	212.5	3825.48	324	227.9619	0.93229
	19	423.8	8052.2	361	231.9065	1.827461
	20	231.5	4629.8	400	235.851	0.98151

Table 2. *Rainfall Prediction Table of 2012*

Year	t_P	y_p	T_p	SI
2012	21	y_{p1} = 81.21	239.795	s_1=0.3386
	22	y_{p2} = 217.58	243.7401	s_2=0.8925
	23	y_{p3} = 431.30	247.684	S_3=1.7409
	24	Y_{p4} = 258.98	251.6291	S_4=1.0295

Shown in Table 1 is a sample set of values needed to work out on the prediction of rainfall of the year 2012. There are 7 fields: year, t, y, ty, t^2, T and SI. The column "t" contains the "t" variables which is the number of all the quarter for a total of five years data gathered.

The column "y" variables can be obtained by querying in the database the summation of the rainfall/evaporation and will be divided by three.

$$y = \sum \text{ of rainfall/evaporation}$$

The column "ty" variables, which is the product of variable "t" and variable "y" for each row.

$$ty = t * y$$

The "t^2" variable is the square of "t" variable for each row.

$$t^2 = t * t$$

While the column "T" variables or the trend variables that can only be obtained after solving for β_1 and β_0 which is both an unknown parameter. And according to the Time Series Analysis, trend is basically the straight line on the graph.

First, get the β_1.

$$\beta_1 = N (\sum ty - \sum t * \sum y) / [N * \sum t^2 - (\sum t)^2]$$

where N variable is equal to the population or in the table is the highest value in the "t" column.
"$\sum t$" is the summation of column "t."
"$\sum y$" is the summation of column "y."
"$\sum ty$" is the summation of column "ty."
"$\sum t^2$" is the summation of column "t^2."

After obtaining the β_1, it will be used for getting the β_0.

$$\beta_o = \text{average of column "y"} - (\beta_1 * \text{average of column "t"})$$

The "T" or the trend field can be filled-up by using the formula:

$$T = \beta_o + (\beta_1 * t)$$

where "t" variable is the value of "t" for each row.

And lastly, the "SI" column, which is the quotient of "y" variable divided by the "T" variable for each row.

$$SI = y/T$$

The "S" is the seasonal impact in each quarter and it is basically divided into four different numbers called S_1 for the first quarter, S_2 for the second quarter, S_3 for the third quarter and S_4 for the fourth quarter.

After completing all the values needed for the prediction, the system will execute the process of prediction.

In table 2, there are five fields labeled as year, t_p, y_p, T_p and SI. The "t_p" field is the continuation of column "t" on table 1. The "T_p" was obtained using the formula:

$$T_p = \beta_o + (\beta_1 * t_p)$$

where "t_p" variable is the value of "t_p" for each row.

The "SI" variable base to the Time Series Analysis is the Season and the Irregularities. The "I" is the Irregular factor, which is basically an unpredictable component or the errors affecting the prediction.

In Table 2, the "I" can be eliminated by simply solving all the "S" variables in the previous years per quarter (refer to table 1) in acquiring the exact measure of the seasonal impact(S) for the prediction of rainfall or variable y_P.

$$y_p = T_p * S$$

Example: We have to know and prepare the suitable crop(s) to be planted for the first quarter of 2012 (y_{p1}), and since we have low agricultural profit for year 2011 caused by heavy rain that softens the root of the crop.

Note: for this example refer to table 1 and 2.

y_{p1} = predicted amount of rainfall for 2012.
T_{p1} = predicted value of trend for the first quarter of 2012.
S_1 = seasonal impact to the trend; obtained by averaging all the first quarters of the gathered data on table 1.

$$y_{p1} = T_{p1} * S_1$$
$$y_{p1} = 239.795 * 0.3386$$
$$y_{p1} = 81.3$$

Through this predicted amount of rainfall, we could classify recommend crops that is/are suitable with 81.3 amount of rainfall.

V. SIMULATION AND RESULT

Decision Support System for Agricultural Management using Prediction Algorithm aimed to develop a system that will determine the trend of rainfall and evaporation using Time Series Analysis as its prediction algorithm, to develop web-based application that displays graphs and tables according to the result of the prediction algorithm, and to utilize a classification of crops that aids farmers as basis for recommendation according to the predicted amount of rainfall per quarter.

The system is found to be useful in terms of efficiency, the reliability of the data that is used for the systems' database. It shows in the interface the quarters of the year labeled as Q1, Q2…Q4, prediction of average amount of rainfall and evaporation, the trends, and the seasonal effects in its provided field in the table.

Along the predicted rainfall per quarter of every year are the recommended crops suited to the weather condition. Trends are viewed in graphs for better understanding of the user. The database is managed by an administrator; input of day-to-day rainfall and evaporation data for the Department of Agriculture to compare the previous and up-to-date data.

VI. CONCLUSIONS AND RECOMMENDATIONS

This research is found to be beneficial to farmers and the Department of Agriculture in determining the trend of rainfall and evaporation using time series analysis as the prediction algorithm. In this paper, the results of predictions are presented in graphical and tabular forms.

The system was able to classify the crops that aid farmers as basis for recommendation according to the predicted amount of rainfall per quarter.

The system should have a Relative Humidity and Temperature as an additional variable for a reliable prediction. And this research should include features such as classifying the specific crops to be planted according to its water and soil moisture requirements.

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