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Precision Farm Monitoring using Internet of Things

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Abstract:- Agricultural fields are segregated into different sizes and structure. Effective usage of modern technologies like Information and communication technology will reduce the manual effort involved in field monitoring and other agricultural activities. Internet of Things which consist of sensors connected to Internet can be used in smart farming to enhance the precision agriculture productivity. Soil parameter estimation is important role in predicting the crop growth. Soil moisture content has to be monitored regularly for effective management of water resources. Moisture sensors are used to retrieve the value of moisture content in the soil. DH22 sensor is used to retrieve temperature and humidity parameters. These values are monitored consistently and used to draw the insight between temperature and humidity parameters. It is also used to design automated irrigation system which saves the water resources. Smart phones and Web presentations gives effective communication among small scale farmers.

Keywords: *Precision Agriculture, Sensors, Information and Communication Technology.*

1. Introduction

Agriculture is the most important work sector of majority popution across the globe. As population increase the demand for food is increasing in a rapid way. Farmers are expecting a radical technology to address the increasing food demand. Precision agriculture is a solution to the problem of increased food demand. The use of Information and Communication Technology in Precision Agriculture reduces the cost of labor, fertilizers, time required for field monitoring etc. Data related to soil moisture, Temperature, Nutritional value, Ph. Level, Humidity, Nutrients level, Fertilizer Requirement of the soil, are very essential in determining the crop growth rate.

Real time sensors are required to implement precision agriculture effectively. Tools are available in market to carry out the agricultural activities but high operational costs involved in usage of existing tools. Small scale farmers cannot use these tools effectively. So cost of tool usage has to be minimized. These tools need to be integrated with real time sensing devices. Monitoring soil quality is very much vital to define the fertilizer requirement. Soil moisture content is considered as the major key feature in soil quality. Internet of Things is motivating smart farming techniques which acts as a backbone of developing country.

Farming is the pillar of every economy. Due to rising population, we can find increasing demand of food. Modern technology has to be integrated in agriculture sector to satisfy the demand. Farming is considered as the main activity which is contributing to the nation economy. Crop cultivation is purely seasonal. It will be affected by changing climatic conditions. Proper technological solutions are required to analyse and overcome these situations. Data analytical techniques are beneficial in in predicting the crop yield.

2. Related Work

Human life is essentially dependent on agriculture for food. Since the production of food is increased as the increase in population, technologies have been developed to minimize labor work and maximize food production. One of such techniques is precision agriculture which uses enhanced image processing and data processing techniques. An appropriate treatment plant for different varieties of crops at different regions is determined by a model created by collecting and analyzing a catalog of images through remote sensing. The important characteristics of images collected from different plantations are fed into the model. Diverse methods are implemented for the process but the most effective technique to generate fast result is convolution neutral network for image classification. This technique can be used to effectively recognize plant image and classify to optimize production. [1]

A new approach is presented to maximize coverage path planning and to minimize path length of an aerial robot in the ground of farming using concave obstacles. A cellular decomposition technique based on a generalization of the Boustrophedon variant, using Morse functions is proposed along with an extension of representing the critical points. There is reduction in number of cells after decomposition as a result of this extension. Even in the occurrence of several concave obstacles inside environment, the new cellular decomposition still works. These cells are additionally divided into two sectors which generate a set of cells to obtain complete coverage by using it in traveling salesman problem (TSP). To obtain shortest path, we use genetic algorithm (GA) and TSP algorithm. The proposed system is used to increase the scanned area on working area consisting of obstacles. The technique is implemented in precision agriculture to monitor the crop pests and other insects. [2]

Big data architecture and MapReduce technique is implemented to process the Weather data which already exists. Nearest neighbor technique predicts the weather data and further crop yield can be predicted in advance centered on the weather data. [3] Decision tree is implemented for yield prediction. Here existing data from Agriculture University is considered for the analysis and PCA is applied for filtering the raw data. Decision tree method predicts the high or low yield of sugarcane for the specified climatic conditions. [4] Work proposed focuses on automating the farming activities which aids the farming community for surviving in global level competitive market. It focuses on existing precision agriculture data and farm vehicles for real time activities [5].

Precisely applying fertilizers in agriculture decreases the cost and increase the production. Minimization in chemical application also decreases the water pollution. In the proposed work numerical regression model is implemented to balance the manure application on fields. It is expensive for small farmers. [6] The work proposes a methodology for extracting information in large databases. Here datasets are classified by Bayesian classification. Crop yield is predicted using knowledge discovery process. [7] Work proposes a software model for improving the efficiency of data analysis in agriculture field and canopy management of crops. [8] In the proposed architecture model IoT can be used track the products in large scale business. Different devices, delivery status and recycle activities can be tracked using RFID [9]. The work proposed discuses about importance of fertilizer application based on plant requirements. New technologies like mobile robotics can be implemented in precision farming to increase the production with reduced cost. [10].

3. Objectives

Three sub-systems make up the system: a web browser, a cloud server, and a smartphone application. Field farmers are able to verify details on work schedules and use a smartphone app to submit field reports back to the admin. Every piece of information is kept on a cloud server and is accessible from offices and farms alike. Costs are managed and work and field schedules are managed using a web browser. The browser may be used on a PC, tablet, or smartphone based usability needs.

4. Methods

Moisture sensors are deployed in agriculture land collects the data about soil moisture content. Figure 1 describes the flow diagram of soil moisture prediction model. Moisture sensor is placed in agricultural field to extract the moisture value of soil. This data is stored in a database. The collected data is classified on hourly basis. Missing values will occur because of technical problems in sensors, frequent power failures in rural areas, and poor maintenance. Since the information is collected on hourly basis it results in huge amount of data. Time series forecasting analyses the data and predicts the missing values of soil moisture content.

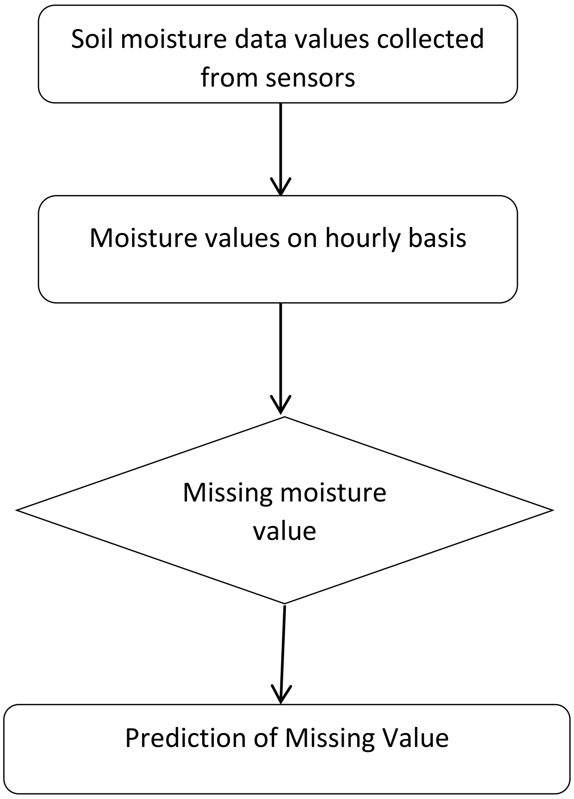


Figure 1: Flow diagram of soil moisture prediction model

Forecasting Techniques

Diverse analytical methods are used to forecast the future value of given data set. Time-series techniques forecasts future values in case of historical data availability. It addresses the values that are gathered over time. Forecasted values in the future depending on the previous values in a stochastic approach. The objective this analysis is to determine the model which represents the essential dynamics. This model can be used for forecasting the series.

Linear Regression Technique

This technique establishes a linear association between the response variable and predictor(s) variable. Multiple regression equation encompasses more than one covariate.

Random Forest Technique

This technique can be used for large and small data to give an effective forecast. Standard Data sets are selected to predict the crop yield. Data pre-processing has done to replace the missing value and null values. The pre-processed data will be processed by random forest technique. It will generate multiple trees and data is passed to trees. Each tree is created on the different situations. This process creates many decision trees and checks for the total tree count giving the same prediction. The result generated by the maximum trees will be taken as a final result.

Double Exponential Smoothing

A double smoothing method is used for the series which has a trend component. Each value in a series is supposed to be consisted of two parts, smoothing part and trend part. Double exponential smoothing technique is used control trend or nonstationary part in the time series.

ARIMA

The ARIMA method is also mentioned as Box-Jenkins methodology. Auto-Regressive-Integrated-Moving-Average (ARIMA) technique is fitted to a selected data set. Main objective in fitting this ARIMA model is to find the stochastic process of the time series and forecast the future values precisely.

Figure 2 describes the architecture model of the proposed system. Multiple sensors are integrated in the farm land to retrieve the field parameters. Data values are stored in the centralized storage system. Time series forecasting is used to predict the missing values. Data is analysed and communicated to the small scale farmers using smart phones and web applications.

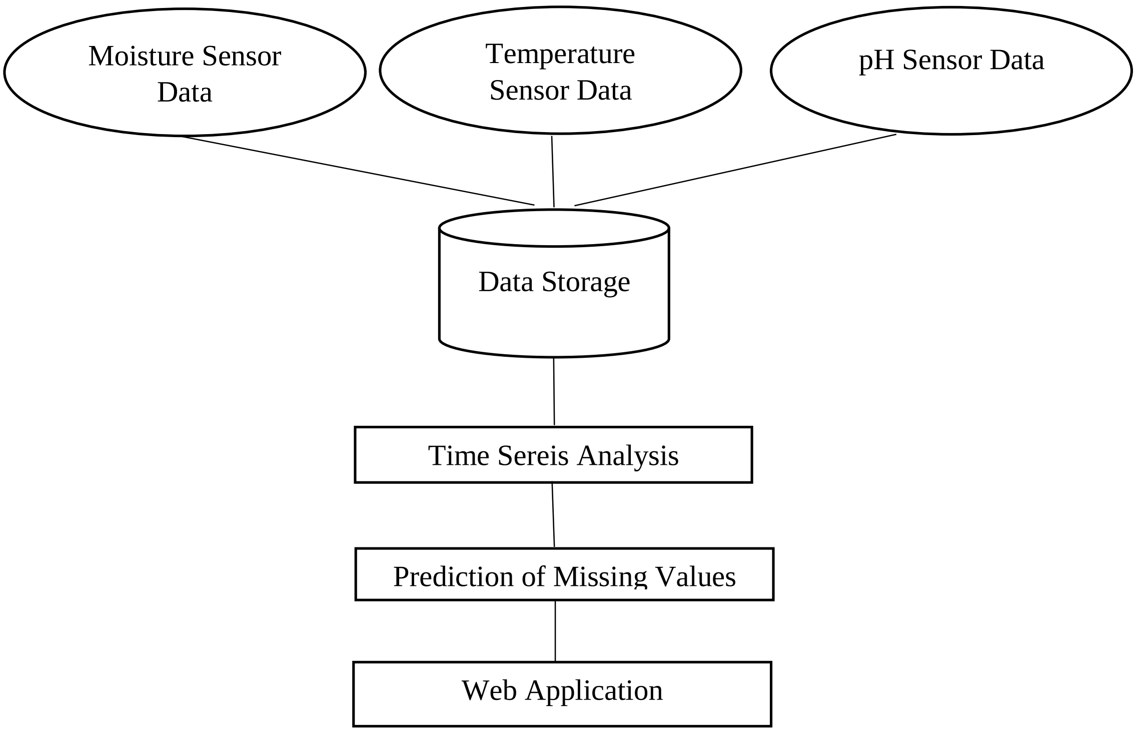


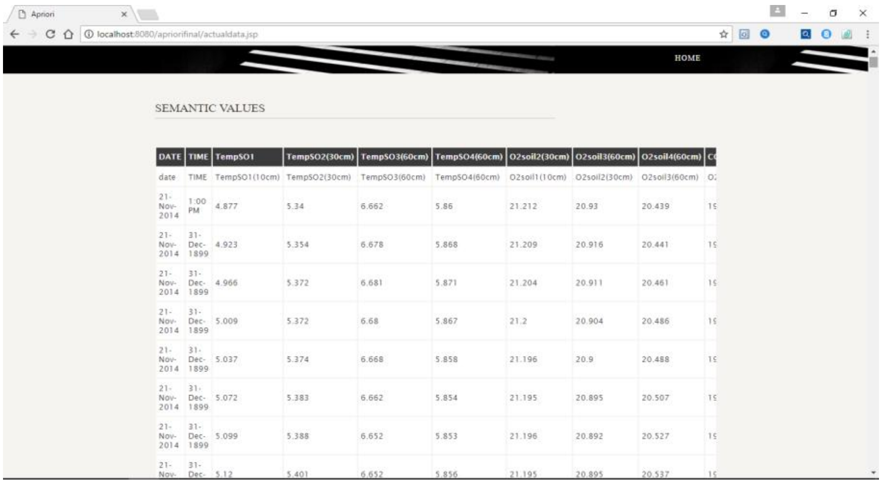
Figure 2: Architecture model of the proposed system

5. Results

Sensors in the farming field collects the moisture values. These data is filtered on hourly basis. Sensors cannot gather the data continuously because of various technical problems like lac of power in rural sector, maintenance problem, circuit problem etc. This missing data is predicted using time series forecasting. Figure 3 describes the experimental setup. Sensor data is displayed in actual data field.

Figure 3: Experimental set up of the preliminary design.

Figure 4 describes the data values collected from the sensors. These values are segregated on hourly basis. For every hour soil moisture data is extracted from field.



SEMANTIC VALUES

DATE	TIME	TempSO1	TempSO2(30cm)	TempSO3(60cm)	TempSO4(60cm)	O2soil2(30cm)	O2soil3(60cm)	O2soil4(60cm)
date	TIME	TempSO1(10cm)	TempSO2(30cm)	TempSO3(60cm)	TempSO4(60cm)	O2soil1(10cm)	O2soil2(30cm)	O2soil3(60cm)
21-Nov-2014	1:00 PM	4.877	5.34	6.662	5.86	21.212	20.93	20.439
21-Nov-2014	31-Dec-1899	4.923	5.354	6.678	5.868	21.209	20.916	20.441
21-Nov-2014	31-Dec-1899	4.966	5.372	6.681	5.871	21.204	20.911	20.461
21-Nov-2014	31-Dec-1899	5.009	5.372	6.68	5.867	21.2	20.904	20.486
21-Nov-2014	31-Dec-1899	5.037	5.374	6.668	5.858	21.196	20.9	20.488
21-Nov-2014	31-Dec-1899	5.072	5.383	6.662	5.854	21.195	20.895	20.507
21-Nov-2014	31-Dec-1899	5.099	5.388	6.652	5.853	21.196	20.892	20.527
21-Nov-	31-Dec-	5.12	5.401	6.652	5.856	21.195	20.895	20.537

Figure 4: Data values

Figure 5 describes the prediction of missing values of soil moisture. Sensors cannot collect data because of power problem in agriculture field or some other technical reasons. During that period we are predicting the data using time series forecasting.

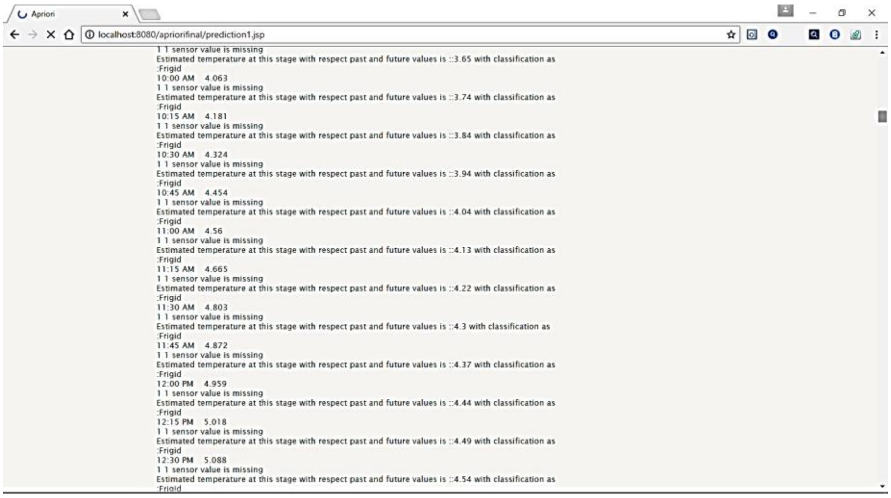


Figure 5: Prediction of missing values

6. Discussion

Information and Communication Technology tools in the field of precision agriculture play an important role in increasing the crop yield. Various soil parameters like Ph. level, moisture content of soil are considered as key factors in determining the soil quality.

In the proposed work soil sensors are used to extract the soil moisture content from the field. Since sensors are placed in fields it is not possible to extract all the values in the specified interval. The various reasons like power problem, Network problem, improper maintenance affects the sensor readings. These moisture values are segregated on hourly basis. The missing value of moisture has been predicted to increase the accuracy of prediction. The work carried out proposes a model to predict the missing values of soil moisture content. Missing sensor data values can be predicted on hourly basis using time series forecasting. These predicted values are integrated with the actual sensor readings which yields a better soil moisture prediction model.

Refrences

[1] Abdullahi, Halimatu Sadiyah, R. Sheriff, and Fatima Mahieddine. "Convolution neural network in precision agriculture for plant image recognition and classification." In *2017 Seventh International Conference on Innovative Computing Technology (INTECH)*, vol. 10, pp. 256-272. New York: IEEE, 2017.

[2] Pham, The Hung, Yasmina Bestaoui, and Said Mammar. "Aerial robot coverage path planning approach with concave obstacles in precision agriculture." In *2017 Workshop on Research, Education and Development of Unmanned Aerial Systems (RED-UAS)*, pp. 43-48. IEEE, 2017.

[3] Wu Fan, Chen Chong, Guo Xiaoling, Yu Hua, Wang Juyun, Prediction of crop yield using big data, 2015 8th International Symposium on Computational Intelligence and Design.

[4] Ashwinirani, Dr. B. M. Vidyavathi, Ameliorated Methodology for the Design of Sugarcane Yield Prediction Using Decision Tree, COMPUSOFT, An international journal of advanced computer technology, 4 (7), July-2015

[5] R. Eaton, J. Katupitiya, K. W. Siew, and B. Howarth “Autonomous Farming: Modeling and Control of Agricultural Machinery in a Unified Framework,” Proceedings in 2008 ISBN 499-504.

[6] Yang Zidong and Du Ruicheng “Research on adaptive control modeling of a manure spreader for precision agriculture,” Proceedings in 2009 IEEE 850-854.

[7] Seok Won Lee and Larry Kerschberg “A methodology and Life Cycle Model for Data Mining and Knowledge Discovery in Precision Agriculture,” Proceedings in 1998 IEEE 2882-2887.

[8] Li Tan1, Ronald Haley, Riley Wortman, and Qin Zhang “AnExtensible and Integrated Software Architecture for Data Analysis and Visualization in Precision Agriculture,” Proceedings in 2012 IEEE 271-278.

[9] Felix Jesus Villanueva, David Villa, Francisco Moya, Maria Jose Santofimia, and Juan Carlos L´opez “Internet of Things architecture for a RFID-based product tracking business model,” Proceedings in 2012 IEEE 811-818.

[10] John Faber Archila, Junior Marques Moreira, Victor Ivar Van Halts, Luiz Antônio Neto Alves, Oscar Eduardo Rueda, Marcelo Becker “Simulation of Rovers for Precision Agriculture” 2014 IEEE Joint Conference on Robotics: SBR-LARS Robotics Symposium and Robocontrol.