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Perceptive Monitoring System using IoT for Agriculture Environment Sector

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ABSTRACT

In today's world, agriculture sector is the backbone of economy. Several challenges exist in agriculture process such as attack from insects, rodents that led to the development of monitoring systems. Such challenges must be considered and a perceptive monitoring system has to be developed. Current monitoring systems focus on providing security to the agriculture fields or grain stores and are not smart enough to monitor, provide real time notification about the problem. Using the latest technologies as Internet of Things and Wireless Sensor Networks is the best resistant method providing solution to the security, monitoring issues in agriculture. With this methodology, the proposed Perceptive Monitoring system is designed, mined, analysed and tested as an IoT device that capture information through sensors, mine and analyse the data further transmit notification to the user. The proposed device can be monitored, controlled from a remote location without human intervention that can be implemented as a security strategy for agriculture fields, storage farms.

Keywords: Agriculture Monitoring System, Internet of Things, Sensors, Crops

I. INTRODUCTION

Over the past years information and communication technologies have been introduced in agriculture, improving food production and transportation. However the integration of these technologies are not yet used for security puposes. The significant challenge facing the security in agriculture is the interaction between security devices and to provide them intelligence to control other electronic devices such as cameras, repellers etc to enhance security in various fields. For example[1], a basic CCTV camera installed in a grain store cannot be of use until recorded media is accessed and it also cannot process the information about what is happening at particular location. In implementation and adoption of information and communication technologies, cost is also a major factor. It is not easy to achieve exchange of information among devices and upgrading their functionality while keeping their cost to a reasonable level[9].

So, the natural conclusion is that the security and monitoring systems must be responsible for transmitting data over network, analyzing the information and notify the user with real time information of surroundings. This lack of information transmission and data analyzing has been ”solved” by integration of internet of things with currently available security devices in order to achieve efficient food preservation and productivity[2]. Although the food crop loss and debilitation of diseases are due to various threats as rodents, pests, insects and grain pathogens, while this research is the designing and analyzing of security device, considering damages to post harvest crop by rodents and grain stores as applicable area. In the context of Smart Security[3] and Monitoring System for Agriculture (S2MSA), we address the challenge of integrating Internet of Things with electronic security devices and systems to improve the efficiency of food preservation in grain stores[4].

II. RELATED WORK

“Stem water potential estimation of drip-irrigated early-maturing peach trees under Mediterranean conditions - Abrisqueta, I., Conejero, W., Valdés-Vela, M., Vera, J., Ortuño, M.F., Ruiz-Sánchez, M.C., 2015”[5]: In the last decade deficit irrigation strategies allowed growers to deal with water shortages, while monitoring stem water potential (system) is deemed essential for maximising fruit yield and quality. However, because of the intensive labour involved in measuring system, alternative methods are desirable. The experiment described was conducted in Murcia (Spain) with adult peach trees (Prunus persica (L.) Batsch cv. Flordastar) submitted to different drip irrigation treatments, measuring system with a pressure chamber and the soil water content with a neutron probe. Agro-meteorological variables were recorded. Seasonal patterns of stem water potential provide a useful diagnostic tool for irrigation management in peach trees. Rainfall events and the meteorological conditions prevailing in autumn pointed to the resilient nature of the peach cultivar studied. Fitting system by linear regression analysis as a function of soil and atmosphere yielded a significant correlation, with the soil water content being the main contributor to estimating system. Linear regression analysis highlighted the importance of considering plant water status as a function of the peach tree cultivar, the atmospheric conditions in which it develops and the soil water conditions resulting from irrigation. A multiple linear regression equation based on soil water content in the soil profile, mean daily air vapour pressure deficit (VPDm) and growing degree hours (GDH) data explained 72% of the variance in system, and is proposed as an alternative to the field measurement of system.

"Neural computing modeling of the reference crop evapotranspiration - Adeloye, A.J., Rustum, R., Kariyama, I.D., 2012"[6]: In order to better manage the limited water resources in arid regions, accurate determination of plant water requirements is necessary. For that, the evaluation of reference evapotranspiration (ET0)—a basic component of the hydrological cycle—is essential. In this context, the Penman Monteith equation, known for its accuracy, requires a high number of climatic parameters that are not always fully available from most meteorological stations. Our study examines the effectiveness of the use of artificial neural networks (ANN) for the evaluation of ET0 using incomplete meteorological parameters. These neural networks use daily climatic data (temperature, relative humidity, wind speed and the insolation duration) as inputs, and ET0 values estimated by the Penman-Monteith formula as outputs. The results show that the proper choice of neural network architecture allows not only error minimization but also maximizes the relationship between the dependent variable and the independent variables. In fact, with a network of two hidden layers and eight neurons per layer, we obtained, during the test phase, values of 1, 1 and 0.01 for the determination coefficient, the criterion of Nash and the mean square error, respectively. Comparing results between multiple linear regression and the neural method revealed the good modeling quality and high performance of the latter, due to the possibility of improving performance criteria. In this work, we considered correlations between input variables that improve the accuracy of the model and do not pose problems of multi-collinearity. Furthermore, we succeeded in avoiding overfitting and could generalize the model for other similar areas.

"**A flexible classification approach with optimal generalisation performance: support vector machines - Belousov, A.I., Verzakov, S.A., von Frese, J., 2002"[7]** Measuring a larger number of variables simultaneously becomes more and more easy and thus widespread. Obtaining a sufficient number of training samples or measurements, on the other hand, is still time-consuming and costly in many cases. Therefore, the problem of efficient learning from a limited training set becomes increasingly important. Support vector machines (SVM) as a recent approach to classification address this issue within the framework of statistical learning theory. They implement classifiers of an adjustable flexibility, which is automatically and in a principled way, optimised on the training data for a good generalisation performance. The approach is introduced and its learning behaviour examined.

"**Development of an intelligent environmental knowledge system for sustainable agricultural decision support - Campos, I., Balbontín, C., González-Piqueras, J., González-Dugo, M.P., Neale, C.M.U., Calera, A., 2016**"[8] The purpose of this research was to develop a knowledge recommendation architecture based on unsupervised machine learning and unified resource description framework (RDF) for integrated environmental sensory data sources. In developing this architecture, which is very useful for agricultural decision support systems, we considered web based large-scale dynamic data mining, contextual knowledge extraction, and integrated knowledge representation methods. Five different environmental data sources were considered to develop and test the proposed knowledge recommendation framework called Intelligent Environmental Knowledgebase (i-EKbase); including Bureau of Meteorology SILO, Australian Water Availability Project, Australian Soil Resource Information System, Australian National Cosmic Ray Soil Moisture Monitoring Facility, and NASA's

Moderate Resolution Imaging Spectroradiometer. Unsupervised clustering techniques based on Principal Component Analysis (PCA), Fuzzy-C-Means (FCM) and Self-organizing map (SOM) were used to create a 2D colour knowledge map representing the dynamics of the i-EKbase to provide "prior knowledge" about the integrated knowledgebase. Prior availability of recommendations from the knowledge base could potentially optimize the accessibility and usability issues related to big data sets and minimize the overall application costs. RDF representation has made i-EKbase flexible enough to publish and integrate on the Linked Open Data cloud. This newly developed system was evaluated as an expert agricultural decision support for sustainable water resource management case study in Australia at Tasmania with promising results.

III. SYSTEM DESIGN AND METHODLOGY

3.1 Agriculture Field Monitoring

Instead of observing the productivity and quality of faming all the time, this paper proposes the design to monitor the same attributes using wireless sensor network. For the growth, quality and productivity of crops in agriculture temperature, humidity and carbon dioxide levels are the most important climatic parameters. Moreover, when a critical change in one of the measurements occurs, then the farmer will be acknowledged via SMS and e-mail by an agriculture expert.

3.2 Environment Monitoring System

There are various problems in the traditional agriculture like weak real-time data acquisition, limitations in monitoring area, excessive manpower etc., The system collects various climatic parameters like temperature, humidity, illumination, voltage etc. from greenhouse and from there it transmits the data to nearest server via GPRS. The system includes a web application which is using Google Maps to show the greenhouse status and provide regular voice and SMS alarm service. Since, it requires lots of power so it is powered by solar and storage batteries. This results that low power system has better scalability and can provide better service.

3.3 Extending Automation to the Farm

Automation can be used to reduce amount of manual labor and make farming precise also leading to more agricultural growth. Number of operations of farm can be automated like irrigation system, temperature controlled system for livestock and farm product. In this work they implemented automatic lighting system, automatic sprinkler system, house temperature control and security in farm houses. System is energy efficient because temperature and motion sensitive devices will work only when required. Energy efficient system is important factor for agro-based economy.

3.4 Development of Precision Agriculture System

In this system temperature and moisture sensors are deployed at suitable location to monitor the crop. Sensing system uses feedback control mechanism with control unit which controls flow of water depending on temperature and moisture value. Control unit collects data from sensor analyze it and take action.

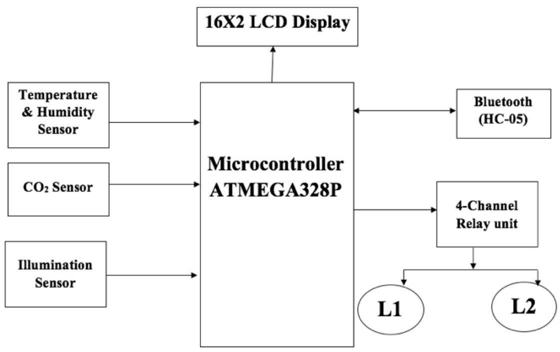

Figure 1. System Architecture

3.5 Components Used

- Microcontroller Unit
- Temperature Sensor
- Humidity Sensor
- CO2 Sensor
- HC-05 Bluetooth
- 16X2 LCD Display
- Motor Pump
- Transformer Unit
- Android Application
- Accessories

3.6 Data Flow Diagram

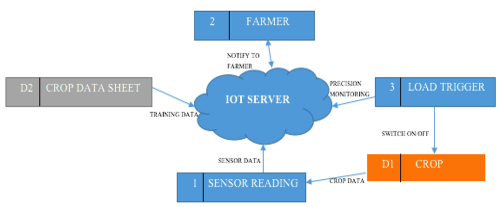

Figure 2. IoT Perceptive Monitoring System

IV. RESULTS AND DISCUSSION

Based on the experiment conducted the following results are obtained:

Test Case ID	Event Description	Illumination	Carbon Dioxide	Temperature	Results Obtained
1	When the Illumination value is greater than Crop data Sheet	High	Normal	Normal	Notified Farmer and reduction of illumination.
2	When the Temperature value is less than Crop data Sheet	Normal	Normal	Less	Farm Field is at Normal Condition.
3	When the Carbon Dioxide value is higher than Crop data Sheet	Normal	High	Normal	Notified Farmer and reduction of CO_2.
4	When the Illumination value is less than Crop data Sheet	Less	Normal	Normal	Farm Field is at Normal Condition.
5	When the Temperature value is greater than Crop data Sheet	Normal	Normal	High	Notified Farmer and reduction of temperature.

Table 1. Results Obtained

V. CONCLUSION

The need to monitor the farm fields via exploring devices and its connectivity through sensors in IoT environment is at high priority. In order to provide the security in preventing farm fields, crops from attacks, integration of sensor data with crop datasheet can produced the desired notification to the farmer as expected. Extraction of useful information and accurately notify about the status of farm field to a remote located farmer is proposed in this paper. Based on the experiment conducted, a suggested perceptive model for monitoring agriculture fields is proposed.

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