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A SURVEY ON DECISION SUPPORT SYSTEM FOR MANAGEMENT OF PARAMETERS IN PRECISION AGRICULTURE USING MACHINE LEARNING

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Abstract:

Agriculture plays a vital role in the economic growth of any country. With the increase of population, frequent changes in climatic conditions and limited resources, it becomes a challenging task to fulfil the food requirement of the present population. Precision agriculture also known as smart farming have emerged as an innovative tool to address current challenges in agricultural sustainability. The mechanism that drives this cutting edge technology is machine learning (ML). It gives the machine ability to learn without being explicitly programmed. In this paper, we presents a systematic review of ML applications in the field of agriculture for decision support system related to parameters management.
Keywords: Decision Support System (DSS), Precision Agriculture, Machine Learning, Agriculture

I. INTRODUCTION

Nowadays, the evolution of information technology applications makes it an absolute obligation on behalf of the decision makers to continuously make the best decisions in the shortest possible time. Decision Support System (DSS) is a technology and application that assists managerial decision makers utilizing data and models to solve semi-structured and unstructured problems. Recently, the collaboration between DSS technologies and Artificial Intelligent techniques has produced another type of DSS technology known as Active DSS, it is a technology that will take place in the new millennium era. Active DSS is an outcome of new DSS technologies and also known as a part of Intelligent System applications. Active DSS applications such as Expert System, Knowledge-based System, Adaptive DSS and Intelligent Decision Support System (IDSS) are categorized as part of Intelligent System studies. Expert systems technology, which was a crucial area for enterprise capital in 1985-1990, is now being replaced by the intelligent system applications. Intelligent systems are developed to fulfill the two main functions. Firstly, to screening, shifting and filtering the increasing overflow of data, information and knowledge. Secondly, as a supporter of an effective and productive decision making that is suitable to the user needs. Intelligent systems can be developed for these purposes; range from self-organizing maps to smart add-on modules to make the use of applications more effective and useful for the users. [1] [2]

However, human decisions are subject to the limitation because sometimes people forget the crucial details of the problem, and besides, fairness and consistency are very important in any types of decisions. Computer applications as decision support tool can be used to provide fair and consistent decisions, and at the same time it can improve the effectiveness of decision making process. In general, the traditional functions of DSS is used to support managerial decision makers in semi-structured and unstructured decision situations, a part from being assistant to the decision makers to extend their capabilities but not to replace their judgment. In the enhancement to DSS traditional approach, advance intelligent techniques are available in designing an intelligent system application. DSS applications which are embedded with intelligent components can improve the traditional DSS such as for reasoning and learning capabilities, and also known as IDSS. In order to improve human resource decisions, the high-quality HRM applications are required to produce precise and reliable decisions. Due to these reasons, this study presents an idea to apply IDSS approach in human resources decision making activities by using some of the potential intelligent techniques. [4] [7]

II. LITERATURE REVIEW

Most of researchers have performed their work in the field of agriculture related to monitoring parameters, its decision support system and intelligence by using machine learning algorithm, is discussed below.

Xiaoping Chena et.al. [3] evaluated, over a three–year period, the effect of a new irrigation scheduling method on seed cotton yield, water productivity, and economic profitability under an arid desert climate. The benefit of the DSS was that, compared to SMS, seed cotton yield, water productivity, and economic profitability were simultaneously enhanced. In addition, the DSS showed higher net water productivity compared to the SMS. Maximum crop yield, plant height, and aboveground biomass of cotton were obtained for the DSS–FI treatment, which may be attributable to better soil water status under the timely and more frequent irrigation events. As the DSS–DI treatment can maintain crop yield with low irrigation level, for sustainable development in an irrigated agricultural region, it may be the best choice for local development owing to its greater water productivity.

Alberto Garinei et.al. [4] presented an approach for modeling soil moisture using machine earning techniques. SM is expressed in terms of Soil Water Index retrieved from satellite measurements. These products are released on the Copernicus website with a time delay of two days after observation. To be cautious it has been assumed that the last available SWI value dates back to four days earlier. Thus, the variation of SWI in a four days period has been modeled through two different network based models: a single hidden layer feedforward Artificial Neural Network (ANN) and a neuro-fuzzy network (ANFIS). Meteorological data, comprising rainfall, temperature, relative humidity and wind speed records, have been used as inputs in both models along with the last known SWI value.

Mohan Sridharan et.al. [5] described and experimentally compare the accuracy of OLS and statistical machine learning models for estimating crop water use (or evapotranspiration). We show that models based on machine learning algorithms provide significant improvement in accuracy in comparison with a state of the art energy balance model based on OLS. We use this example to highlight the potential benefits of the use of statistical machine learning algorithms in precision agriculture.

Ms. Priyanka S Jawale et.al. [6] presented a structure of a decision support system for more efficient and effective management of water supplies, and more timely delivery of irrigation water to agricultural users. The DSS may be linked with the SCADA (Supervisory Control and Data Acquisition) system for real-time monitoring of flow details and water level information and operation of canal gates to manage water deliveries. The use of decision support systems linked with SCADA and automated structures presents a very effective method for irrigation water distribution, which may ultimately result into conservation of precious water.

Yonghui Wang et.al. [7] focused on a United State Department of Agriculture sponsored project for smart irrigation. Field sensors collect temperature, humidity information, and transmit them through wireless sensor network. Mobile devices, such as iPhone and iPad applications are developed for farmers to help them make decisions. Furthermore, a data cloud expands the system by providing data storage space. The data cloud is enabled by a National Science Foundation sponsored IBM high performance cluster which has mass storage capability. The design of a smart irrigation system was a success. The system can observed data, such as temperature and humidity, from a computer and from mobile devices. The system can assist farmers to make irrigation decision and it is able to email or text the user.

Ali Fares et.al. [8] presented a distributed IoT system which can better inform and engage farmers with the automated irrigation process in agriculture fields. The developed system would create a better opportunity for farmers to irrigate more efficiently, remotely, as well as reducing the field's overwatering based on actual soil watering needs.We developed three different types of applications as part of the IoT system executing on sensing IoT devices, Azure cloud platform, as well as on users' mobile devices. These applications give the ability to users to set various irrigation parameters such as the thresholds for the moisture, temperature and humidity sensors, which makes the system widely useable for a different type of crops and soils considering they have their suitable soilmoisture threshold values.We also carried out several sets of experiments for evaluating the performance and scalability of our system, paying particular attention to establishing the relationship between the number of IoT end-devices connect to the IoT hub and the response time of the system. The results showed that the response time depends on various granularity characteristics of the systems, most notably the number of messages exchanged between the IoT end-devices and the IoT Event Hub. Also, the experimental evaluation showed that the system is highly responsive and scalable despite the number of messages exchanged as well as the number of contributing IoT end-devices.

Akhilesh Patel et.al. [9] developed DSS for on-farm irrigation water management to make the irrigation scheduling for border, sprinkler and drip irrigation systems for wheat, maize, potato and chilli crops. Overall, this research will be very helpful to the farmer to take the decision on when to irrigate and how much to irrigate for sustainable on-farm irrigation water management. Moreover, there is need to adopt the management strategies to minimize losses of irrigation water and crop yield at farm level.

Jérôme Treboux et.al. [10] presented the impact of machine learning in precision agriculture. State-of-the-art image recognition is applied to a dataset composed of high precision aerial pictures of vineyards. The study presents a comparison of an innovative machine learning methodology compared to a baseline used classically on vineyard and agricultural objects. The baseline uses color analysis and can discriminate interesting objects with an accuracy of (89:6%). The machine learning, an innovative approach for this type of use case, demonstrates that the results can be improved to obtain 94:27% of accuracy. Machine Learning used to enrich and improve the detection of precise agricultural objects is also discussed in this study and opens new perspectives for the future of high precision agriculture.

Haimid Vimit et.al. [11] aimed at the actuality that soil salinization deteriorates in oasis and irrigation scheme management is unreasonable from the point of view that develop irrigation decision support system(DSS) about irrigation area management, and studies the optimal distributing of irrigation water in the irrigation area which take the Yutian oasis demonstration area as an example. The irrigation DSS is developed based on irrigation scheme management scenario which solves the muti-object models and geographic information system (GIS) which support spatial management. The irrigation DSS includes information systems that perform data acquisition, management and visualization, and models that performs simulation and optimization of the irrigation scheme. Multiple, competitive targets and constraints with different priorities can be set. The studying of irrigation DSS in irrigation area will provide scientific decision basis and design scheme for reasonably ascertaining the type of irrigation area and scientific management and optimal allotting of agriculture water resources in the arid area.

Alan Bauer et.al. [12] reported AirSurf, an automated and open-source analytic platform that combines modern computer vision, up-to-date machine learning, and modular software engineering in order to measure yield-related phenotypes from ultra-large aerial imagery. To quantify millions of in-field lettuces acquired by fixed-wing light aircrafts equipped with normalised difference vegetation index (NDVI) sensors, we customised AirSurf by combining computer vision algorithms and a deep-learning classifier trained with over 100,000 labelled lettuce signals. The tailored platform, AirSurf-Lettuce, is capable of scoring and categorizing iceberg lettuces with high accuracy (>98%). Furthermore, novel analysis functions have been developed to map lettuce size distribution across the field, based on which associated global positioning system (GPS) tagged harvest regions have been identified to enable growers and farmers to conduct precision agricultural practices in order to improve the actual yield as well as crop marketability before the harvest.

Alexander Kocian et.al. [13] has goal is to maximize yield by minimizing water consumption, usage of fertilizers, and amount of arable land in an automatic fashion. Although there has been an evolution of research in this area, more knowledge is needed to close the gap between current practice and optimum precision farming. Precision farming for current arable land is a promising approach to meet the vast global demand for agricultural products on current land. Internet-of-Things provides vast real-time information on crop related parameters, soil, and weather that feeds machine learning algorithms for better crop productivity while protecting the environment.

Rachana P. Koli et.al. [14] pesented android application which will be useful for farmers & agricultural institutes for cultivation of various kind of crops in various type of atmosphere. Android mobile use in Agriculture is as the core component to more helpful to increase productivity of crops and indirectly to increase GDP of India & reduce poverty. Achieving maximum crop yield at minimum cost is one of the goals of agricultural production. Process of taking a decision is so complex as there are several factors affecting entire farming process. This

smart phone app is easy to use and in affordable cost which will suggest most probable matching crops to people according to basic inputs like water availability in mm, average temperature, average soil Ph of farm, locality of farm, soil Type, Crop Duration etc so by certain calculation at backend this app will show most probable crops List for that farm. It is one farmer's friend kind of app. By this farmers can cultivate more suited crop and increase production ratio.

Benya Suntaranont et.al. [15] proposed a decision support system for weir sluice gate level adjusting. The proposed system, named AWARD (Appropriate Weir Adjustment with Water Requirement Deliberation), is composed of three modules, which are (1) water level prediction, (2) sluice gates setting period estimation, and (3) sluice gates level adjusting calculation. The AWARD system applies an artificial neural network technique for water level prediction, a fuzzy logic control algorithm for sluice gate setting period estimation, and hydraulics equations for sluice gate level adjusting. The water requirements and supplies are deducted from the field-survey and telemetry stations in Chiang Rai Province, Thailand. The results show that the proposed system can accurately estimate the water volume. Water level prediction shows high accuracy. The standard error of prediction (SEP) is 2.58 cm and the mean absolute percentage error (MAPE) is 7.38%. The sluice gate setting period is practically adjusted. The sluice gate level is adjusted according to the water requirement.

Most of researchers developed precision agriculture for various scenarios in decision support system. Techniques are still under development and so it is important to take specialist advice before making expensive decisions. Initial capital costs while implementing DSS may be high and so it should be seen as a long-term investment. It may discourage farmers to not adopt this method of farming. Also, it may take several years before you have sufficient data to fully implement the system. Precision agriculture techniques are still under development and requires expert advice before actual implementation. It may take several years before the actual collection of sufficient data to fully implement the system. It is an extremely difficult task particularly the collection and analysis of data.

CONCLUSIONS

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