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OPERA software

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PREFACE

International Seminar on Information Technology (ISIT 2009) is a scientific meeting in the information technology (IT) is the International level, where inside there are the researchers and practitioners who can show the results of their latest research as well as discuss current issues in IT. This seminar is also a gathering place of ideas of thinkers who might be thinking that is pure and applied. Some researchers who will show results of their research from leading universities in Indonesia and neighboring countries Japan and Sweden.

Collection of papers packed in the form of proceeding, and grouped according to the study area include Soft Computing, Software Engineering, Data Mining and Data Warehouse, Governance IT and IT Management, Data Communications and Computer Networking, Computer Based Learning and Control System.

The paper received from all over Indonesia and neighboring countries Japan and Sweden. The paper published in 2009 this gum has through the stages of evaluation by the reviewers, reviewers who are competent in their fields. Committee congratulate and thank you for participation and papers in the Proceedings contain gum is 2009. The committee also like to thank all stakeholders who have supported and active in participation success of this international seminar.

Suggestions and criticisms in order to perfection isit Proceeding 2009 is expected. Proceeding Hopefully this can be used as a reference in the development and improvement of learning technologies in the field of Information Technology and its applications.

Jakarta, November 25th, 2009
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CONTENTS

PRECISION IRRIGATION WITH SENSOR-GRID FOR DECISION SUPPORT SYSTEM

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ABSTRACT

Precision irrigation is the new generation irrigation systems that have tremendous potential to improve water control. This paper presents decision support system for precision irrigation in which sensor-grid technology is used to assist irrigation management decisions. Besides, this paper also explains the definition of precision irrigation and its benefits in irrigation management system. The agriculture is depended on quantity and quality of water. The main problem of water quantity is how to consider the water resources like dam or river, irrigation infrastructure and rain condition. The methodology to establish large-scale remote intelligent irrigation system based on sensor-grid by using wireless sensor network and considering grid climate stations.

Keywords

Precision Irrigation, Sensor-grid, Wireless Sensor, Network, Oracle and MIMOs.

1. INTRODUCTION

Nowadays, the fulfillment of human needs particularly in agriculture and the pollution of water resources as a result of various human activities are increasing according to the human population in the world. It makes many problems, such as, the limitation on space land for agriculture and land resources, the quality of soil and water, the dynamic and varied of environment's condition. All of these problems are required to be solved so that the optimization of the crop productivity on farm land and the efficiency of agricultural water-use can be improved.

Precision irrigation is now used as an appropriate solution. Precision irrigation, a new method in water management system, is used to improve the efficiency of irrigation management and water management decision support system. It presents the most innovative results appearing from re-search in field of precision irrigation. It provides a better management decision making to the producers or farmers. So farmers not only can maximize their crops productivity but also can save water [4]. This paper defines precision irrigation as a major concern in order to apply water in the right place with the right amount at the right time [8] by using of new technology, such as sensor-grid.

Sensor-grid is a new technology that combines sensor networks and grid computing to provide real-time sensor data collection and database of the resources for sensor data processing and management. In sensor grid, various sensor networks are treated as resources to provide important information in precision irrigation with the sensor nodes. All of these resources will be integrated by using grid computing. It is a platform which enables to collect information in network for optimal efficiency in precision management techniques. This powerful combination between sensor network and grid computing aims at making possible to formulate a complete decision support system for precision irrigation.

In this paper, we want to describe sensor-grid as a solution to solve irrigation problems which are very important to ensure the optimal amount of water to different portions of a field [9], determine the water depth of dam or river that used to irrigate the farm land, and provide near-real time in- formation for prediction of rain with networks of automated agricultural meteorological stations. This new and improved technology is necessary to develop an innovative irrigation techniques and management system.

Collaboration between Oracle and MIMOs

Oracle and MIMOs collaborate on a research project to build sensor-grid technology that aims to help farmers to manage their agricultural land. The results of this project which are conducted under the auspices of Knowledge Grid, considered to become very good in helping to gather, process, and visualize large amounts of sensor data in the area of agriculture. The farmers will be able to apply the solution to the better management of irrigation management. This means farmers will be able to plan and improve the operational processes of irrigation control and management technologies.

MIMOs integrate Oracle technology and precision sensors. MIMOs using Oracle's knowledge database 11g as the beginning of the project. MIMOS is also using Oracle Fusion Middleware. The advantages of the Oracle Database 11g -Grid Computing are:

- The flexibility to meet changing business needs
- A high quality of service at low cost
- Faster computing for better information
- Investment protection
- A shared infrastructure environment

Meanwhile, the advantages of Oracle Fusion Middleware are:

- Lower deployment and deployment costs
- Lower management and maintenance costs
- Highly scalable and high performance

2. RELATED WORKS

The sensor-grid for agricultural decision support has combined data from various different databases such as weather data, dam or river data, crop data, and field data simultaneously with various application programs in order to lead an end-use to a decision [7]. So, the use of modern network-computing technologies is very important to integrate several databases and applications based on agricultural information system. This new technologies provides improved access to programs and effective utilization of available databases to support the decision for the users. So that, the distributed decision support system for agriculture can be realized.

The sensor-grid technology supports the irrigation techniques to maintain crop production through more efficient use of rain and irrigation [6]. Irrigation technique means applying water in the right place with the right amount. The use of precision agriculture for irrigation water management is potentially possible to vary water applications to meet the specific needs of crop in each unique zone within a field to optimize crop productivity. This new technique is requiring an integrated irrigation control and monitoring system to support decision support systems and monitoring and feed back to irrigation control in real time.

For precision real-time irrigation control, controllers and sensors are installed at each plot or at least at every group of sprinklers in the field [3]. Each controller performs an individual irrigation schedule which is set and reprogrammed on a regular basis. Because many controllers and sensors are involved, the high cost for investment, installing wiring, maintenance, data-handling and use is becoming a large bottleneck, which forces growers to look for new improved and cost-effective monitoring and control systems. This new improvement of control and management system called wireless sensor network (WSN). The use of wireless sensor networks (WSN) saves a lot of installation, more efficiently, and cost-effective manage irrigation.

3. METHODOLOGY

Decision support system for precision irrigation scheduling is required to improve the efficiency of irrigation management. Wireless sensor network have a potential for represent a better decision support system that allows to maximize crop productivity and irrigation control.

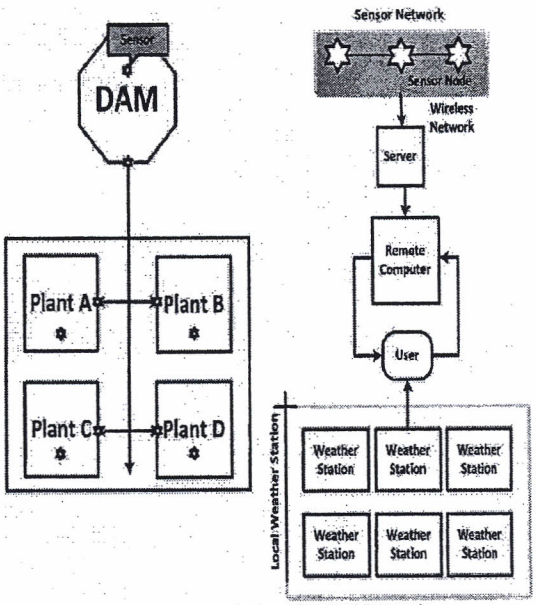

Figure 1: Wireless Sensor Network

Demand of Water	Supply of Water
D = f (soil, plan)	S = f(source, infrastructure, rain)

Figure 2: Illustration Figure 1

Wireless sensor network is integrated system that consists of a group of sensor nodes that distributed and connected with wireless on a network topology and a function to share information according to application. In general, sensor network use wireless communication as a medium for transmitting data.

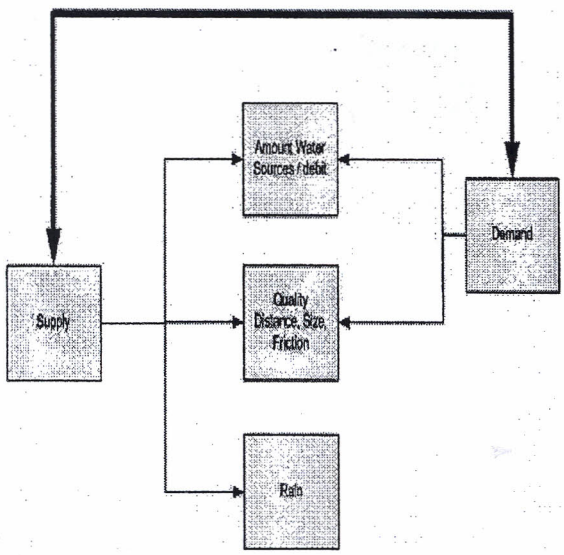

Figure 3: Supply And Demand of Water

Wireless sensor network consists of two components, there are source and sink. Source is component a network that can produce information, usually a sensor or actuator that produces feedback for all operation. Sink is unit that collects information for source, so that processing information can be performed. There are three forms of sink. First, sink can be a source that has a form of sensor/actuator from the network, or another network. Second, Sink can be a computer/laptop and PDA that use to interact with sensor network. The last can be a gateway to the wider network such as internet, so that interaction can be done through a very far distance and not directly connected with the sensor network.

Source/sensor is unit of some device consists of a CPU (for processing data), memory (to store data), battery (as a source of energy) and transceiver (for sending and receiving radio signals from / to another node). Few sources that include in a wireless network through wireless is wireless sensor networks that play a role in detecting incidents (events), or phenomena, collect, process data, and send the results to users who need.

The characteristics of wireless sensor network are:

- Self-organizing ability
- Broadcast capability in short distance multi-hop routing
- Easy in setting of sensor nodes
- Change topology refers to the failure node
- Restrictions on the energy, transmits power, memory and computing capability

A sensor node is a node in a wireless sensor network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network. The typical architecture of the sensor node is shown in figure

Most sensor nodes have a very simple architecture, and lack features, such as memory management units (MMU) and privileged-mode execution, used in desktop/server class systems to isolate or protect the data and code of one program from another. The micro-controllers used in sensor nodes typically have separate memories.

However, sensor software is quite complex. This complexity arises mainly from the need to support diverse sensors, multiple distributed middleware services, dynamic code updates, and concurrent applications. Implementing the software components presents a tough challenge. Programmers have to deal with minimized resource constraints and con-currency issues. Furthermore, there is very limited debugging support on the sensor node hardware. Therefore, programming errors are quite common. The impact of these errors can be minimized.

Virtual machines for sensor nodes, such as ASVM [5], ensure that programming errors in high-level scripts cause no harm. However, individual script instructions are executed as native code which could be buggy.

Component of sensor node:

- Microcontroller
- Transceiver
- External Memory
- Power Sources
- Sensor

Irrigation System in Indonesia

The method of using water in irrigation system for crop productivity can be classified into:

- Surface Irrigation
- Sprinkler
- Sub-surface irrigation
- Drip or trickle irrigation

All of these choices of irrigation method are depend on the water availability, climate, farm land, the topography, the habit, and the type and value of economic plants. In Indonesia, the most of irrigation system can be included into surface irrigation. This method of irrigation that based on the difference in soil moisture status and the need of water for plants can be divided into two, namely: (a) the irrigation for

paddy field, and (b) the irrigation for non-paddy field (upland crops).

The improvement of irrigation management or precision irrigation is very important to maximize the development of rice cultivation technology. The crucial aspect in water management is knowledge of the optimum water conditions for paddy field. The necessity of water during the process of land cultivation generally determines the amount of water that have to be available in an irrigation area. Thus, in the first tread, it is purposed for soil saturation and maintaining amount water in field, whereas at the end of the cultivation period, the maintenance of water in field becomes a dominant factor (topping up the requirement). The necessity of water for plant growth of rice is begun from the beginning until harvest which depends on many factors, such as: (a) the initial phase of soil moisture, (b) the type of soil and soil fertility, (c) the period of plant growth, (d) the method of culture-techniques, (e) topography, (f) plant varieties, and others.

There are two kinds of method of water supply for paddy field, like: (1) continuous submergence, and (2) intermittent irrigation. The benefits of continuous submergence, such as: it does not need specific control, the cost of weeds control can be reduced, and the control of irrigation system is easy. In the other hand, the benefits of intermittent irrigation are to create aeration land, thus preventing the establishment of poisons in the soil, and save the water. The continuous submergence method is easier to be controlled than the intermittent irrigation method.

The effective rainfall is part of total rainfall which directly fulfills the necessity of water for plants. The effective rainfall for paddy field is a complex issue and it depend on: (a) the characteristic of rainfall, whether the rainfall occurred in regular intervals of time or very diverse, (b) a high diversity of water in field, and (c) the method of water supply, whether continuous or intermittent irrigation.

In the irrigation areas with surging up to sloping topography, the water supply for irrigation to the field generally is started from the highest paddy field on the map. Then, after the field gets enough of water, the water will go to the bottom field. All of the fields that have already had the water for irrigation from one inlet will establish a path (inlet group). This irrigation system is called plot to plot irrigation. In the situation of limited amount water sources or debit, the highest paddy field on the map still can get enough of water, while the bottom field cannot get water for its irrigation. So, if the amount of water is calculated with the effective rainfall (e.g. 30% of plant needs), the 30% of the bottom field on the map does not get any amount of water for its irrigation until the rain actually take place.

The Efficiency of Irrigation in Indonesia

The efficiency of irrigation in irrigation infrastructure quantitatively is a difficult parameter to measure. However, it is very important and generally assumed to increase 40 to 100% of the water irrigation needs in dam. The lost of water irrigation in paddy field is related with: (a) the lost of water in irrigation infrastructure through evaporation, the use of water without any permission and others, (b) the lost of water in operating irrigation system including over-used water irrigation. This irrigation issues can be solved by a new method called precision irrigation.

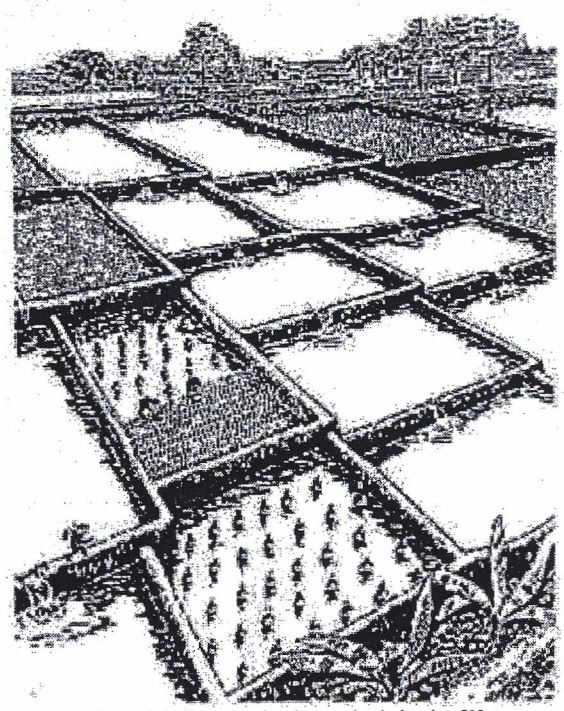

Figure 4: Inlet group in plot to plot irrigation [2]

Precision irrigation combines different factors including the crop water requirements, the water supply, the field size and shape, the topography, and the climate of the area. A technology is required to achieve this precision irrigation. This new technology is known as sensor-grid. It has given a tremendous potential to improve irrigation control. The use of sensor-grid technology is implemented through wire-less sensor network (WSN). The WSN is placed at the rain station, the irrigation infrastructure, and the dam.

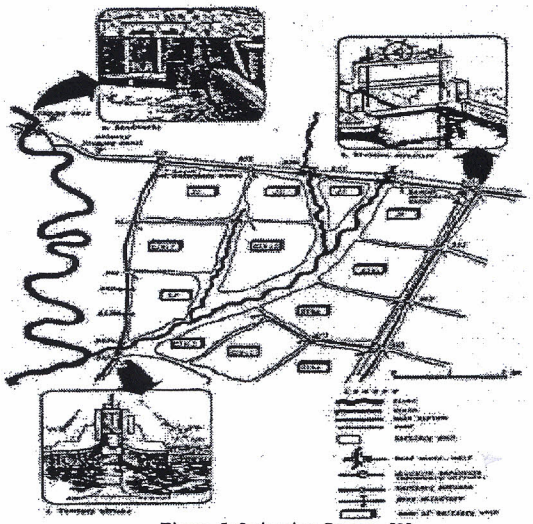

Figure 5: Irrigation System [2]

An irrigation rain sensor is simply a switching mechanism activated by rainfall. The device is connected directly or indirectly to a controller which operates an automatic sprinkler system. There are several rain sensor devices on the market but they all share the same purpose and that is to mitigate water usage by preventing an automatic irrigation system to run while it is raining. Most rain sensors will also keep the system shut o® for a duration after the rain has stopped. In most cases the system will not shutdown until enough rain water is absorbed by the rain sensor or until the moisture is significant enough to trigger the switch to shut down the system. There are some different types of rain sensor, namely: (1) Mini-Clik, (2) Rain-Clik, and (3) Irritrol Rain Sensor Series. The irritrol rain sensor series is a kind of rain sensor that needs three models of rain sensor devices: wireless Rain Sensor (RS100), non wireless Rain Sensor (RS5000), and the wireless rain/freeze model (RSF1000). The wireless model provides constant communication between the transmitter and receiver connected to the sprinkler system controller. This wireless rain sensor conserves water by suspending irrigation during rain-fall. Besides, the wireless rain/freeze sensors also reduce the damage to plants and danger to walkways caused by ice buildup by interrupting irrigation when the air temperature drops below a predetermined set point.

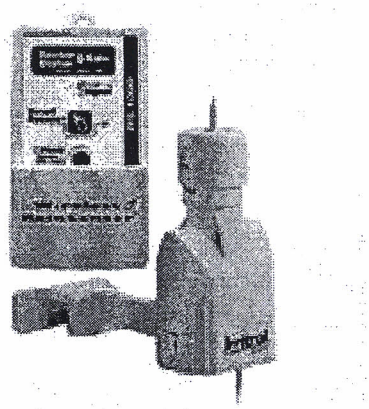

Figure 6: Irritrol Rain Sensor Series [1]

The wireless sensor in irrigation infrastructure is intended to control the amount of water in the fields. To ensure that the optimal amount of water per plot is allocated according to the real-time crop status, each plot has an individual irrigation controller node, and local or remote sensors are added to it as needed by the application, either via hard wire or a wireless link [6]. It can open and close multiple valves, to make it possible to choose between one or more water sources of distinct water quality (a well, a reservoir, reuse of water, irrigation network etc.). Once programmed by the DSS Irrigation Scheduler, the controller keeps on running its irrigation or fertigation tasks autonomously, until it is re-programmed or stopped by the local computer. It makes the irrigation of individual plots fail safe, in the sense that it does not rely on real-time communication with a remote computer. To be practically of use, the irrigation controllers must be rugged and affordable, have low maintenance cost, easy installation and reprogramming, no wiring in the field, use little energy, and can accommodate a wide range of sensors.

All of these wireless sensors will be integrated with grid technology. In grid technology those sensors are treated as resources to provide important information in precision irrigation. This method will provide an effective irrigation control and monitoring in real time. So, the distributed decision support system for agriculture can be realized.

4. CONCLUSIONS

A precision irrigation is a major concern in many crop systems. It is a new technology in irrigation management system that can spatially and temporally direct the amount and frequency of water applications. It means that a precision irrigation system have the ability to apply the right amount of water directly where it is required. To improving its performance, a precision irrigation needs sensor-grid technology to support decision support system and improve crop

productivity. The sensor-grid technology presents precision real-time irrigation control. The use of wireless sensor network is to collect various data in environment with its sensor nodes. It eliminates difficulties to wire sensor stations across the field and reduces maintenance cost. Since the installation of WST is easier than existing wired solutions, sensors can be more densely deployed to provide local detailed data. Instead than irrigating an entire field in response to broad sensor data, each section could be activated based on local sensors.

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