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Smart Irrigation System Using Wireless Sensor Network and GPRS Module

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Abstract-An automatic irrigation system is developing to optimize water use for agricultural crops. The system consist of distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. Also, a gateway unit handles sensor information, enables actuators, and transmits data to a web application. An algorithm is developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water supply. The system was powered by photovoltaic panels and had a duplex communication link based on a cellular-Internet interface that allowed for data inspection and irrigation scheduling to be programmed through a web page. The automatic irrigation system saves water as compared with traditional irrigation. Because of its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated areas.

Keywords- Automation, Irrigation, Wireless Sensor networks (WSNs), Internet, cellular networks, water resources.

I. INTRODUCTION

Agriculture uses majority of available freshwater resources worldwide, and this will continue to be dominant in water consumption because of population growth and increased food demand. There is need to find approach based on science and technology for continuous use of water supply, including technical, , managerial, agronomic and institutional improvements. Automatic irrigation scheduling consistently has shown to be valuable in various crops and use water efficiency with respect to manual irrigation based on direct soil water measurements. An alternate parameter to determine yield irrigation needs is estimating plant evapotranspiration (ET) which is affected by weather parameters, including solar radiation from sun, relative humidity in soil, temperature, wind speed, and crop factors, such as stage of growth, variety and management elements, plant density, soil contents, pest, and disease control, that allow water savings of up to 42% on time-based irrigation schedule.

A system developed in large areas of land allowed for the optimizing of irrigation through decision support software and its integration with wireless sensor network (WSN). Using the wireless network information and the irrigation machine positions via a GPS, the software controlled the sprinkler irrigation with application of the appropriate amount of water. A data acquisition system is used for monitoring crop conditions by means of soil moisture and air, soil, and ambient canopy temperature measurement in cropped fields. Data is downloads using a handheld computer connected via a serial port for analysis and storage. Water flux leached below the root zone of crops under an irrigated cropping system was measured.

II. LITERATURE SURVEY

There are many systems available to attain water savings in various crops, from basic ones to more technologically advanced ones e.g. irrigation scheduled by canopy temperature which is based on thermal imaging, crop water stress index (CWSI). This was first defined before 30 years ago. Irrigation systems can also be automated through information on volumetric water content of soil, using dielectric moisture sensors to control actuators and save water, instead of a irrigation schedule at a specific time of the day and with a particular duration.

Recent advances in microelectronics and wireless technologies created low-cost and low-power components, which are essential issues specially for such systems such as WSN. Power management has been addressed in both hardware and software with new electronic designs and operation techniques. The selection of a processor becomes important in power design. There are algorithms to maximize the network coverage ratio with a predefined balance the energy consumption in the whole WSN, to reduce both the transmission and the computational loads at the node level, and to estimate online the optimal sampling frequencies for sensors. In a wireless node, the radio modem is the major power consuming component; currently, wireless standards have been established with medium access control protocols to provide multitask support, energy efficiency performance and data delivery. Because of its energy autonomy and less cost, the system has use for organic crops, which are mainly located in geographically isolated areas where the energy grid is far away.

III. SYSTEM FUNCTIONALITY

A. Block Diagram

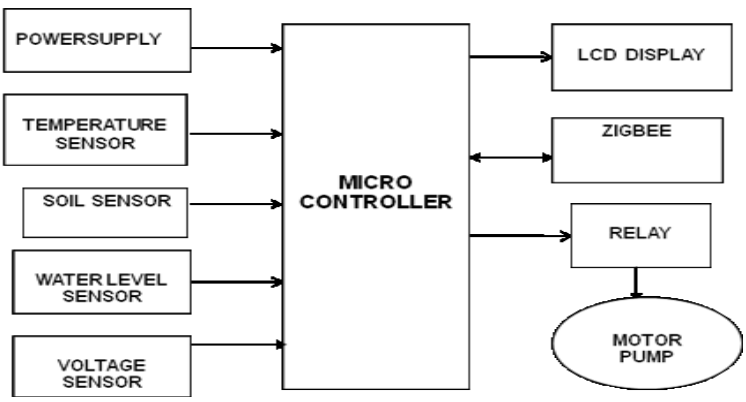

Figure 1.Block diagram of system

In this, the development of the automated irrigation system based on microcontrollers and wireless communication at experimental scale within rural areas is presented. The aim of the implementation is to demonstrate that the automatic irrigation can be used to reduce water use.

A microcontroller for data acquisition, and transceiver; the sensor measurements are transmitted to a microcontroller based receiver. This gateway permits the automatic enables the irrigation when the threshold level value of soil moisture and temperature is obtained. Communication between the wireless sensor nodes and the data receiver is through the Zigbee. This receiver unit also has a two way communication link based on a cellular Internet interface, using General Packet Radio Service (GPRS) protocol, which is a packet oriented mobile service cellular global system for mobile communications (GSM).The Internet connection allows the data inspection in real time on a website, where the moisture of soil and temperature levels are graphically displayed through an application interface and get stored in a database server. This mobile access also enables direct programming of scheduled irrigation schemes and trigger values in the receiver according the crop growth and season management. Because of its energy autonomy as well as cost effectiveness, the system has potential use for various organic crops, which are mainly placed in geographically isolated areas where the energy grid is far away.

IV. SYSTEM OVERVIEW

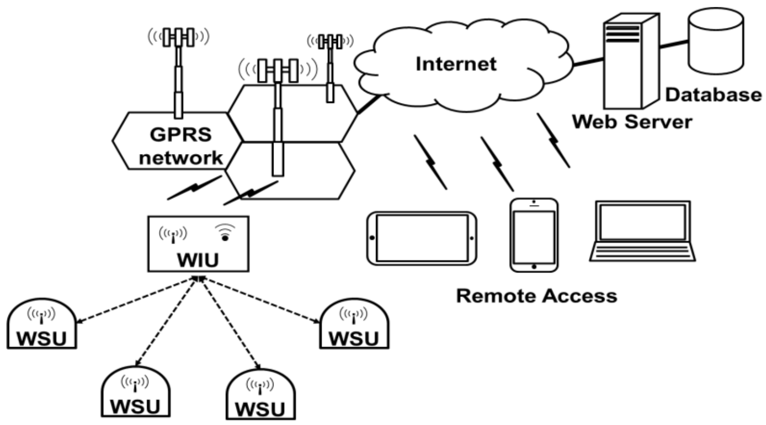

Figure 2. Configuration of the automated irrigation system. WSUs and a WIU, based on microcontroller, ZigBee, and GPRS technologies.

The automatic irrigation system hereby reported, consists of two components as shown in Fig.2, wireless sensor units (WSUs) and a wireless information unit (WIU), linked by radio transceivers that allowed the transfer of soil moisture and temperature data, implementing a WSN that consists of ZigBee technology. The WIU contains a GPRS module to transmit the data to a web server via the public mobile network. The data can be remotely monitored online through a graphical application through Internet access devices.

A. Wireless Sensor Unit

A WSU is consists of a microcontroller, various sensors, RF transceiver and power sources. Several WSUs can be placed in-field to configure a distributed sensor network for the automated irrigation system. Every wireless sensor unit is based on the microcontroller that controls the radio modem XBee Pro S1 and processes information from the soil-moisture sensor, and the temperature sensor. These components are powered by rechargeable batteries. These components are selected to minimize the power consumption for the proposed application.

A 16-bit microcontroller with 44-pins and nanoWatt technology that operates in range from 2.0 - 3.6 V. The microcontroller is most suited for the remote application, because of it has low-power operating current. The microcontroller is programmed in Keil Software with the appropriate algorithm for monitoring the soil-moisture probe through an analog-to-digital port and the soil-temperature probe through another digital port, implemented in single-Wire communication protocol. A battery voltage is monitor through a high-impedance voltage divider coupled to an analog-to-digital port. The data are packed with the appropriate identifier, date, and time to be transmitted via XBee modem using a RS-232 protocol through two digital ports configured as transmitter (TX) and receiver (RX), respectively. After sending data in packets, the microcontroller is set in sleep mode for a certain period according to the sensor sampling rate desirable, whereas the RTCC is running. This mode allows energy savings. As the WSU is launched for very first time, the algorithm also considered the WIU, the date and time for programming the RTCC, and regularly updates it for synchronization.

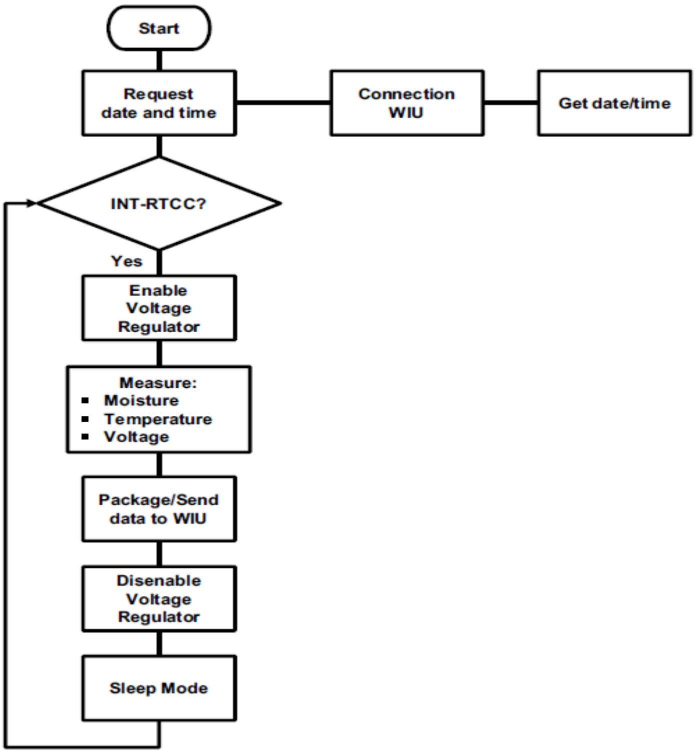

Figure 3. Algorithm for Wireless Sensor Unit (WSU) for monitoring for soil, moisture and temperature.

B. Wireless Information Unit

The soil moisture and temperature data from each WSU are received, identified, stored, and analyzed in the WIU. The WIU consists of a microcontroller, a GPRS module, an ZigBee radio modem, an RS-232 interface, electronic relays, Livewell pumps for driving the water of the tank.

Irrigation actions (IA) are implemented in the WIU algorithm in following four ways:

1) fixed duration for the manual irrigation with the push button;
2) decide date and time for irrigations through the web page for any desired time;
3) automated irrigation with a periodic duration, in case of at least one soil moisture sensor value of the WSN drops below the programmed threshold level;

4) automated irrigation with a periodic duration, in case of at least one soil temperature sensor value of the WSN exceeds the programmed threshold level.

C. Web Application

Graphical user interface software is developed for real time monitoring, controlling and programming of irrigation based on soil moisture value and temperature data. The software application allows the user to visualize graphically the data from every WSU online using any device with Internet. Besides the soil-moisture and temperature graphs, the web application also displays the water consumption. The web application enabled the user direct programming of scheduled irrigation and adjusting the trigger values in the WIU according to the crop species and season management. All the data is stored in a database.

V. CONCLUSION

The automated irrigation system found to be feasible and cost effective for obtaining water resources for agricultural production. This irrigation system allows cultivation instead of water scarcity thereby improving water sustainability. This system developed proves that the use of water can be diminished for a given amount of fresh biomass production. The use of solar power energy in this irrigation system is significantly important for organic crops and other agricultural products that are geographically isolated, where the investment in electric power would be expensive. The irrigation system can be adjusted to a variety of specific crop needs and requires minimum maintenance. The modular configuration of the automated irrigation system allows it to be scaled up for larger greenhouses or open fields and parks. In addition, some other applications such as temperature monitoring in compost production can be easily implemented. Besides the monetary savings in water use, the importance of the saving of this natural resource justify the use of this kind of irrigation systems.

The working of this project is basically depend on humidity, temperature and moisture sensors. Whenever there is need of excess water in the desired field (Rise crops) then it will not be possible by sensor technology. For this we will have to apply the DTMF technology. By using this we will able to irrigate the desired field and in desired amount.

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