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Self Regulating Irrigation System Using Mobile AD-HOC Network and Wireless Sensor Network

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ABSTRACT:
A self regulated irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a mobile communication. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity. The system was powered by photovoltaic panels and had a duplex communication link based on a Mobile Ad-Hoc Network that allowed for data inspection and irrigation scheduling to be programmed through a mobile. Its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated areas.

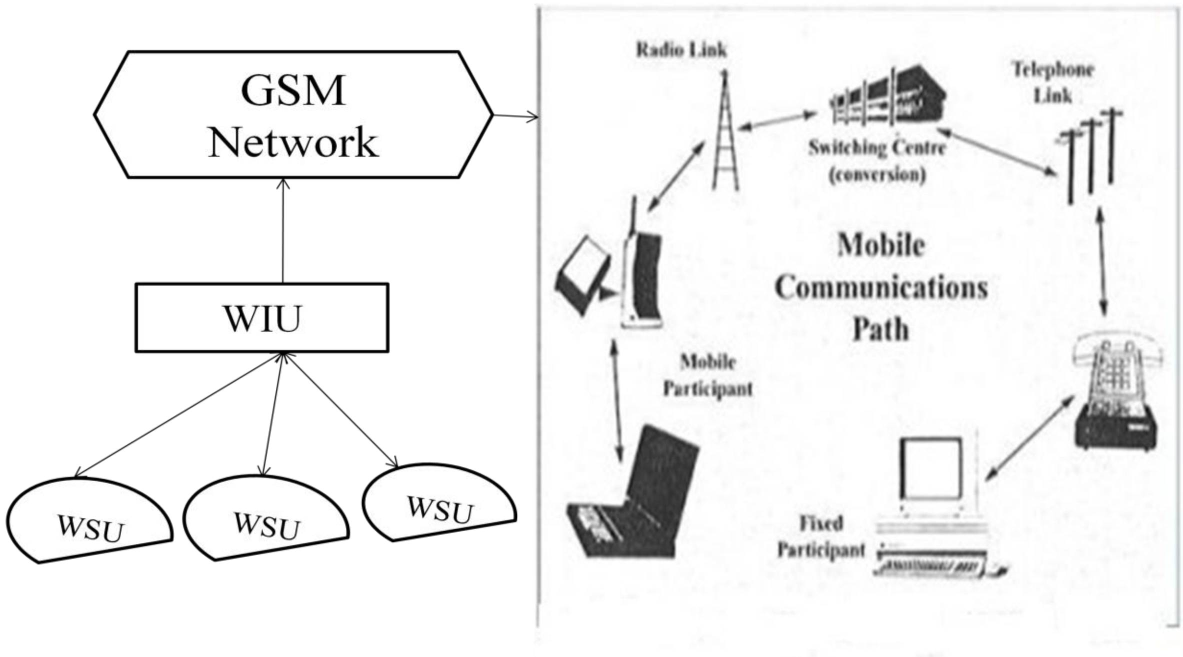
Keywords:- Mobile Ad-Hoc Network, soil-moisture, temperature sensors, irrigation schedule.

I.INTRODUCTION

AGRICULTURE uses 85% of available freshwater resources worldwide, and this percentage will continue to be dominant in water consumption because of population growth and increased food demand. There is an urgent need to create strategies based on science and technology for sustainable use of water, including technical, agronomic, managerial, and institutional improvements. 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 predetermined irrigation schedule at a particular time of the day and with a specific duration. The development of Wireless Sensor Networks based on microcontrollers and communication technologies can improve the current methods of monitoring to support the response appropriately in real time for a wide range of applications.

A self regulating irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a mobile communication. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity.

The system was powered by photovoltaic panels and had a duplex communication link based on a Mobile Ad-Hoc Network that allowed for data inspection and irrigation scheduling to be programmed through a mobile. Its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated areas.The irrigation system can be adjusted to a variety of specific crop needs and requires minimum maintenance. In addition, other applications such as temperature monitoring in compost production can be easily implemented. The duplex communication system provides a powerful decision making device concept for adaptation to several cultivation scenarios.



Block diagram of proposed system

II. WIRELESS SENSOR NETWORK

A Wireless Sensor Network (WSN) is composed of a large number of small sensor nodes having limited computation capacity, restricted memory space, limited power resource, and short-range radio communication device. It has a base-station or sink, which does the functions of calculation and decision-making, and can be compared with the functionalities of server or in some cases as a gateway in a computer network. The nodes communicate wirelessly and often self-organize after being deployed in an ad-hoc fashion. In this, we can have thousands of nodes, with each node performing some allocated function. Such systems can revolutionize the way we live and work. Within few years, we can expect them to cover a substantial part of the world with access to them via the Internet. This can be considered as the Internet becoming a physical network.

Since WSNs are generally deployed in an unattended, hostile and adverse environment, hence the chances of threats and attacks are very high. So the design of an efficient authentication scheme is of great importance to secure the data flowing in the WSNs Sensor networks are vulnerable to many attacks and to put it in a more generalized way, they are mainly susceptible to False Data Injection attacks and Denial-of- Service attacks. Most of the attacks aim to suck out the energy of the nodes by draining the battery of the node, thereby making the node to sleep indefinitely; disrupting the communication in the sensor network

III. MOBILE AD-HOC NETWORK

A mobile ad hoc network (**MANET**) is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. Ad hoc is Latin and means "for this purpose". A Mobile Ad hoc NET work (MANET) is a set of mobile nodes which communicate between themselves through wireless links. In contrast with conventional networks, a MANET does not need any previous infrastructure, since nodes rely on each other to operate themselves, forming what is called multi-hop communication.

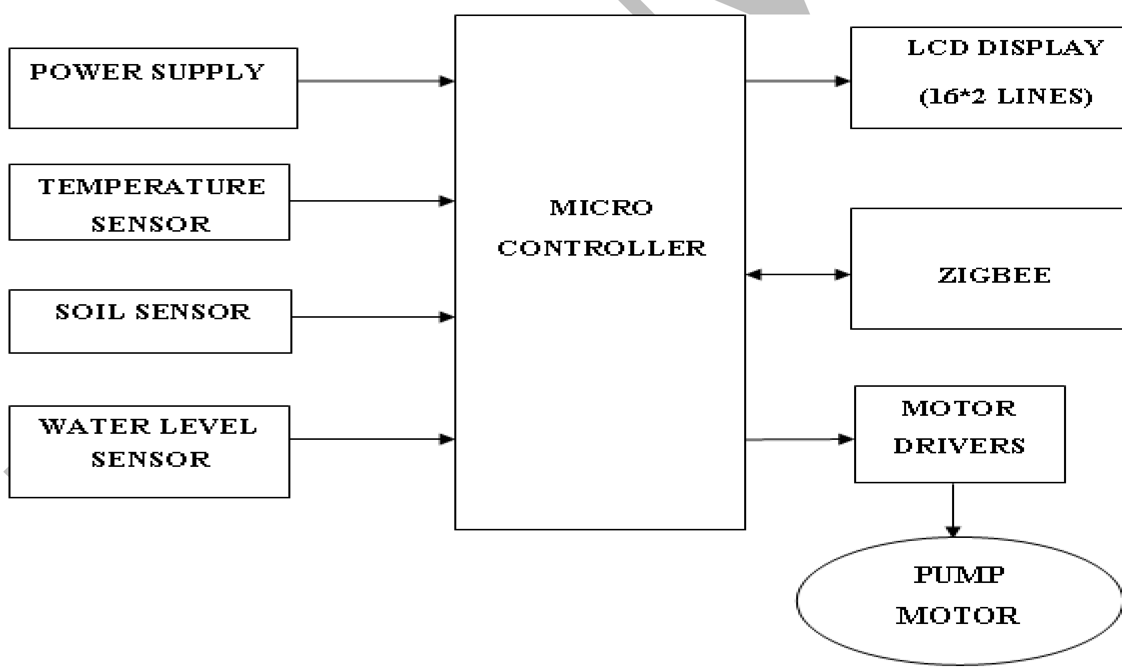
Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. They may contain one or multiple and different transceivers between nodes. This results in a highly dynamic, autonomous topology.

IV. GSM NETWORK

GSM (Global System for Mobile Communications) is a second-generation digital mobile telephone standard using a variation of Time Division Multiple Access (TDMA). It is the most widely used of the three digital wireless telephone technologies - CDMA (Code Division Multiple Access), GSM and TDMA. GSM digitizes and compresses voice data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900, 1800 or 1,900MHz frequency bands. The GSM standard was developed as a replacement for first generation (1G) analog cellular networks, and originally described a digital, circuit-switched network optimized for full duplex voice telephony. This was expanded over time to include data communications, first by circuit-switched transport, then packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS).

V TRANSMITTER SECTION

The purpose of this project is to provide cell phone based embedded system for irrigation to reduce the manual monitoring of the field and get the information in the form of GPRS.



A microcontroller for data acquisition, and transceiver; the sensor measurements are transmitted to a microcontroller based receiver. This gateway permits the automated activation of irrigation when the threshold values of soil moisture and temperature is reached. Communication between the sensor nodes and the data receiver is via the ZigBee. Each unit is based on the microcontroller PIC16F877A that controls the radio modem XBee pro S2 and processes information from the soil-moisture sensor VH400 and the temperature sensor TMP108. These components were selected to minimize the power consumption for the proposed application.

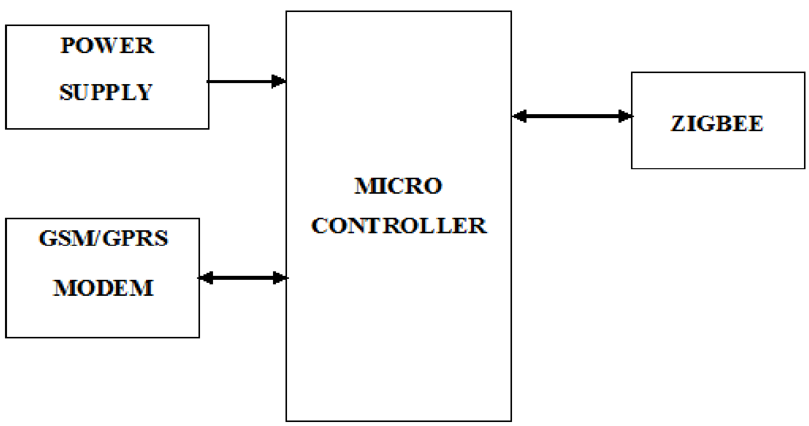
The microcontroller was programmed in C compiler 4.12 for monitoring the soil-moisture probe through an analog-to-digital port and the soil-temperature probe through another digital port, implemented in 1-Wire communication protocol. A battery voltage monitor is included through a high-impedance voltage divider coupled to an analog-to-digital port.

The data are packed with the corresponding identifier, date, and time to be transmitted via XBee radio modem using RS-232 protocol through two digital ports configured as transmitter (TX) and receiver (RX), respectively. After sending data, the microcontroller is set in sleep mode for certain period according to the sensor sampling rate desired, whereas the internal RTCC is running. This operation mode allows energy savings. When the WSU is launched for first time, the algorithm also inquires the WIU the date and time to program the RTCC, and periodically updates it for synchronization.

The sensor array consists of two soil sensors, including moisture and temperature that are inserted in the root zone of the plants. The probe measures the dielectric constant of the soil using transmission line techniques at 80 MHz, which is insensitive to water salinity, and provides an output range between 0 and 3.0 V, which is proportional to the volumetric water content (VWC) according to a calibration curve provided by the manufacturer. The sensor was powered at 3.3 V and monitored by the microcontroller through an ADC port.

VI RECEIVER SECTION

This receiver unit also has a duplex communication link based on a cellular Internet interface, using General Packet Radio Service (GPRS) protocol, which is a packet oriented mobile data service cellular global system for mobile communications (GSM).



Many systems have been designed and experimented by using GSM-SMS which normally involved the use of GSM modem for carrying sensing and control of devices in the system using message transfer. Numerous systems have been developed using Wireless Sensor Networks which consists of several sensor nodes in proximity and having data transmission and reception capability between nodes and central base station.

The soil moisture and temperature data from each WSU received, identified, recorded, and analyzed in the WIU. The functionality of the WIU is based on the microcontroller, which is programmed to perform diverse tasks. The WIU is ready to transmit via XBee the date and time for each WSU once powered. Then, the microcontroller receives the information package transmitted by each WSU that conform the WSN.

The soil moisture and temperature data are compared with programmed values of minimum soil moisture and maximum soil temperature to activate the irrigation pumps for a desired period. The algorithm also records a log file with the data, including soil moisture and temperature, the battery voltage, the WSU ID, the date, and time generated by the internal RTCC. If irrigation is provided, the program also stores a register with the duration of irrigation, the date, and time.

Finally the information is transmitted at each predefined time to a customer mobile via the GSM module in real time. The link is bidirectional and permits to change the threshold values, scheduled watering or remote watering can be performed.

The WIU has also a push button to perform manual irrigation for a programmed period and a LED to indicate when the information package is received. All the WIU processes can be monitored through the RS-232 port.

VII CONCLUSION

The self regulated irrigation system implemented was found to be feasible and cost effective for optimizing water resources for agricultural production. This irrigation system allows cultivation in places with water scarcity thereby improving sustainability. The self regulated irrigation system developed proves that the use of water can be diminished for a given amount of fresh biomass production. The system was powered by photovoltaic panels and had a duplex communication link based on a Mobile Ad-Hoc Network that allowed for data inspection and irrigation scheduling to be programmed through a mobile. The use of solar power in this irrigation system is pertinent and significantly important for organic crops and other agricultural products that are geographically isolated, where the investment in electric power supply would be expensive.

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