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A Wireless Application of Drip Irrigation Supported by Soil Moisture Sensors

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Abstract—An intention of this topic is to describe the design and implementation of a low-cost multi-mode control for an irrigation system. Irrigation by help of freshwater resources in agricultural areas has a crucial importance. The system uses soil water potential measures, the weather condition parameters and the data provided by the user to decide when and how much water to apply to the irrigated field. The soil moisture contents and the climatic parameters are monitored by a controller-based data acquisition and distribution controller system. Full circuit and program codes were implemented to verify system operation. Because of highly increasing demand for freshwater, maximum use of water resources has been provided with greater extent by automation technology and its apparatus such as solar power devices, drip irrigation, sensors and remote control. Traditional instrumentation depends on discrete and wired solutions, which represents many difficulties on measuring and control systems especially over the large geographical areas. This topic describes an application of a WSN for low-cost wireless controlled irrigation solution and real time monitoring of water content of soil. Data acquisition is performed by using solar powered wireless acquisition stations for the purpose of control of valves for irrigation. The designed system has 3 units namely: Base Station Unit (BSU), Valve Unit (VU) and Sensor Unit (SU). The obtained irrigation system not only prevents the moisture stress of trees and salification, but also gives an efficient use of fresh water resource. In addition, the developed system removes the need for workmanship for flooding irrigation.

Keywords-Base Station Unit, Valve Unit, Sensor Unit, Solenoid Valve, ZigBee

I. INTRODUCTION

Agriculture is main source of the people in current scenario. It provides food as well as large employment. So modernization of agriculture is important because traditional farming is unable to boost up the crop yield. Therefore farmer start to use the various technology to achieve better yield and reduce the required man power. As the source of life, water is an essential element in modern agriculture. So with sharp increase of population, the development of modern agriculture has severe problem concerning water resources [15]. Human being is facing a double challenge of both protecting and utilizing water resources. The crop yields depend on the sufficiency of water supply. Water is essential for crop production so the effect of water, rainfall and irrigation on crop growth and yield under different agro climatic conditions is essential in planning, design and operation of irrigation schemes. The maximum potential yield of crop is determined by climate and availability of water in quantity and time, including periods of water shortage during the critical periods in its growing phase. The irrigation system is to be designed and managed to meet the crops water requirement in quantity and time to attain optimum yield.

In conventional system, the farmer has followed a schedule for watering, which is different for different crops [12]. In automatic drip system, irrigation will take place only when there will be requirement of water. A variety of drip irrigation method has been used but most of them are very expensive and complicated. So proposed application system is minimal cost & useful for different crops irrigation. Too much watering causes diseases to plants and even they die out [14]. To provides uniform and required level of water for both plain and sloppy areas and avoids the water overflow at the sloppy areas and considering the current labor shortage situation, the automated sensing system will be most appropriate. The rapid changing agricultural market requires new farming strategies [8]. The pest and diseases have increased; insects are responsible for major kinds of damage to growing crops. It directs injury to the plants, which eats leaves or fruit, or roots. Most of the vegetable crops are subject to pest damage. With increasing population pressure throughout the nation and need for increased agricultural production there is need for management of nation agricultural resources. The RT (Real Time) values of soil moisture, air/wind humidity, temperature and water level in the soil are wirelessly transmitted using wireless technology and protection from insect attack to the crop for better production.

II. IRRIGATION WATER MANAGEMENT

Increasing energy costs and decreasing water supplies point out the need for better water management. Irrigation water management involves more than just turning on the irrigation system because it has not rained for a few days. Irrigation management is a complex decision-making process to determine when and how much water to apply to a growing crop to meet specific management objectives [16]. It is known that it takes some time for water to infiltrate through the soil; hence using a simple on-off controller would result in a waste of water past the root zone. By the time the water reaches the root zone, the system is triggered to stop irrigation, but the soil above the root zone being saturated; water will continue to flow below the root zone. One possible way to minimize deep percolation losses is the use of an anticipatory approach. This technique requires at least two soil moisture probes to properly monitor and control the water flow front, Fig. 1. One "deep" start probe is installed in the center of the root bowl of the plant and is set to the desired moisture level to indicate when irrigation should start. A second, stop probe installed below the surface anticipates the water movement by cutting off the irrigation as soon as it detects the advancing front flow. As soon as the upper layer is wetted to saturation, by gravity water begins to percolate to the root zone [17].

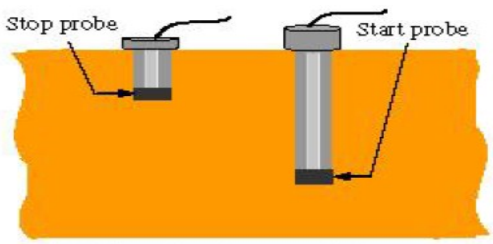

Figure1. Automatic Moisture Control using two probes: Start & Stop probe

2.1.Effect of Major Climatic Factors on Crop Water Needs

The greater need of water for crops are thus found in areas which are hot/warm, dry, windy and sunny. The lowest values are found when it is cold, humid and cloudy with little or no wind. The water requirement of crops varies with the growth stage of the crop, ground area covered by the crop, crop height and change in leaf area. The growing period of crops can be divided into four stage.

Table 1. Water Need in different Climatic Condition

Climatic Factor	Crop water need	
	High	Low
Temperature	hot	cool
Humidity	low (dry)	high (humid)
Wind speed	windy	little wind
Sunshine	sunny (no clouds)	cloudy (no sun)

Table 2. Approximate duration of growth stages for various field crops

	Total	Initial stage	Development stage	Mid season stage	Late season stage
Wheat	120	15	25	50	30
	150	15	30	65	40
Onion	150	15	25	70	40
	210	20	35	110	45
Groundnut	130	25	35	45	25
	140	30	40	45	25
Potato	105	25	30	30	20
	145	30	35	50	30
Soybean	135	20	30	60	25
	150	20	30	70	30
Tomato	135	30	40	40	25
	180	35	45	70	30

III. BLOCK DIAGRAM

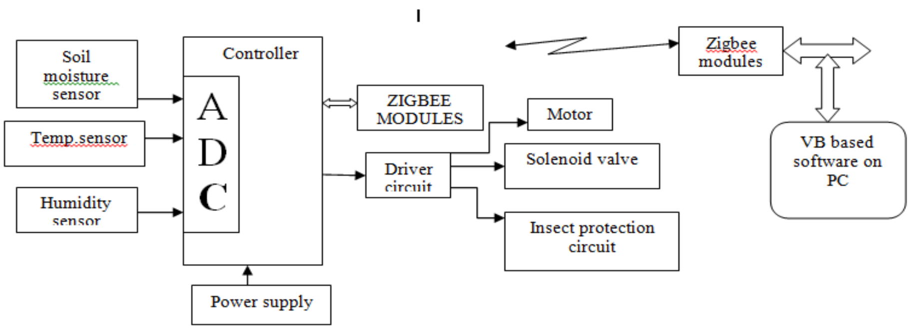

Figure 2. Block Diagram for proposed Irrigation System

The base station which receives the information data from the field station using wireless module and check the predefined condition. On the basis of that base station send the control signal back to the field station. Also display the sensor reading on LCD display. The basic resources for crop production are climate, water and soil. An efficient utilization of these is essential for optimum crop production. Climate determines the suitability of a crop and soil serves as the reservoir for water and nutrients. All plant s require water in order to live, grow and provide satisfactory yields to meet the human needs. The relationship between different climate factors and crop water requirement is as shown below.

3.1.Soil moisture sensor and unit

In the developed system, 10 HS coded pre-calibrated Soil Moisture Sensor of Decagon has been used to measure water content of soil (Figure 3). The 10 HS has a low power requirement and very large resolution. This gives you the ability to make as many measurements as you want (that is, hourly) over a long period of time with minimal battery use. 10 HS needs 12 to 15 mA and runs with 3 to 15 V DC. Output voltage of this sensor is 300 to 1250 mV (independent from the excitation voltage). This 10 HS measures the dielectric constant of the soil in order to find its volumetric water content (VWC) using a capacitance techniques. Since the dielectric constant of water is much higher than that of air or soil minerals, the dielectric constant of the soil is a very sensitive measure of volumetric water content. The SU acquires data given by the ADC, & the data sent to BSU. Value of ADC input which comes from the sensor is stored in a 10-bit register. Different types of sensors can be added easily for future developments. Output voltage level of Controller (5 V) is higher than RF module (3 V). Cause of that 5 to 3 V level conversion was used for communication microcontroller with RF module. In this design, a 20 MHz oscillator was selected to use. The output value which was produced by the sensor value is as an analog data and it is converted to digital data by the PIC and sent to PC via serial ports. In this system two LEDs were added for notifications.

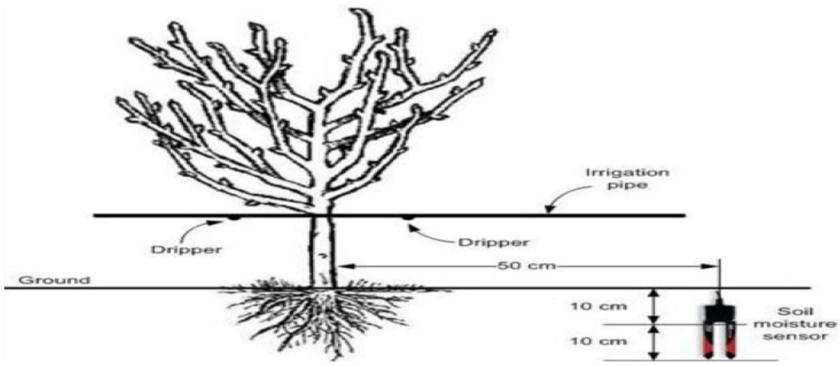

Figure 3.Location of the Soil Moisture Sensor in this Application

3. 2.Valve unit

Valve unit has the same connection with wireless module and the same properties with SU. It has an output for controlling valve. This valve was operated by digital outputs (RD6) on the microcontroller by transistor (MJE3055). PVD Brand, ½", normally-closed solenoid valves with a 12 V, 10 W coil gets selected.

3.3Base station unit (BSU)

The BSU is a master device that is programmed to read and to evaluate sensors data, to control valve and to communicate with other units. The mounted PCB was interfaced to the outsides by a RS- 232 serial port.

3.4. TransmittingTechnology

Wi-Fi and Bluetooth.are high costs, hard to be developed and limited signal coverage. So the Zigbee WSN technologies are most suitable for agriculture applications when compared with Wi-Fi and Bluetooth.

3. 4. 1. Details of Zigbee

The ZigBee and ZigBee Pro protocol are used for fast point-to-point or peer-to-peer networking. Also, the most different part between ZigBee and ZigBee Pro is they have different cover distance range for communicate with own module. ZigBee covers around 30m at indoor and 100m at outdoor. Inversely, ZigBee Pro can cover larger distance range than ZigBee which is 100m at indoor and 1500m at outdoor[4].

Table 3. Comparison of Wireless Technologies

Technology	Operating range	Network tropology	Power consumption	Monitoring Station
Zigbee pro	>100m	Ad-hoc,point–multipoint	Very low	PC
Zigbee	10-100m	Ad-hoc, peer-peer	Low	PC
Wi-Fi	50-100m	Point to hub	High	PC, Mobile
Bluetooth	10m	Ad-hoc	Medium	PC

IV. RESULT

The project "A Wireless Application of Drip Irrigation Supported by Soil Moisture Sensors" system has 3 units namely: base station unit (BSU), valve unit (VU) and sensor unit (SU). The obtained irrigation system not only prevents the moisture stress of trees and salification, but also provides an efficient use of fresh water resource. In addition, the developed irrigation method removes the need for workmanship for flooding irrigation.

V. CONCLUSION

In this study, a wireless data acquisition network was implemented and applied to irrigate trees/plants. The developed irrigation automation system can be proposed to be used in several commercial agricultural productions since it was obtained in low cost and in reliable operation. This application of sensor-based site- Specific irrigation has some advantages such as preventing moisture stress of trees, diminishing of excessive water use, ensuring of rapid growing weeds and derogating salification. If different kinds of sensors (that is, temperature, humidity) are involved in such irrigation in future works, it can be said that an internet based remote control of irrigation automation will be possible.

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