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WirelessSensor Network and GPRS Module Application for Automatic Irrigation Operated System

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Abstract: —Irrigation is need of farmer to save water resource which is essential and need to use in minimum quantity because it is not free forever to use and not conversational resource. In drip irrigation water is given to root of plants to save water and stop land infertility and nutrition count. In irrigation farmer have to keep time table for irrigation which changes as per crop, soil and weather. Web based intelligent drip irrigation system is one and only solution to water management and precision agriculture. In web based system we can control water supply using solenoid valve. This whole system is micro control based and can be operated from remote location through web based so there is no need to concern about irrigation timing as per crop or soil condition. Sensor is used to take sensor reading of soil like soil moisture, temperature, air moisture and light micro controller take decision control by user (farmer). Web based intelligent irrigation system helps a farmer to take decision on water management in farm and there is no need to maintain irrigation time table .Irrigation time table can be fetch and map from agriculture university or government web site as per soil and crop type. It gives maximum profit from minimum cost.

Keywords:Wireless Sensor Network (WSN), Internet, Automation, Irrigation, web application

I. INTRODUCTION

In agriculture water is important factor. Agriculture sector uses maximum water in world. Indian economy mainly based on agriculture field and water is vanishing day by day due to its immense use. Irrigation is one solution to this problem because in drip irrigation water is supplied to root zone of crop. Irrigation saves a large amount of water. But still in irrigation sometimes water is over supplied or less supplied to crop and irrigation time table should be maintained which is not easy for farmer. Manual irrigation is the traditional method in world for water supply in agriculture farm. So it is hard to take decision to save water and get maximum profit from field. Sensors and sensor networks are making Hugh progress in agriculture field [1][2]. For sensor based agriculture and networks, varieties of terminologies now in use like Precision Agriculture (PA), site specific crop monitoring, automated irrigation system, GPS based agriculture etc. [3]. Sensors are used to collect data from environment like soil moisture, temperature, air direction, air speed, etc. Actuators are control units as per situation occurred [4][5]. Different communication technology has been developed for communication between network and its element. Zigbee, WIFI, Bluetooth, Wibree are communication technology used in sensor network. Zigbee is preferred over other technology due to low cost and less power consumption [6]. Web based intelligent irrigation system is solution for this problem. It is automated and micro controlled based can be control from remote location [7].It takes decision on sensor value of agriculture farm. Wireless sensor Network is back bone of whole system. Sensor node, master node, Base station and server are elements of WSN application.

This paper defines the internet driven intelligent and completely automated water management system. The software and hardware combined together provide a very advanced control over the currently implemented manual system. The implementation involves use of water management system using a microcontroller based board. PC based software is used to interface the board and control the valve on/off timings. The software is capable of downloading the on/off timings for drips from websites hosted by agricultural universities. Farmers can get instant assistance from universities to change the drip on/off timings based on current climate, soil condition, fertilizers used, etc. The microcontroller based unit can operate in standalone mode since and only needs to be connected shortly to the PC in order to download the new valve on/off timings. A software module will also be designed for agricultural universities to upload the drip on/off timings for particular farm layout.

Automated Irrigation system using WSN and GPRS Module having only main goal is that optimize use of water for agriculture crops. This system is composed of distributed wireless sensor network with soil moisture and temperature sensor in WSN. Gateway units are used to transfer data from sensor unit to base station, send command to actuator for irrigation control and manage data of sensor unit. Algorithm used in system for controlling water quantity as per requirement and condition of field. It is programmed in micro controller and it sends command through actuator to control water quantity through valve unit. Whole system is powered by photovoltaic panels. Communication is duplex take place through cellular network. Web application mange the irrigation through continues monitoring and irrigation scheduling programming. It can be done through web pages. System with three replicas of automated irrigation system can save 90% water as compare to traditional irrigation method.

A system developed for malting barley cultivations in largeareas of land allowed for the optimizing of irrigation throughdecision support software and its integration with an infieldwireless sensor network (WSN) driving an irrigationmachine converted to make sprinkler nozzles controllable.The network consisted of five sensing stations and a weatherstation. Each of the sensing stations contained a data loggerwith two soil water reflect meters, a soil temperature sensor,and Bluetooth communication. Using the network information and the irrigation machine positions through a differentialGPS, the software controlled the sprinkler with applicationof the appropriate amount of water [13]. Software dedicatedto sprinkler control has been variously discussed [14].

A data acquisition system was deployed for monitoringcrop conditions by means of soil moisture and soil, air, andcanopy temperature measurement in cropped fields. Data weredownloaded using a handheld computer connected via a serialport for analysis and storage [15]. Another system used toachieve the effectiveness of water management was developedbased on a WSN and a weather station for Internet monitoringof drainage water using distributed passive capillary wick-typelysimeters. Water flux leached below the root zone under anirrigated cropping system was measured [10]. There are hybridarchitectures, wireless modules are located inside the greenhousewhere great flexibility is required, and wired modulesare used in the outside area as actuator controllers [10].

The development of WSNs based on microcontrollers andcommunication technologies can improve the current methodsof monitoring to support the response appropriately inreal time for a wide range of applications [11], consideringthe requirements of the deployed area, such as terrestrial,underground, underwater, multimedia, and mobile [12]. Theseapplications involve military operations in scenarios of battlefield,urban combat, and force protection, with tasks ofpresence, intrusion, ranging, imaging, detection of chemical,toxic material, biological, radiological, nuclear, and explosive[2], [3]. In addition, sensor networks have been usedin health care purposes for monitoring, alerting, assistance,and actuating with security and privacy to support real-timedata transmission [11]. Vital sign monitoring, such as ECG,heart rate, body temperature, has been integrated in hospitalsand homes through wearable or e-textile providing reportsand alerts to personal in case of emergency and tracking thelocation of patients within the hospital limits [13]. WSNs havebeen used to remote monitor healthcare of dependent people attheir homes through several biomedical sensors such as ECG,blood pressure, body temperature and body motion.

II. **PROPOSED** AUTOMATED IRRIGATION SYSTEM

Existing wireless sensor networks that monitor agriculture infrastructure measures different soil parameter and environment conditions. This WSN is composed of node with software and hardware units. Nodes manage and monitor farm parameter for precision agriculture purpose. Node has control unit which control sensors and communicate with base station. At mega and ARM are frequently used as control unit. Zigbee, Bluetooth, wifi used for transceiver in WSN. Nodes in WSN send information to base station for decision purpose. Wireless underground sensor network is deployed underground. Network sensor components work underground at specific depth. Wireless communications take place between networks. Network report soil value, volumetric water contains, landscape movement, earthquakes and volcano information. Limitation of above two network infrastructures solve by hybrid sensor network. It is a combination of wireless sensor network and wireless underground sensor network. Hybrid sensor network combine advantages of these two infrastructure system. When WSN is out off line of sight WUSN collect the information from node. Mobile information collected by terrestrial WSN.

Water management system is microcontroller based and web application is used for monitor and control the water management system from remote location. Whole system is in WSN infrastructure. Water management is done through sensor reading from farm. Web application provide easy monitor and control mechanism to farmer. Graph generated in web application make easy analysis and the proposed system architecture is shown by Fig.1..

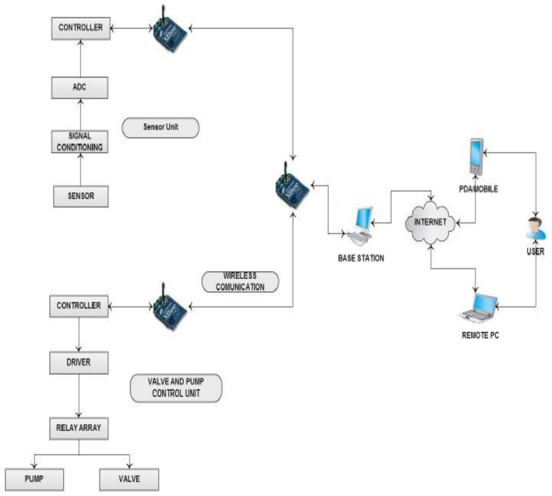

Fig.1.System Architecture Diagram

Sensors (Light, Temperature, PH_Value, and Moisture): Sensor senses the different physical parameters like soil ph-value, soil moisture, temperature and humidity.

Micro-Controllers: It is heart of system, means it control all operation of system.

ADC (Analog to Digital): It convert analog signal to digital signal and fed this digital signal to microcontroller.

Signal Array: It take sensor data as input and give this data as input to signal conditioning.

Signal conditioning: It work as amplifier .It convert weak signal of sensor in its Original state

Darlington Driver: It is control unit it control fan motor valve etc. It works as per decision.

Valve: Valve can be Solenoid valve work as per soil moisture threshold value and operate by Darlington driver.

Base station: It is master unit to control valve and take data from all sensor node which are at the end.

Server: It collects data from all WSN network and take decision if threshold cross of any sensor unit. Irrigation timing can be synch from server for water management purpose.

Web application: It collect data from server of agriculture field where WSN network application is deployed. Web application provide graphical interface to user and graph of sensor data value is generated so it is easy to understand for user to analyze and take decision. Web application help to store data and maintain irrigation time table. User can download irrigation timing from Agriculture University.

These components were selected to minimize the power consumption for the proposed application.

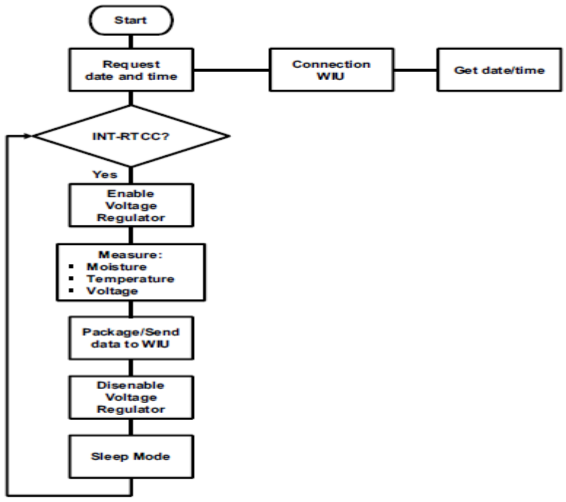

Fig.2. Algorithm of wireless sensor unit (WSU) for monitoring the soilmoistureand temperature.

These data are processed by the algorithm that first identifiesthe least significant byte of a unique 64-bit address encapsulatedin the package received. Second, the soil moistureand temperature data are compared with programmed valuesof minimum soil moisture and maximum soil temperatureto activate the irrigation pumps for a desired period. Third,the algorithm also records a log file with the data in a solidstate memory 24FC1025 (Microchip Technologies, Chandler,AZ) with a capacity of 128 kB. Each log is 12-B long,including soil moisture and temperature, the battery voltage,the WSU ID, the date, and time generated by the internalRTCC. If irrigation is provided, the program also stores aregister with the duration of irrigation, the date, and time.Finally, these data and a greenhouse ID are also transmittedat each predefined time to a web server through HTTP via theGPRS module to be deployed on the Internet web applicationin real time.

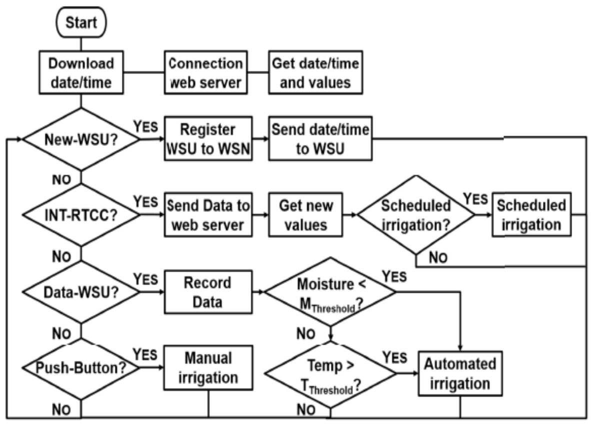

Fig.3. Algorithm of the master microcontroller in the WIU for the automatedirrigation system.

During the cultivation, several automated irrigation periodswere carried out by the system because of the soil-moisture(IA-3) or temperature (IA-4) levels, regardless of the scheduledirrigation (IA-2). All data were uploaded each hour to theweb server for remote supervision. For instance, data offour days are shown in (Fig. 4). The first graph shows soiltemperatures. The vertical bars indicate automated irrigationperiods triggered by temperature when soil temperature wasabove the threshold value (30 °C). The second graph showssoil moistures that were above the threshold value (5.0%VWC), and thus the automated irrigation was not triggeredby soil moisture. Finally, the last graph shows the total waterused by the sage with the corresponding scheduled irrigationvertical bars for the IA-2. The dots denote the automated andscheduled irrigation.The pumping rate provided 10 ml/min/driphole, which wasmeasured in the automated irrigation zone in six different dripholes.

III. RESULTS AND DISCUSSIONS

Automated irrigation triggered by soil moisture for four days are shown in Fig. 4; when the soil moisture value fell below the threshold level of 5.0% VWC, the irrigation system was activated for 35 min according to IA-3, whereas the soil temperature remained below the threshold level. Similarly, Fig.5 shows automated irrigation triggered by soil temperature; when the temperature was above 30 °C, the irrigation system was activated for 5 min according to IA-4, whereas the soil moisture remained above the threshold level.

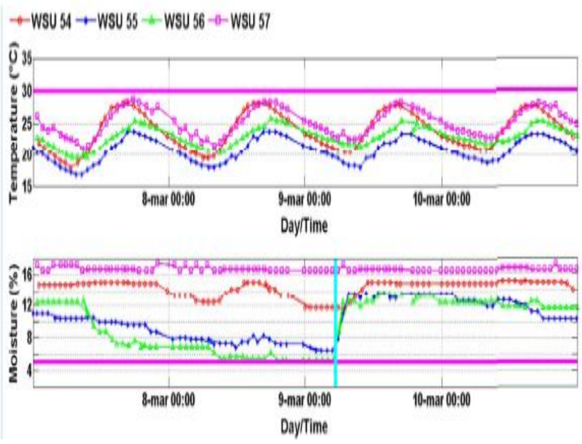

Fig.4.Automated irrigation (vertical bars) triggered by the soil moisturethreshold ≤ 5% VWC.

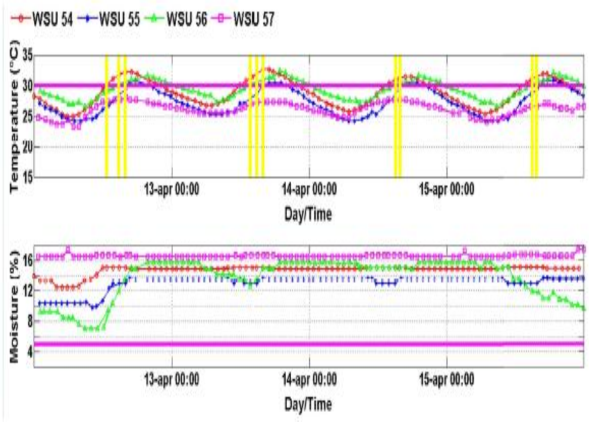

Fig.5. Automated irrigation (vertical bars) triggered by the soil temperaturethreshold ≥30 °C.

The automated system was tested in the greenhouse for 136 days (Fig. 6). Daily mean soil moisture and temperatureare shown, as well as the accumulated water used for bothsystems. Both mean temperatures presented similar behaviourfor the production period, except for the last 30 days, wherethe soil temperatures for the traditional irrigation practice. (Curve a) was lower than the automated irrigation (curve b).The daily mean VWC for the traditional irrigation practice(curve c) was almost constant >16%, whereas that for theautomated irrigation (curve d) was below 10%. In addition, theaccumulated water used are shown corresponding to 14 bedsfor each irrigation system. The total water requirement was341 m^3 for the traditional one and 29 m^3 for the automatedone. Then, the automated irrigation used ~ 90% less water withrespect to the traditional irrigation practice.

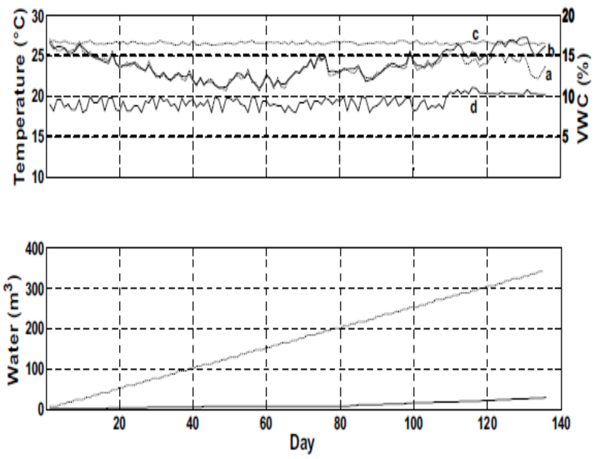

Fig.6.Daily mean soil temperature (a: traditional; b: automated), dailymean soil moisture (c: traditional; d: automated), and accumulated waterirrigation volumes

(dotted line: traditional; solid line: automated) over theentire sage cropping season.

Each hour, the soil-moistureand temperature data were transmitted to the WIU. Beforetransmitting the data, the XBee of the WSU was powered onthrough the voltage regulator that was enabled for a periodof 20 s by the microcontroller, which was a long enoughtime for the radio modem to wake up and transmit thedata. Then, the total average power consumption was keptat0.455 mAh. The charge-discharge cycle of the batteries isshown for 20 days in the winter with the solar panel connectedand disconnected (Fig. 7) using the data registered by thebattery voltage monitor. The solar radiation for those days isshown in Fig. 8. Thus, the photovoltaic panel and the batteriesprovide sufficient energy to maintain the WSU running for thewhole crop season at almost any latitude, due the low energyconsumption.

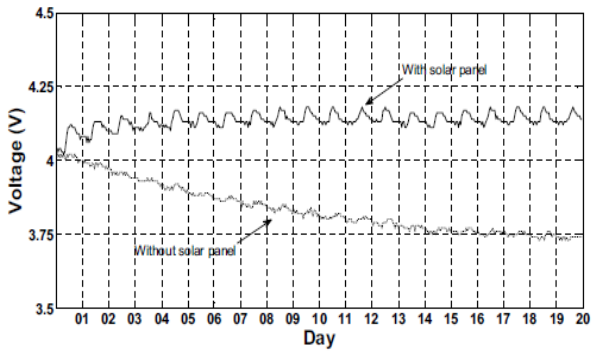

Fig.7.Battery charge–discharge cycle of a wireless sensor unit (WSU).

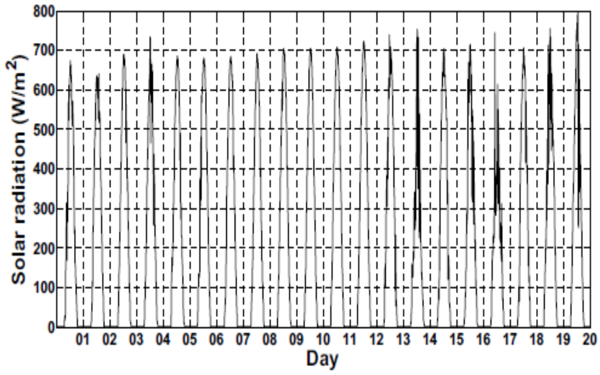

Fig.8.Solar radiation along the experiment of charge-discharge cycle ofa wireless sensor unit (WSU).

IV. CONCLUSION& FUTURE SCOPE

Irrigation is today's need to save the water in which potential using of WSN and micro controller, actuators is very high. A review of several solution and efforts has been presented in automated irrigation field. The major concerns are develop decision support system withWSN infrastructure is difficult. Proposed system gives automation to irrigation for agriculture field decision support system act with network infrastructure. The web based Automated Wireless Drip Irrigation provides a real time feedback control system which monitors and controls all the activities of drip irrigation system efficiently. Using this system, one can save water, manpower as well as energy in order to improve productivity and ultimately the profit.

This system can also supply fertilizer and the other agricultural chemicals like calcium, sodium, ammonium, zinc to the field with adding new sensors and valves. Also it is possible to registered farmer to download drip control timings from agricultural universities website control own drip irrigation system according to university and weather condition of that particular geographical area.

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