Automatic Irrigation System using Arduino Controller
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Abstract: An micro 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 web application. 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 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 micro system was tested in a sage crop field for 136 days and water savings of up to 90% compared with traditional irrigation practices of the agricultural zone were achieved. Three replicas of the micro system have been used successfully in other places for 18 months. Because of its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated areas.

Keywords: Microcontroller, GSM/GPRS Modem, LCD display, Temperature Sensor, Humidity Sensor, Water Level Sensor, Soil Sensor, ZIGBEE Module.

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. There are many systems to achieve water savings in various crops, from basic ones to more technologically advanced ones. For instance, in one system plant water status was monitored and irrigation scheduled based on canopy temperature distribution of the plant, which was acquired with thermal imaging. In addition, other systems have been developed to schedule irrigation of crops and optimize water use by means of a crop water stress index (CWSI).

II. OVERVIEW OF THE PROJECT

In some of the irrigation system irrigation scheduling is achieved by monitoring soil, water status with tension meters under drip irrigation by the automation controller system in sandy soil. It is very important for the farmer to maintain the content in the field. In this the design of a Micro-controller based drip irrigation mechanism is proposed, which is a real time feedback control system for monitoring and controlling all the activities of drip irrigation system more efficiently. Irrigation system controls valves by using automated controller allows the farmer to apply the right amount of water at the right time, regardless of the availability of the labour to turn valves. Some irrigation systems are used to implement efficient irrigation scheme for the field having different crops. The system can be further enhanced by using fuzzy logic controller. The fuzzy logic scheme is used to increase the accuracy of the measured value and assists in decision making. The green house based modern agriculture industries are the recent requirement in every part of agriculture in India. In this technology, the humidity and temperature of plants are precisely controlled. Due to the variable atmospheric conditions sometimes may vary from place to place in large farmhouse, which makes very difficult to maintain the uniformity at all the places in the farmhouse manually. For this GSM is used to report the detailed about irrigation. The report from the GSM is send through the android mobile. The software and hardware combine together provide a very advanced control over the currently implemented manual system. The implementation involves use of internet for remote monitoring as well as control of Drip Irrigation system.

This system uses sensors like humidity, soil moisture. These sensors send values to micro-controller. Micro-controller sends values to PC using serial communication. According to real time sensors values continuous graph is displayed on PC and Android Based mobile using Internet and Android application. Here threshold value is keep, if sensor values cross the threshold value then Drip Irrigation components can be control automatically by micro-controller. User can also control Drip Irrigation from anywhere via Android mobile. In the Micro-controller based drip irrigation mechanism, this is a real time feedback control system for monitoring and controlling all the activities of drip irrigation system more efficiently. Irrigation system controls valves by using automated controller to turn ON OFF. This allows the farmer to apply the right amount of water at the right time, regardless of the availability of the labour to turn valves or motor ON OFF. This reduces run off over watering saturated soils avoid irrigating at the wrong time of the day. It improves crop performances and help in

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time saving in all the aspects. The management of this kind of farms requires data acquisition in each greenhouse and their transfer to a control unit which is usually located in a control room, separated from the production area. At present, the data transfer between the greenhouses and the control system is mainly provided by a suitable wired communication system, such as a field bus. In such contexts, even though the replacement of the wired system with a fully wireless one can appear very attractive, a fully wireless system can introduce some disadvantages.

A solution based on a hybrid wired/wireless network, where Controller Area Network and ZigBee protocols are used. In particular, in order to integrate at the Data Link Layer the wireless section with the wired one, a suitable multi-protocol bridge has been implemented. Moreover, at the Application Layer, porting of Smart Distributed System services on ZigBee, called ZSDS, allows one to access the network resources independently from the network segment. The some system highlights the development of temperature and soil moisture sensor that can be placed on suitable locations on field for monitoring of temperature and moisture of soil, the two parameters to which the crops are susceptible. The sensing system is based on a feedback control mechanism with a centralized control unit which regulates the flow of water on to the field in the real time based on the instantaneous temperature and moisture values. Some system presents Artificial Neural Network (ANN) based Intelligent control system for effective irrigation scheduling. The proposed Artificial Neural Network (ANN) based controller was prototyped using MATLAB. The input parameters like air temperature, soil moisture, radiations and humidity are modelled. Then using appropriate method, ecological conditions, evapotranspiration and type of crop, the amount of water needed for irrigation was estimated and then associated results are simulated.

**A. Introduction to Proposed Design**

The proposed system has two main units one is wireless sensor unit (WSU) and another is Wireless information unit (WIU). Wireless sensor unit is nothing but transmission section which Transmit the sensor data to the wireless information unit. Wireless information unit is nothing but section which receives sensor data from wireless sensor unit. A. Wireless Sensor Unit A WSU is comprised of a RF transceiver, different sensors, a micro-controller, ZigBee and power sources. Several WSUs can be deployed in-field to configure a distributed sensor network for the automated irrigation system. Each unit is based on the micro-controller that controls the radio modem ZigBee and processes information from the soil-moisture sensor, temperature sensor and water level sensor. In this wireless sensor unit or transmission unit the sensor data from different sensors (Soil moisture, temperature, humidity and water level) are collected in the main controller. This data is displayed on transmission section LCD. ARM controller is programmed to some threshold values of temperature and soil moisture. Sensed values are compared with the threshold values and according to comparison automation is takes place.

**B. Wireless information unit**

The soil moisture, temperature and water level sensor data from each WSU are received, identified, recorded, and analysed in the WIU. The WIU consists of a master micro controller, an ZigBee radio modem, a GPRS module This processed information is send to web page where status of all these sensors are display graphically using graphical user interface using the GPRS module. The data from the transmission section is received by ZigBee communication modem. much simpler than those of Complex Instruction Set Computer(CISC) designs.
III. DESIGN OF PROPOSED HARDWARE SYSTEM

Fig. 3. The Hardware System.

A. Micro controller

This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

ATMEGA328 Controller:

The ATmega328/P is a low-control CMOS 8-bit smaller scale controller in light of the AVR improved RISC building design. By executing intense directions in a solitary clock cycle, the ATmega48A/PA/88A/PA/168A/PA/328/P accomplishes throughputs drawing closer 1 MIPS for every MHz permitting the framework intended to upgrade power utilization versus preparing pace as shown in Fig. 6. The AVR center consolidates a rich guideline set with 32 broadly useful working registers. All the 32 registers are specifically joined with the Arithmetic Logic Unit (ALU), permitting two autonomous registers to be gotten to in one single guideline executed in one clock cycle. The outcome in structural planning is more code proficient while accomplishing throughputs up to ten times speedier than customary CISC smaller scale controllers. The ATmega48PA/88PA/168PA/328PA gives the accompanying elements: 4K/8K bytes of In-System Programmable Flash with Read-While-Write capacities, 256/512/512/1K bytes EEPROM, 512/1K/1K/2K bytes SRAM, 23 broadly useful I/O lines, 32 universally useful working registers, three adaptable Timer/Counters with think about modes, interior and outside intrudes on, a serial programmable USART, byte-situated 2-wire Serial Interface, a SPI serial port, a 6-channel 10-bit ADC (8 diverts in TQFP and QFN/MLF bundles), a programmable Watchdog Timer with inner Oscillator, and five programming selectable force sparing modes. The Idle modes stops the CPU while permitting the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interfere with framework to keep working.

The Power-down mode spares the register substance yet solidifies the Oscillator, incapacitating all other chip capacities until the following interfere with or equipment reset. In Power-spare mode, the offbeat clock keeps on running, permitting the client to keep up a clock base while whatever remains of the gadget is dozing. The ADC Noise Reduction mode stops the CPU and all I/O modules with the exception of offbeat clock and ADC, to minimize exchanging commotion amid ADC changes. In Standby mode, the precious stone/resonator Oscillator is running while whatever is left of the gadget is dozing. This permits quick start-up joined with low power utilization. The gadget is produced utilizing Atmel's high thickness non-unpredictable memory innovation. The On-chip ISP Flash permits the project memory to be reconstructed In-System through a SPI serial interface, by a routine non-unpredictable memory developer, or by an On-chip Boot project running on the AVR center. The Boot system can utilize any interface to download the application program in the Application Flash memory. Programming in the Boot Flash area will keep on running while the Application Flash segment is upgraded, giving genuine Read-While-Write operation.

Fig. 4. Piece chart.

Introduction to ARDUINO: The Arduino Uno is a microcontroller board taking into account the ATmega328. It has 14 computerized info/yield pins (of which 6 can be
In the ICSP header, development of the micro irrigation system based supply is entirely from the board. In future, Arduino will be the reference variants of Arduino, pushing ahead. The Uno contrasts from every former board in that it doesn't utilize the FTDI USB-to-serial driver chip. Rather, it includes the Atmega16U2 (Atmega8U2 up to versionR2) modified as a USB-to-serial converter. Update 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it simpler to put into. Modification 3 of the board has the accompanying new elements:

- 1.0 pin out: included SDA and SCL pins that are close to the AREF pin and two other new sticks put close to the RESET stick, the IOREF that permit the shields to adjust to the voltage gave from the board. In future, shields will be good with both the board that uses the AVR, which works with 5V and with the Arduino Due that works with 3.3V. The second one is a not joined pin that is held for future purposes.
- Stronger RESET circuit.
- At mega 16U2 supplant the 8U2.

"Uno" implies one in Italian and is named to check the up and coming arrival of Arduino 1.0. The Uno and rendition 1.0 will be the reference variants of Arduino, pushing ahead. The Uno is the most recent in a progression of USB Arduino sheets.

B. Power Supply

The information to the circuit is connected from the directed power supply as shown in Fig.8. The a.c. information i.e., 230V from the mains supply is venture around the transformer to 12V and is nourished to a rectifier. The yield acquired from the rectifier is a throbbing d.c voltage. So as to get an immaculate D.C voltage, the yield voltage from the rectifier is bolstered to a channel to uproot any A.C segments present even after correction. Presently, this voltage is given to a voltage controller to get an unadulterated consistent d.c voltage.

Transformer: For the most part, DC voltages are required to work different electronic hardware and these voltages are 5V, 9V or 12V. In any case, these voltages can't be acquired straightforwardly. Along these lines the a.c data accessible at the mains supply i.e., 230V is to be conveyed down to the required voltage level. This is finished by a transformer. In this manner, a stage down transformer is utilized to diminish the voltage to a required level.

Rectifier: The yield from the transformer is encouraged to the rectifier. It changes over A.C. into throbbing D.C. The rectifier may be a half wave or a full wave rectifier. In this venture, a scaffold rectifier is utilized in light of its advantages like great dependability and full wave correction.

Filter: Capacitive channel is utilized as a part of this task. It expels the swells from the yield of rectifier and smoothen the D.C. Yield got from this channel is consistent until the mains voltage and burden is looked after steady. Be that as it may, if both of the two is differed, D.C. voltage got as of right now changes. Subsequently a controller is connected at the yield stage.

Voltage Controller: As the name itself suggests, it manages the data connected to it. A voltage controller is an electrical controller intended to naturally keep up a consistent voltage level. In this task, power supply of 5V and 12V are required. To get these voltage levels, 7805 and 7812 voltage controllers are to be utilized. The main number 78 speaks to positive supply and the numbers 05, 12 speak to the required yield voltage levels. A variable directed power supply, additionally called a variable seat power supply, is one where you can ceaselessly change the yield voltage to your necessities. Differing the power's yield supply is the prescribed approach to test a task in the wake of having twofold checked parts situation against circuit drawings and the parts position guide. This kind of regulation is perfect for having a straightforward variable seat power supply. Really this is very critical on the grounds that one of the first tasks a specialist ought to attempt is the development of a variable controlled power supply. While a devoted supply is entirely helpful e.g., 5V or 12V, it's much handier to have a variable supply available, particularly to test.

Liquid-crystal display (LCD): LCD is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. In this paper, the development of the micro irrigation system based on microcontrollers and wireless communication at experimental scale within rural areas is presented. The aim of the implementation was 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 micro 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. 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).

VI. BOARD HARDWARE RESOURCES FEATURES
A. Temperature Sensor

Thermistors are thermally sensitive resistors whose prime function is to exhibit a large, predictable and precise change in electrical resistance when subjected to a corresponding change in body temperature. Negative Temperature
Coefficient (NTC) thermistors exhibit a decrease in electrical resistance when subjected to an increase in body temperature and Positive Temperature Coefficient (PTC) thermistors exhibit an increase in electrical resistance when subjected to an increase in body temperature. U.S. Sensor produces thermistors capable of operating over the temperature range of -100° to over +600° Fahrenheit. Because of their very predictable characteristics and their excellent long term stability, thermistors are generally accepted to be the most advantageous sensor for many applications including temperature measurement and control.

Fig.5. Temperature Sensor.

B. Soil sensor
The circuit designed uses a 5V supply, fixed resistance of 100Ω, variable resistance of 10KΩ, two copper leads as the sensor probes, 2N222N transistor. It gives a voltage output corresponding to the conductivity of the soil. The conductivity of soil depends upon the amount of moisture present in it. It increases with increase in the water content of the soil. The voltage output is taken at the transmitter which is connected to a variable resistance. This variable resistance is used to adjust the sensitivity of the sensor.

Fig.6. Soil Sensor.

C. Humidity Sensor
Humidity is the presence of water in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries. The presence of water vapor also influences various physical, chemical and biological processes. In agriculture, measurement of humidity is important for plantation protection (dew prevention), soil moisture monitoring, etc. For domestic applications, humidity control is required for living environment in buildings, cooking control for microwave ovens, etc. In all such applications and many others, humidity sensors are employed to provide an indication of the moisture levels in the environment.

Fig.7. Humidity Sensor.

D. Water level Sensor
The purpose for this Sensor is to allow the user to evaluate a pressure sensor for not only water level sensing and to replace a mechanical switch, but also for water flow measurement, leak detection, and other solutions for smart appliances. This system continuously monitors water level and water flow.

E. ZIGBEE
ZIGBEE is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for Low-Rate Wireless Personal Area Networks (LR-WPANs), such as wireless light switches with lamps, electrical meters with in-home-displays, consumer electronics equipment via short-range radio needing low rates of data transfer. The technology defined by the ZIGBEE specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZIGBEE is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking. ZIGBEE is a low-cost, low-power, wireless mesh networking standard. First, the low cost allows the technology to be widely deployed in wireless control and monitoring applications. Second, the low power-usage allows longer life with smaller batteries. Third, the mesh networking provides high reliability and more extensive range.
F. Relays
A relay is an electrically controllable switch widely used in industrial controls, automobiles and appliances. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The relay allows the isolation of two separate sections of a system with two different voltage sources i.e., a small amount of voltage/current on one side can handle a large amount of voltage/current on the other side but there is no chance that these two voltages mix up.

G. GPRS
GPRS technology enabled much higher data rates to be conveyed over a cellular network when compared to GSM. GPRS technology offering data services with data rates up to a maximum of 172 kbps, facilities such as web browsing and other services requiring data transfer became possible. GPRS and GSM are able to operate alongside one another on the same network, and using the same base stations. However upgrades are needed. The network upgrades reflect many of those needed for 3G, and in this way the investment in converting a network for GPRS prepares the core infrastructure for later evolution to a 3G W-CDMA / UMTS.

IV. RESULTS
Whenever the soil is dry and the water level is full or middle then the motor is activated i.e, the motor is in ON condition. The above figure 12 show the sensor values displayed on the LCD of the transmission section. The figure 13 shows the sensor values displayed on the LCD of the receiver section. The figure 14 is the screenshot of the values that are updated on the web page.
The use of solar power in this system can scheduling and irrigation systems: –electron. T. Erdem, S. Polat, M. Deveci, T. Atkinson, –Irrigation systems. Furthermore, the Internet link allows the device concept for adaptation to several cultivation communication system provides a powerful decision making such as greenhouses or open fields. In addition, other applications micro irrigation system allows it to be scaled up for larger minimum maintenance. The modular configuration of the power supply would be expensive. The irrigation geographically insolated, where the investment in electric organic crops and other agricultural products that are irrigation system is pertinent and significantly important for production. This irrigation system allows controlling drought stress and irrigation in potted plants, –Canopy temperature based system effectively schedules and controls center pivot irrigation of cotton, –Irrigation scheduling performance, –Plant response to evapotranspiration and soil water sensor irrigation scheduling methods for papaya production in south Florida, –Precise irrigation scheduling for turfgrass using a subsurface electromagnetic soil moisture sensor, –Remote sensing and control of nan irrigation system using a

V. CONCLUSION AND FUTUTRE SCOPE

The micro irrigation system implemented was found to be feasible and cost effective for optimizing water resource for agricultural production. This irrigation system allows cultivation in places with water scarcity thereby improving sustainability. The micro irrigation system developed proves that the use of water can be diminished for a given amount of fresh biomass production. The use of solar power in this irrigation system is pertinent and significantly important for organic crops and other agricultural products that are geographically insolated, where the investment in electric power supply 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 micro irrigation system allows it to be scaled up for larger greenhouses or open fields. In addition, other applications such as temperature monitoring in compost production can be easily implemented. The Internet controlled duplex communication system provides a powerful decision making device concept for adaptation to several cultivation scenarios. Furthermore, the Internet link allows the supervision through mobile telecommunication devices, such as a smart phone. Besides the monetary savings in water use, the importance of the preservation of this natural resource justify the use of this kind of irrigation systems. Due to the soil’s natural variability, location and number of soil water sensors may be crucial and future work should include specific calibration. Power supply can be replaced with the solar panels. We can add extra sensors like gas sensor, voltage sensor.

IX. REFERENCES


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