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WIRELESS SENSOR TECHNOLOGIES FOR THE DEVELOPMENT OF AGRICULTURE

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Abstract:

This project probes into the design of the automated irrigation system based on ARM microcontroller. This Embedded project is to design and develop a low cost feature which is based on embedded platform for water irrigation system. Optimum use of water is main objective of this irrigation system to reduce water consumption.

This project uses temperature, light (LDR), humidity and soil moisture sensors to detect the water quantity present in agriculture. Aim of this embedded project is to monitor status of the sensors on remote PC using Zigbee network. PC contains all the information about the status of the sensors and ON/OFF status of the motor.

Keywords: ARM, ZigBee, WSN, Agriculture Monitoring, Water pump.

INTRODUCTION:

Indian economy is basically depends on agriculture. Agriculture uses most of available fresh water resources and this use of fresh water resources will continue to be increases Because of population growth and increased food demand. Increased labor costs, stricter Environmental regulations and increased competition for water resources from urban areas Provide strong motivation for efficient Irrigation system. The automated irrigation system is feasible and cost effective for optimizing water resources for agricultural production. Using the automated irrigation system we can prove that the use of water can be reduced for different agricultural production. The irrigation system provide only required amount of water to crop. This automated irrigation system allows it to be scaled up for larger greenhouses or open fields. An automated irrigation system was developed to optimize water use for agricultural crops. The system has a distributed network of soil moisture, humidity, light 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 PC based application. An algorithm was developed with threshold values of temperature, soil moisture and ON/OFF status of the motor that was programmed into a micro-controller based gateway to control water quantity. The project is designed to develop an automatic irrigation system that switches a pump motor on or off upon sensing the moisture content of the soil. In the field of agriculture, use of proper method of irrigation is important. The advantage of using this method is to reduce human intervention and still ensure proper irrigation.

AN OVERVIEW WIRELESS SENSOR TECHNOLOGY FOR THE DEVELOPMENT OF AGRICULTURE

The proposed system has two main units one is Transmitter unit and another is Receiver unit.

Transmitter section transmits the sensor data to receiver unit and receiver unit receives sensor data from transmission unit.

A. TRANSMITTER UNIT

A unit is comprised of a different sensor, a micro-controller, ZigBee and power sources. Transmitter unit is based on the micro-controller that controls the radio modem ZigBee and processes information from the soil-moisture sensor, LDR sensor, temperature sensor and humidity sensor. In this transmission unit the sensor data from different sensors (Soil moisture, light, temperature and humidity) are collected in the main controller. This data is displayed on transmission section LCD.

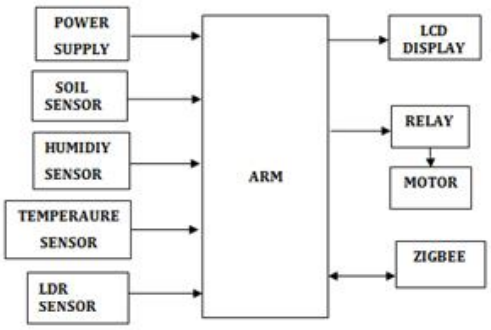

Fig: Field section

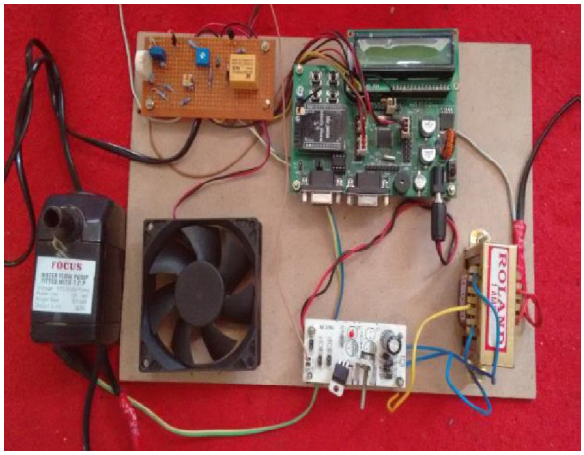

Fig: Transmitter unit

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.

A. RECEIVER UNIT

The soil moisture, temperature, Light and humidity sensor data received using ZigBee radio modem. This information is send to PC where statuses of all these sensors are display using hyper terminal or flash magic application. The data from the transmission section is received by ZigBee communication modem.

Fig: Monitor section

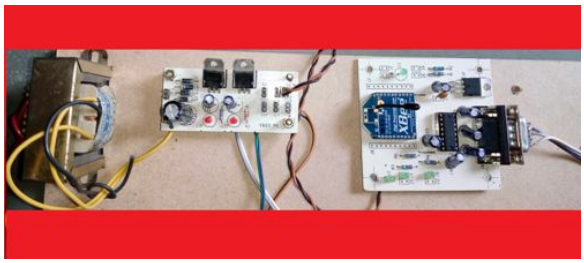

Fig: Receiver unit

I. Hardware system:

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.

ARM7TDMI: ARM is the abbreviation of Advanced RISC Machines, it is the name of a class of processors, and is the name of a kind technology too. The RISC instruction set, and related decode mechanism are much simpler than those of Complex Instruction Set Computer (CISC) designs.

Liquid-crystal display (**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.

II. Board hardware resource features

ZIGBEE:

Zigbee modules feature a UART interface, which allows any microcontroller or microprocessor to immediately use the services of the Zigbee protocol. All a Zigbee hardware designer has to do in this case is ensure that the host's serial port logic levels are compatible with the XBee's 2.8- to 3.4-V logic levels. The logic level conversion can be performed using either a standard RS-232 IC or logic level translators such as the 74LVTH125 when the host is directly connected to the XBee UART. The X- Bee RF Modules interface to a host device through a logic-level asynchronous Serial port. Through its serial port, the module can communicate with any logic and voltage Compatible UART; or through a level translator to any serial device.

Data is presented to the X-Bee module through its DIN pin, and it must be in the asynchronous serial format, which consists of a start bit, 8 data bits, and a stop bit. Because the input data goes directly into the input of a UART within the X-Bee module, no bit inversions are necessary within the asynchronous serial data stream. All of the required timing and parity checking is automatically taken care of by the X-Bee's UART.

Temperature sensor:

A thermistor is a type of resistor whose resistance is dependent on temperature. Thermistors are widely used as inrush current limiter, temperature sensors (NTC type typically), self-resetting overcurrent protectors, and self-regulating heating elements. The TMP103 is a digital output temperature sensor in a four-ball wafer chip-scale package (WCSP). The TMP103 is capable of reading temperatures to a resolution of 1°C.

Fig: Temperature sensor

Light dependent resistor:

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically. The general purpose photoconductive cell is also known as LDR – light dependent resistor. It is a type of semiconductor and its conductivity changes with proportional change in the intensity of light. The

complete principle of an LDR is as follows. In a semiconductor an energy gap exists between conduction electrons and valence electrons.

Fig: LDR

As an LDR is also known as semiconductor photo-conductive transducer, when light is incident on it, a photon is absorbed and thereby it excites an electron from valence band into conduction band. Due to such new electrons coming up in conduction band area, the electrical resistance of the device decreases. Thus the LDR or photo-conductive transducer has the resistance which is the inverse function of radiation intensity.

$$\lambda_0 = \frac{h.c}{e.E_\omega}$$

Where,

λ0 = threshold wavelength, in meters

e = charge on one electron, in Coulombs

Ew = work function of the metal used, in eV

Relays:

There are four relays connected. It operates in two modes:

1. Normally Open
2. Normally Closed

Different devices can be controlled i.e. they can be turned On/Off whenever required.

Humidity sensor:

Humidity sensor is a device that measures the relative humidity of in a given area. A humidity sensor can be used in both indoors and outdoors. Humidity sensors are available in both analog and digital forms. An analog humidity sensor gauges the humidity of the air relatively using a capacitor-based system. The sensor is made out of a film usually made of either glass or ceramics. The insulator material which absorbs the water is made out of a polymer which takes in and releases water based on the relative humidity of the given area. This changes the level of charge in the capacitor of the on board electrical circuit. A digital humidity sensor works via two micro sensors that are calibrated to the relative humidity of the given area. These are then converted into the digital format via an analog to digital conversion process which is done by a chip located in the same circuit. A machine made electrode based system made out of polymer is what makes up the capacitance for the sensor. This protects the sensor from user front panel (interface).

Fig: Humidity sensor

Soil sensor:

The two copper leads act as the sensor probes. They are immersed into the specimen soil whose moisture content is under test. The soil is examined under three conditions:

STEP1: Dry condition- The probes are placed in the soil under dry conditions and are inserted up to a fair

depth of the soil. As there is no conduction path between the two copper leads the sensor circuit remains open. The voltage output of the emitter in this case ranges from 0 to 0.5V.

STEP2: Optimum condition- When water is added to the soil, it percolates through the successive layers of it and spreads across the layers of soil due to capillary force. This water increases the moisture content of the soil. This leads to an increase in its conductivity which forms a conductive path between the two sensor probes leading to a close path for the current flowing from the supply to the transistor through the sensor probes. The voltage output of the circuit taken at the emitter of the transistor in the optimum case ranges from 1.9 to 3.4V approximately.

STEP3: Excess water condition- With the increase in water content beyond the optimum level, the conductivity of the soil increases drastically and a steady conduction path is established between the two sensor leads and the voltage output from the sensor increases no further beyond a certain limit. The maximum possible value for it is not more than 4.2V

Fig: Soil sensor

III. EXPERIMENTATION AND RESULTS

When soil moisture value is less than the threshold value then the motor is start automatically and soil moisture value is more than the threshold value then the motor is stop automatically. There are different conditions for the automation of the irrigation system depends on the sensor values and these conditions are given in Table1 and Table2.

Table1

Temperature Value	FAN
Less than threshold	OFF
More than threshold	ON

Table2

Soil Moisture	Motor
Dry	ON
Wet	OFF

IV. CONCLUSION:

This system is reduces the water use because it provide irrigation as per the requirement of the crop. This system is automated irrigation system so it reduces the human resources. This irrigation system was found to be feasible and cost effective for optimizing water resources for agricultural production. The irrigation system can be adjusted to a variety of specific crop needs and requires minimum maintenance.

Using this system we can monitor the status of all the sensors (Soil-moisture, Temperature, Light, Humidity) and also the ON/OFF status of the motor and Fan.

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