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COMPLETE IRRIGATION SOLUTION USING WIRELESS SENSOR NETWORKS

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***Abstract*— Using Wireless Sensor Network, this proposed system gives a complete irrigation solution. Sensor networks are highly distributed networks of small lightweight wireless nodes which are deployed in large numbers to monitor the environment or system. Building sensors has been made possible by the recent advances in micro-electro mechanical systems (MEMS) technology. The challenge is to create an automated irrigation system which prevents the wastage of water, and fertilizers and also uses minimum power to the possible extent. Different physical parameters are measured using sensors in order to calculate the efficient quantity of water needed by the plants. In this paper, the objective is to realize the necessary requirements using low-cost sensors with reduced power consumption.**

***Index Terms*— Humidity Sensor, Soil Moisture Sensor, Temperature Sensor, Wireless Sensor Network, ZigBee.**

INTRODUCTION

Wireless Sensor Networks (WSNs), sometimes are also called Wireless Sensor and Actuator Networks (WSANs). WSNs are distributed sensors which are used to monitor physical or environmental conditions. The information collected through these sensors are then sent to the main location. Initially, wireless sensor networks were used for military purposes such as the surveillance of the battlefield, but today one can find these networks being used in many industrial and consumer applications.

The WSN is built of nodes, where each node is connected to one sensor or sometimes several sensors. The number of these nodes may vary from a few to several hundreds or even thousands. Each node of the sensor network consists of three subsystems, they are: the sensor subsystem which senses the parameters required, the processing subsystem where the computations or the processing of the sensed data takes place, and the last subsystem is the communication subsystem through which the neighboring sensor nodes exchange messages. When a single sensor is used, its sensing region, processing power, and energy are all limited, whereas, when a large number of sensors are used, a wider region can be sensed and the sensed information will also be reliable and accurate as many nodes would be sensing the same event. The propagation of data throughout the network and the collection of observed data from individual sensor nodes to a sink are the two most important operations in a sensor network.

Sensor networks are used to monitor a variety of conditions such as temperature, humidity, pressure, characteristics of objects and their motions. Sensor nodes are used in the fields of military, health, chemical processing, and disaster relief scenarios. Some of the academic and industry supported research programs on sensor networks include working on Smart Dust at the University of California, Berkeley (UCB), and wireless integrated network sensor (WINS) at the University of California, Los Angeles (UCLA).

LITERATURE SURVEY

With reference to [1], the WSN was deployed in the paddy fields in Kuttanad, India. The soil in these fields are salty and acidic in nature. This acidity can be neutralised by regular rinsing of the soil with water. Hence, a soil sensor was used to find the acid level in the soil and in turn the quantity of water required to neutralise the acidity of the soil.

With reference to [2], a WSN with a sensor which senses the temperature and moisture of the soil was deployed in the fields. The program was developed such that, in addition to the above parameters, it also checked the battery levels of the sensors used. To run the circuit, a 12V direct current power supply was required.

With reference to [3] a smartphone is used as a sensor where a smartphone is placed at the root level within a chamber and it uses the camera of the smartphone to senses the soil moisture by taking the picture of the soil at the root level. This image is enhanced and the ratio between dry and wet is calculated. But the drawback is that it’s very limited and for every 100ft a smartphone has to be placed at the root level. Instead

With reference to [4] smart irrigation system using sensor network, the amount of water is calculated by the device is sent to the user (PC) using a serial communication and the decision is made. Here PC is the bridge between the device and the water pump where both are connected serially to the PC

With reference to [5] a drip irrigation system using wireless sensor network the water to be supplied depends on a priority based protocol where information from soil sensor and temperature sensor is gathered and based on the need the user can make the decisions.

EXISTING MODEL

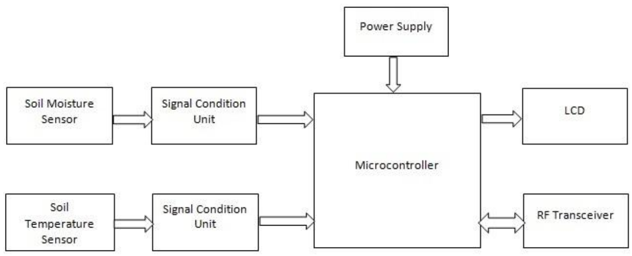


Fig (a): Transmitting Block of Irrigation system

Fig (b): Receiving Block of Irrigation system

In the existing model, the WSN consists of a soil moisture sensor, soil temperature sensor, RF transceiver, and microcontroller. The temperature and the moisture of the soil are sensed and the sensed values are sent to the microcontroller through the signal condition unit. The values are displayed on the LCD as well as sent to the PC via RF transceiver. According to the collected data, the required decisions are taken. A 12V direct current power supply is required to run this circuit.

PROPOSED METHOD

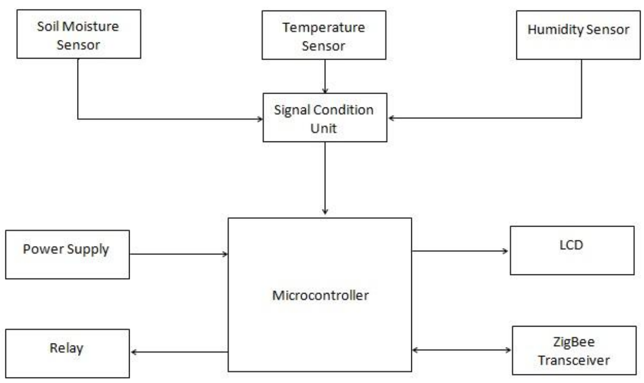


Fig (c): Transmission Block of Irrigation system

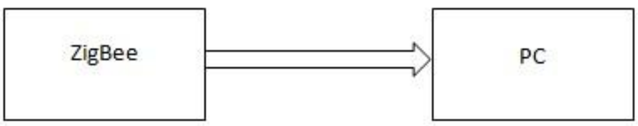


Fig (d): Receiving Block of Irrigation system

The proposed method uses a soil moisture sensor, temperature sensor, and a humidity sensor. The soil moisture sensor used is LM-393. It has an operating voltage range of 3.3 V to 5 V. The probe of this sensor is inserted into the soil for approximately 60 seconds to know whether the soil is too dry, moist or too wet for the plants. LM-35 is the temperature sensor used. It draws only 60 µA current from the power supply, as a result, it has very low self- heating, which is less than 0.1ºC in still air. It operates in the voltage range of 4 V to 30 V. The humidity sensor used is HSM-20G. This is essential for those applications where the relative humidity can be converted to standard voltage output. It has an input voltage range of 4.8 V to 5.2 V and output voltage range of 1 V to 3 V. The maximum operating current it requires is 2 mA.

The microcontroller used in this paper is ATMEL-AT89C51. It is an 8-bit microcontroller, with an operating frequency of 11.0592 MHz and an operating voltage range of 4.5 V to 5 V. It has 4 KB on chip program memory and 128 bytes on chip data memory. A signal condition unit is nothing but an Analog to Digital Converter (ADC). ADC0808 is analog to digital converter used in the proposed model. It is a unidirectional 10-bit ADC. It has 8 channels; hence, up to 8 sensors can be connected to it at a time. The ZigBee transceivers are used to communicate between the transmitting block and the receiving block. ZigBee is an improvised RF transceiver which is usually used for low power, low data rate wireless monitoring and control applications in sensor networks. The circuit in this paper runs on solar energy. Photovoltaic cells are used to charge a battery, which in turn, powers the circuit. The battery used here is a rechargeable battery.

IMPLEMENTATION

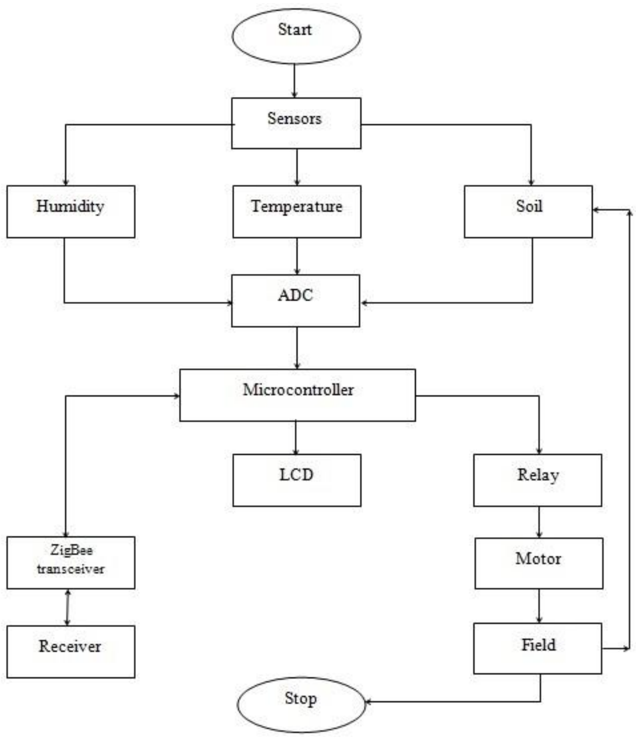
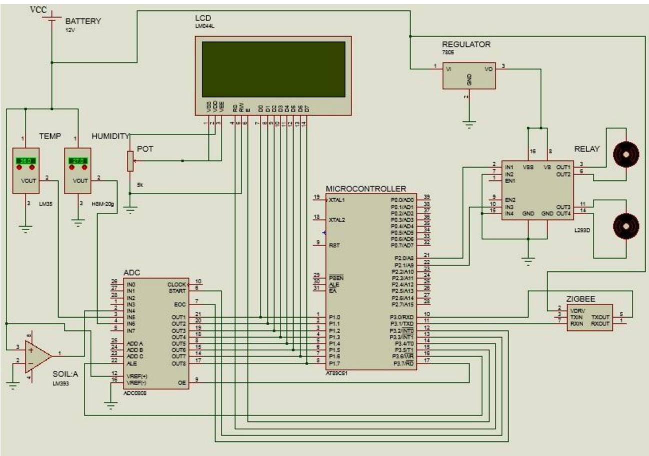


Fig (e): Flowchart

The parameters sensed by the three sensors are sent to the microcontroller through the ADC. All the signals sensed by the sensors are analog in nature, but a microcontroller cannot process analog signals, it can only process digital signals. Hence, an ADC is used before the microcontroller. The microcontroller on receiving the data, processes it and checks whether the soil moisture is in the desired range or not. If it is below the required amount, then it sends a signal to the motor to switch ON and the water flows out. Once the moisture level of the soil reaches the desired point, the motor switches OFF automatically. The moisture levels of the soil before watering and after watering are displayed on the LCD and the same is sent to a PC through ZigBee transceiver. The temperature and humidity levels are also displayed on the LCD and sent to the PC, but the microcontroller does not take decisions on whether to water the plants or not, based on these parameters. These parameters, on the other hand are used by the farmer to switch ON or switch OFF the motor. That is, by checking the temperature and humidity, the farmer from his experience, or for any other reason, may feel there is no need to water the plants, even if the soil moisture is not within the required range. In such a case, the farmer can switch off the motor using terminal windows on his PC.

Simulation Results



Fig(f): Interface diagram

The above fig(f) shows how the different components of the circuit are interfaced with each other.

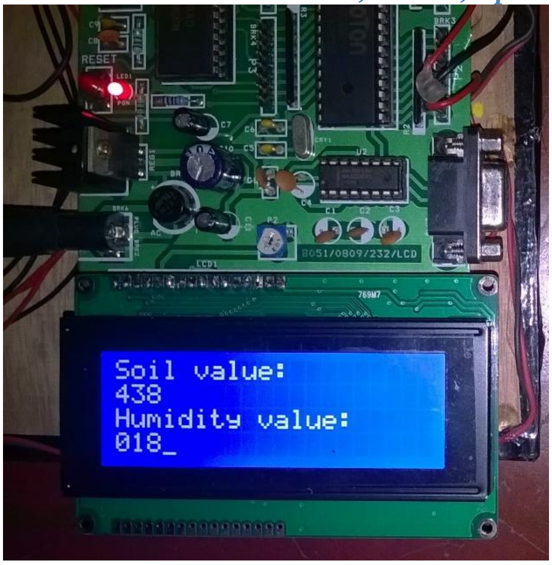


Fig (g): Display of soil moisture and humidity value on LCD.

Fig (g) shows the soil moisture value and the humidity value. Here the moisture value of the soil sensed by the soil moisture sensor is seen to be 438, which according to this paper is above the required range. Hence, the motor doesn’t switch ON. The humidity value is seen to be 18.

Fig (h): Display of battery level and temperature value on LCD.

Fig (h) shows the battery level as well as the voltage value the battery is receiving from the photovoltaic cells. The temperature value sensed by the temperature sensor is also been displayed.

Tools Used

KEIL µVision:

Keil is a company which implemented the first C compiler designed specifically for 8051 microcontroller. It supports every level of software developer.
The Keil µVision debugger accurately simulates on-chip peripherals of 8051 device. Simulation helps in hardware configuration. With simulation we can write and test applications before target hardware is available.

CONCLUSION

In this system the combination of sensors and ZigBee based wireless network has been tested and seen that it is more effective and efficient. Complete irrigation system and wireless sensor network applications, both combined improved the quality of precision irrigation and agricultural production. As low cost sensors are used, the implementation cost of the system is very low. Renewable energy is used as photovoltaic cells are used to power the battery which runs the circuit.

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