Research Paper Engineering

Embedded System for Automatic Irrigation Using Xbee-Pro Technology

*Amogh Inamdar

* B.E. ECT Final Year Student, Jawaharlal Nehru Engineering College, Aurangabad-431 003.India

ABSTRACT

This project proposed an embedded system for automatic irrigation which has a wireless sensor network for real time infield sensing and control of an irrigation system. This system provides uniform and required level of water for both plain and slope areas and therefore it avoids the water overflow at the slope areas which saves the plant and also water This system also senses the water level of the tank and whenever the water level is too low then the system immediately provides a visual and sound alarm and then it automatically switches ON the motor. When the water level reaches 90% of the tank then the motor is switched OFF through the remote system. Communication signals from the sensor network and irrigation controller to the base station interfaced using Xbee-PRO communication and this technology is a low-cost, low-power wireless sensor network.

Keywords : Embedded System, Irrigation, PIC Microcontroller, Wireless Communication, Xbee-PRO

INTRODUCTION

This project develops an automatic irrigation system based on the vital parameters like Temperature, Humidity and soil moisture. The system has two modes one is manual mode the other is automatic mode. The set points may be varied manually according to the season to satisfy the given conditions for the irrigation. Field conditions were site-specifically monitored by in-field sensor stations distributed across the fields divided based on a high, low, sloppy and flat areas, then wirelessly transmitted to a base station by using XBee-PRO technology. The base station sends the control signals to the field station by same technology. The tank water level is monitored and controlled for continuous irrigation. This irrigation system is controlled by base station that automatically updates the valves for specified location. The proposed system uses some conditions to start the proper irrigation such as the current temperature should lie in between the maximum and minimum values of set points. The current humidity is less than the minimum value and current soil moisture should also be less than the minimum value of the set point. If these three conditions are satisfied then the system automatically starts the irrigation. The field does not need irrigation whenever there is a very cool temperature, high humidity and too soil moisture. If any of the field area reaches the maximum values or equals to the humidity or moisture then the base station stops irrigation process of that particular area only.

IRRIGATION SYSTEM DESIGN PROCESS

The system design process consists of the following steps as shown figure 2 and these steps are referred as the major levels of abstraction in the design process. There are two types of designing methods, one is Top-down method and the other is Bottom-up method. This work adopts the Top-down method.

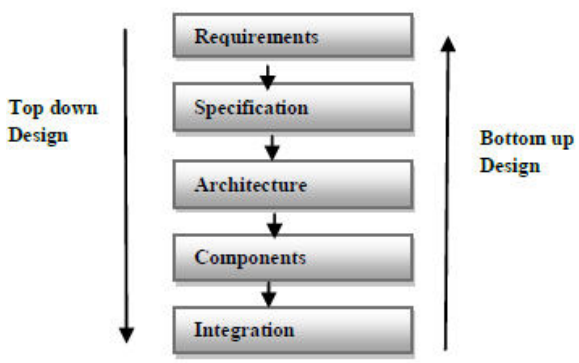


Fig 2: Major levels of abstraction in the design process

2.1 Requirement Analysis for the irrigation system:

The Requirement phase is the first level in which the functional and non functional requirements like performance cost, physical size and weight and power consumption for developing the proposed project were analyzed.

2.2 Specification Level:

The Specification level reflects the requirements specified in the first level, it says only what the system does and not how to implement. In this proposed work the specification of the automatic irrigation system includes,

- Data received from XBee-PRO (1200M)
- User interface
- Sensor data to the Microcontroller
- LCD Display
- Alarm monitoring

2.3 Architecture Level:

The Architecture level is a plan for overall system that will be

used to design the components that make up the architecture. The system architecture further refined in to Hardware and software architecture to ensure all specifications. It shows the components required to build the project. The architecture should satisfy the functional and non functional requirements.

Component Level:
The Component level involves in designing the hardware and software components. First we have to decide that either to buy the components which are readymade, for example CPU, memory and I/O, or build by ourselves. If we buy the components then the design time will be reduced and also increases the implementation speed.

2.5 Components Description

2.5.1 Temperature Sensor
The LM35 series are precision integrated-circuit temperature sensor. The LM35 is rated to operate over a −55° to +150°C temperature range. The proposed system maintains the temperature range between 240C to 350C. This value manually is changed according to the seasonal temperature using the manual mode.

2.5.2 Humidity Sensor
This sensor senses the field humidity and is connected to microcontroller. We use the set points of Humidity as 54% to 80% for standard irrigation, but this is changeable according to the climate and type of soil. In this situation we can change the set points manually for proper irrigation

2.5.3 Soil Moisture Sensor
Grid-like resistance-type sensor senses the moisture on vegetation from 0% (dry) to 100% (wet). The sensor is a circuit board with interlacing fingers. Condensation on the sensor lowers the resistance between the fingers, which is measured by a data logger. The proposed system uses the moisture range in between 50% to 70%.It can be changed manually whenever we want.

2.5.4 Mist Emitter
Mist irrigation, also known as micro irrigation is an irrigation method which saves water by allowing water to mist to the plants, either onto the soil surface or directly onto the leaf zone, through a network of valves, pipes, tubing, and emitters. Mist irrigation system is used largely to create a suitable microclimate within the plant eco-system to create favorable environment for growth, flowering and seed setting. The frequency of operation of irrigation system depends on the macroclimate in the plantation and hence has to be standardized for specific local weather situation.

2.5.5 PIC Micro Controller
A microcontroller is a compact standalone computer, optimized for control applications. Entire processor, memory and the I/O interfaces are located on a single piece of silicon so, it takes less time to read and write to external devices. The proposed work is developed using PIC 16F877A microcontroller. The positioners and switches are controlled remotely through the microcontroller. This microcontroller have inbuilt ADC.

2.5.6 Xbee-PRO
XBee and XBee-PRO 802.15.4 OEM RF modules are embedded solutions providing wireless end-point connectivity to devices. These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking. They are designed for high-throughput applications requiring low latency and predictable communication timing. XBee modules are ideal for low-power, low-cost applications. XBee-PRO modules are power-amplified versions of XBee modules for extended-range applications. Module users have the ability to substitute one XBee module for another with minimal development time and risk. XBee products are offering users seamless wireless communication between devices, including adapters and gateways. Create distributed sensor systems and intelligent interactive devices using the XBee wireless networking protocol and Series 2 XBee radios. XBee wireless network delivers the remotely sensed data.

2.5.7 Xbee-PRO Interfacing
XBee and XBee-PRO 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.

2.6 Integration
The System Integration is not simply plugging everything together but also finding the bug at this stage. In Embedded system, the system integration is a challenging task, since it is difficult to find why things are not work properly. Due to limited facility at the target system, we have to go to host system for testing. This proposed system has two modules, one is Field station and the other is Base station. The base station analyzes these parameters with set points for proper irrigation. When ever need the irrigation then sent the valves open signal for specified area by using the Xbee-PRO wireless technology. The Xbee-PRO technology has reached the long distance as 1200M.

3. SOFTWARE DISCRIPTION

3.1 MPLAB IDE

MPLAB IDE is a development system for embedded controllers, a system of programs running on a desktop PC to help write, edit, debug and program code. It has the intelligence of embedded systems applications to download into a microcontroller. MPLAB IDE runs on a PC and contains all the components needed to design and deploy embedded systems applications. It is called an Integrated Development Environment, or IDE, because it provides a single integrated “environment” to develop code for embedded microcontrollers.

3.2 Hi Tech C Compiler
HI-TECH C PRO compilers enabled with Omniscient Code Generation (OCG), a whole program Compilation technology, to facilitate more intelligent, state-of-the-art code generation and enhance product usability. Omniscient Code Generation has been developed to read and process all C source modules in one step and can deliver denser code. A HI-TECH C compiler allows more comprehensive debugging of code, even with the optimizations turned on.

3.3 Embedded C
Embedded C is a set of language extensions for the C Programming language. C is often used for “system programming”, including implementing applications, due to a combination of desirable characteristics such as code portability and efficiency, ability to access specific hardware addresses, and low run-time demand on system resources. Some reasons for choosing C over interpreted languages are its speed, stability, and near-universal availability.

3.4 VB.Net
In this proposed system VB.NET is used as a front end of the base station. This software analyzes the data from Xbee-PRO and control the Irrigation. This base station set the set points of temperature, Humidity and soil moisture then receives the present parameters from field station using Xbee-PRO technology. The irrigation decision is taken based on the following condition which is written at the base station coding.

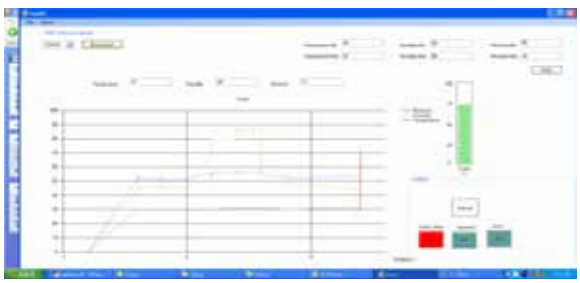
4. RESULTS AND DISCUSSION

Case 1: Irrigation ON

In case 1 the temperature is in between to the minimum and maximum value that are acquired from the field sensor, and received by the base station. The irrigation process starts until its remains in that values.

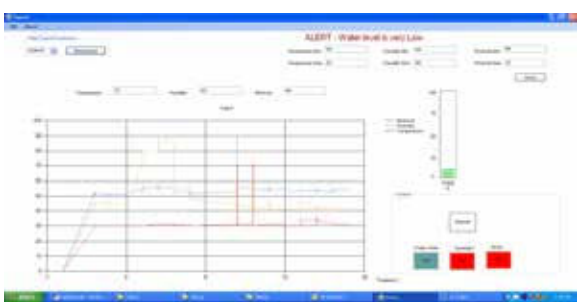
Case 2: Irrigation OFF

In case 2 the temperature and Humidity values are satisfies but Moisture level is exceeds the maximum values so irrigation cannot done here. Then the sprinkler is stop. The irrigation will again start only when the humidity values are below the minimum value. Water main remains constant at every Case.



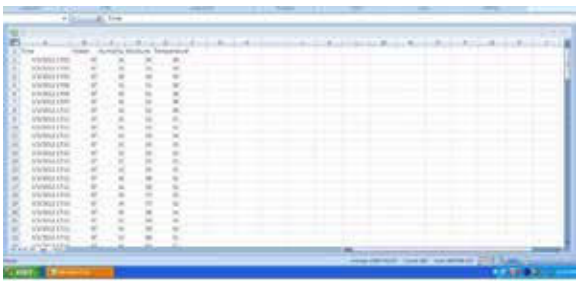
Case 3: Motor ON

In case 3 water is the main fact that is required to do the proper irrigation. In this case the water level sensor senses the water level continuously, if it is below than the set point (minimum value) then immediately the irrigation process will be terminated, and the motor is automatically switched on to fill the tank.



Case 4: Motor OFF

In case 4 the water level is low, then the irrigation process will be automatically stops. Whenever the tank reaches its maximum level then motor will be stopped. And again it starts the irrigation process according to the sensor conditions.



6. CONCLUSION

Embedded system for automatic irrigation offers a potential solution to support site-specific irrigation management that allows producers to maximize their productivity while saving the water. This project is designed using PIC16F877A microcontroller. The temperature and humidity sensors detect the field temperature and field humidity, the moisture sensor detects the soil moisture and then the sensor values are sent to the base station. The base station checks the conditions for irrigation and performs automatic irrigation. There are two modes for performing the irrigation, one is automatic and the other is manual. The mist emitters can also be controlled manually whenever we require. Field conditions were site-specifically monitored by in-field sensor stations based on high, low, sloppy and flat areas. This irrigation system updates solenoid valves for specified location of mist emitters automatically according to the maximum and minimum values of temperature, humidity and moisture in the control system for a proper irrigation. Each field station are wirelessly communicates with a base station by Xbee PRO technology. The modules operate within the 2.4 GHz frequency band and outdoor RF line-of-sight range up to 4000 ft. (1200 m) with RF data rate of 250,000 bps.

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