ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 19, April 2016

A Software Analysis of Smart Irrigation System for Outdoor Environment Using Tiny OS

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Abstract;-In recent years wireless sensor networks are widely used in many automated system like vehicle monitoring, heavy duty plants, robotic control etc. One of the best automated systems is the smart irrigation system. Our system deploys wireless sensor motes from a wireless sensor network. The system is modeled in outdoor environment using TINY OS based IRIS motes to measure the moisture level of the paddy field and to set the threshold value. MDA100CB sensor motes can measure up to -40°c to 80°c and operate at a range between 1.6 to 2.7 volts. The proposed scheme is simulated and uses data visualization and monitoring tool MOTEVIEW 2.0f developed by crossbow technology.

Keywords;- irrigation, tiny /OS, MOTO Tier, low power system

I.INTRODUCTION

As we know water is essential and important resource in the world, whose value increase day by day. Especially country like India which has got more population depends only on this resource. If we save a drop of water it will be a great resource for tomorrow. In olden days our elder used large amount of water agriculture. The proposed work, monitor the level of water in the field to control the same through sensor from remote station. Rizwin Shooja et al (2010) discusses the proposed Vehicle Speed Monitoring and Traffic Routing System (VSMTRS) utilizes WSN wherein a sensor node is installed in all automobiles which can communicate among themselves and with a Central Monitoring Station (CMS), along with the sensor nodes placed at appropriate points on the roads. Martin Turonet al (2005) discusses that paper presents a scalable software framework for managing, monitoring, and visualizing sensor network deployments called MOTE-VIEW.

representation presents a variety of challenges and has become a vital component of sensor networks. Marco Gattusoet al (2010) discussesWireless Sensor Networks (WSNs) are more and more used in several and heterogeneous contexts (e.g. home automation, health and process control systems). Furthermore, the design of new simple protocols and wireless telecommunication systems allow create cheap architectures to easily monitor harsh environments. Mokhloss I et al (2012) discusses that paper presents a data acquisition system that is capable to monitor and measure three types of environmental parameters: dust, temperature, and humidity. The remote board containing sensors and processing circuits is connected to the server through wireless network. The analogue to digital conversion is realized by data acquisition card (MDA300). Tarun Dubeyet al (2013) discusses simple, practical and cost effective localization scheme that can be used to manually deploy wireless sensors to form wireless sensor networks (WSNs). Outdoor environments using

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commercially available IRIS XM2110 sensor motes. The outcome of experiments performed on data visualization and monitoring tool Mote View 2.0.F developed by Crossbow
Technology.

Venkatesh.K etal (2013) discusses the main objective of the present paper is to develop a smart wireless sensor network (WSN) for an agricultural environment. Monitoring agricultural environment for various factors such as temperature and humidity along with other factors can be of significance.

V.Divya,et al (2013) discusses the main aim of the work is to simplify the method of irrigation using vocal commands through the mobile phone. The Farmer just needs to call a fixed number and utter the control commands through his phone. The control system at the field involves a PIC microcontroller interfaced with GSM modem to receive the command from the farmer and a voice recognition unit which decodes it. Irrigation systems are completely automated after the invention of wireless sensor networks. In most of the developed countries economic growth depends on agriculture. Due to water scarcity problem a predetermination of water level is a mandatory for paddy field. Monitoring of water level can automated using many techniques available and among them wireless technology stands in first place. Wireless technology leads to a smart irrigation system. It uses sensor nodes to measure the humidity level present in the soil there by intimating it to the motor room in any good land of paddy field. Most of the traditional system use microprocessor and zigbee module. Zigbee is interfaced with the processor which receives the wireless sensor data kept away from the motor control room of a paddy field. One of the limitations faced by the traditional system is number of nodes. Also as system design point of view is considered traditional system are complex in nature. Hence a new sensor network system is developed by researchers from Berkely University. The new WSN is named as motes which are designed for specific application and run by RTOS named as TinyOS. Applications are written in MOTEWORKS for reading and sending message to the sensor. Proposed mote has got better visualization and monitoring GUI. TinyOS Supports external interfaces with its own board processor. We proposed a new model which introduces a smart irrigation system for any type of dry level soil

II. OVERVIEW

MoteWork is the end-to-end enabling platform for the creation of wireless sensor networks. The optimized processor/radio hardware, industry-leading mesh networking software, gateway server middleware and client monitoring and management tools support the creation of reliable, easy-to-use wireless OEM solutions. OEMs are freed from the detailed complexities of designing wireless hardware and software enabling them to focus on adding unique differentiation to their applications while bringing innovative solutions to market quickly.

MoteWorks Network Landscape

A wireless network deployment is composed of the three distinct software tiers:

1. The **Mote Tier**, where XMesh resides, is the software that runs on the cloud of sensor nodes forming a mesh network. The XMesh software provides the networking algorithms required to form a reliable communication backbone that connects all the nodes within the mesh cloud to the server.
2. The **Server Tier** is an always-on facility that handles translation and buffering of data coming from the wireless network and provides the bridge between the wireless Motes and the internet clients. X Serve and XOtap are server tier applications that can run on a PC or Stargate.
3. The **Client Tier** provides the user visualization software and graphical interface for managing the network. Crossbow provides free client software called MoteView, but XMesh can be interfaced to custom client software as well. The software platform provided with MoteWorks™ is optimized for lowpower battery-operated networks and provides an end-to-end solution across all tiers of wireless sensor networking applications.

XMesh Mote Tier

XMesh is a full featured multi-hop, ad-hoc, mesh networking protocol developed by Crossbow for wireless networks. An XMesh network consists of nodes (Motes) that wirelessly communicate to each other and are capable of hopping radio messages to a base station where they are passed to a PC or other client.

XMesh provides a TrueMesh networking service that is both self-organizing and self-healing. XMesh can route data from nodes to a base station (upstream) or downstream to individual nodes. It can also broadcast within a single area of coverage or arbitrarily between any two nodes in a cluster. Also, XMesh can be configured into various power modes including HP (high power), LP (low power), and ELP
(extended low power).

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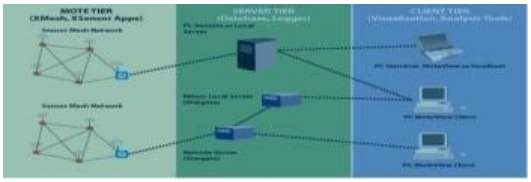

Fig 1. XMesh Landscape

XServe Server Tier

XServe serves as the primary gateway between wireless mesh networks and enterprise applications interacting with the mesh. At its core, XServe provides services to route data to and from the mesh network with higher level services to parse, transform and process data as it flows between the mesh and the outside applications. Higher level services are customizable using XML based configuration files and loadable plug-in modules.

XServe offers multiple communication inputs for applications wishing to interact with XServe or the mesh network. Users can interact with XServe through a terminal interface applications can access the network directly or through a terminal interface applications can access the network directly or through a powerful XML RPC command interface.

MoteView Client Tier

MoteView is the client user interface that enables MoteWorks to deliver an end-to end solution across all tiers of wireless sensor networks. MoteView displays the information from the network to developers or end-users. The entire network or individual nodes can be displayed and analyzed in graphical charting or textual format. MoteView's playback capability allows historical viewing of network status and sensor readings over time, and is based on the logging information stored in XServe. MoteView's analysis capabilities allow automatic email alerts when user-definable conditions are met. For example, if RF links are re-routed because of changes in the environment or sensor readings exceed a specified threshold, an e-mail will alert an operator or field technician via PDA or mobile phone. MoteView enables end-users to optimize network layout and configuration, analyse sensor information interactively and then take corrective action. MoteView provides an interface to remotely configure motes in the wireless network. Each node can be individually updated with configuration parameters provided by the mote. This makes it transparent for the user of an installed wireless sensor network to configure motes, e.g. change frequency of sensor readings, without requiring any programming knowledge. MoteView also has built-in support for Crossbow's entire range of sensor boards, enabling very fast prototyping. If custom sensor boards are required for an application, these boards can be integrated for management in MoteView.

Low-Power Operating System - TinyOS

MoteWork includes TinyOS, the opensource operating system originally developed by University of California, Berkeley. TinyOS has developed a broad user community withthousands of developers, making it the standard operating system for wireless sensor networking in the research community. It is also the most widely-deployed wireless sensor network operating system for commercial applications. TinyOS is a componentbased, event-driven operating system designed from the ground up for low-power devices with small memory footprint requirements. TinyOS supports microprocessors ranging from 8-bit architectures with as little as 2 KB of RAM to 32-bit processors with 32 MB of RAM or more. It provides a well-defined set of APIs for application programming. These APIs provide access to the computing capabilities of the sensor node, allowing for intelligence within the network. Using these capabilities, sensor data can be pre-processed on the node, optimizing both network throughput and battery life by avoiding unnecessary send and receive messages.

III. PROPOSED IRRIGATION SYSTEM

The whole system is integrated in to different blocks as shown in Fig 2.1. The moisture pattern of the soil is tested by means of the moisture sensor. The motor is interfaced with a driver circuit designed for the mote which is going to be interfaced with the submersible motor. The hardware interfaced mote data will be read out by the gateway base station through router which is nothing but another mote. The moisture level is tested for a threshold value if the voltage exceeds that threshold it represents the driest soil. The motor will be automatically switched on by pressing the button task of the visualization panel. Thus a closed loop WSN based motor control is implemented as shown in Fig. 2.1.

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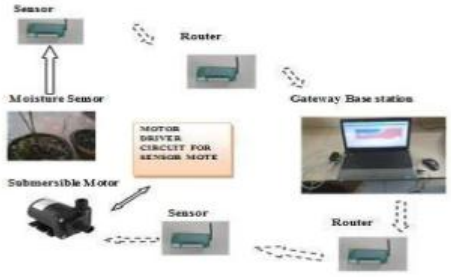

Fig.2. Block Diagram of Proposed Smart Irrigation System

3.1 Motor Driver Circuit

The driver circuit for the mote and motor interface is shown in Fig.2.2. The motor is switched ON and OFF by a relay coil operated at a range of 12 V supply. The relay switching is done by a common emitter transistor. The collector current is given to the input relay coil. The transistor base input voltage is obtained from the mote which is given as an input from the mote.

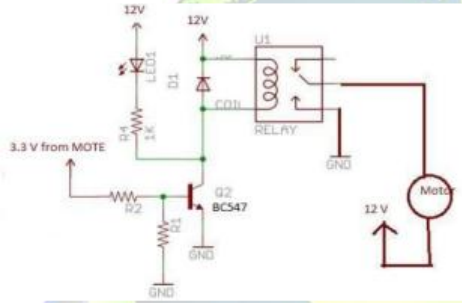

Fig 3. Motor driver circuit

IV. PROGRAM AND FLOWCHART

The sensor board can be able to send and receive data up to eight analog to digital values. We are using the adc3 for getting the threshold value for the driest soil. We have used the external interface pin of the sensor board for reading the adc3 output. The small section of the program code runs in the server side for reading the adc3 output using NesC program is shown in Fig. 2.3 The whole program flow is given as flow chart as shown in Fig 4.

```
* Photocell ADC data ready
* Read and get next channel.
* Send data packet
async event result_t Light.dataReady(uint16_t data) {
    atomic pack.xData.datap1.photo = data ;
    post photostop();
    post tempstop();
    call ADC2.getData();
    TOSH_uwait(100);
    return SUCCESS;
}

async event result_t ADC2.dataReady(uint16_t data) {
    atomic pack.xData.datap1.adc2 = data ;
    call ADC3.getData();
    return SUCCESS;
```

Fig 4. Program code

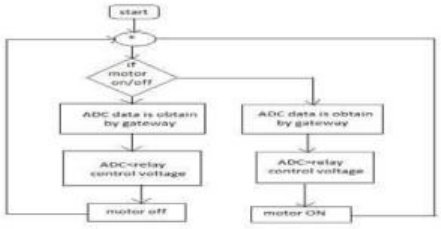

Fig5. Flow Chart of the ON-OFF control

4.1 Software Development Tools

MOTEWORKS is provided with a set of software development tools for end to end communication enabling platform to create a wireless sensor networks. The software platform provided to lowpower, battery-operated or solar operated networks and provides an end-to-end communication across all tiers of wireless sensor network applications. These are Mote Network tier, Server tier and Client tier (MOTE-VIEW). Tiny OS is an open source component-based low power operating system. It is designed only for embedded system application. It is introduced in collaboration as between the University of California and Intel Research. It's an embedded operating system written in the nesC (network embedded system C) programming language. TinyOS support various controller families and radio boards. TinyOS is specially used for nesC programming language. This language learning is very easy because of same body of existing code. Because TinyOS has million of users this code is very robust, efficient and very easy to bugs. TinyOS was developed primarily for use with networks of small sized sensor devices. A number of trends have been enabled the development of extremely compact, low-power sensors. Smaller size in turn reduces power consumption. The Architecture of TinyOS is shown in Fig.2.5 Low power and small

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size trends are also evident in wireless communication hardware, micro-electrical sensors (MEMS) and transducers.

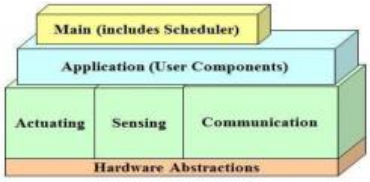

Fig. 6 Architecture of Tiny OS

An interface is used to provide an abstract definition of the interaction of two components. This concept is similar to Java in that an interface should not contain code or wiring. It simply declares a set of functions that the interface's provider must implement commands and another set of functions the interfaces' requirer must implement events. In this way it is different than Java interfaces which specify one direction of call. NesC interfaces are bidirectional. For a component to call the commands in an interface it must implement the events of that interface. A single component may require or provide multiple interfaces and multiple instances of the same interface. These interfaces are the only point of access to the component.

Separation of construction and composition

Programs are built out of components, which are assembled ("wired") to form whole programs. Components define two scopes, one for their specification and one for their implementation. Components have internal concurrency in the form of tasks. Threads of control may pass into a component through its interfaces. These threads are rooted either in a task or a hardware interrupt.

Specification of component behaviour in terms of set of interfaces

Interfaces may be provided or used by the component. The provided interfaces are intended to represent the functionality that the component provides to its user.

Interfaces are bidirectional

Interfaces specify a set of functions to be implemented by the interface's provider (commands) and a set to be implemented by the interface's user (events). This allows a single interface to represent a complex interaction between components. This is critical because all lengthy commands in TinyOS are non-blocking and their completion is signaled through an event (send done). By specifying interfaces, a component cannot call the send command unless it provides an implementation of the send done event.

Use of whole-program compilers

NesC is designed under the expectation that code will be generated by whole-program compilers. This allows for better code generation and analysis. An example of this is nesC's compile-time data race detector.

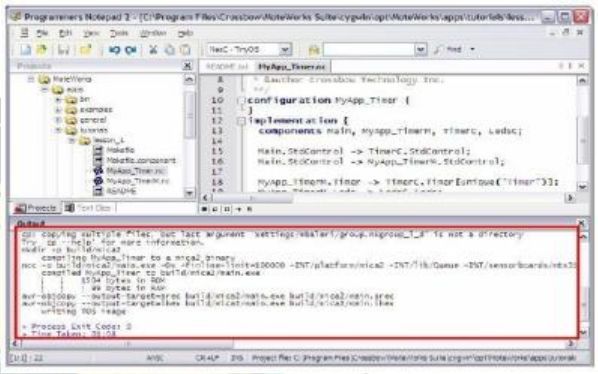

Fig 7. Compilation and Installation of moteworks applications

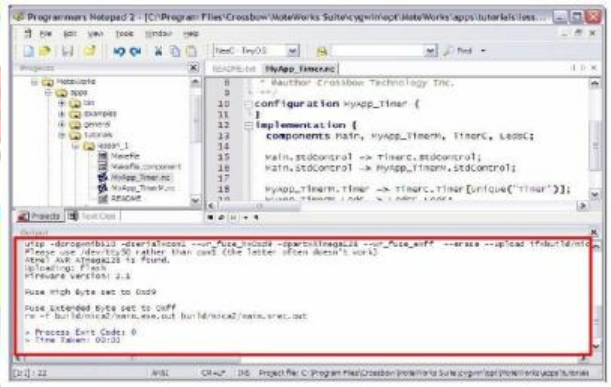

Fig 8. Programming the Flash in to the motes

Mote view is designed to be an interface between a user and a deployed network of wireless sensors. Mote view provides the tools to simplify deployment and monitoring. It is also easy to connect to a
database to analyze and to graph sensor reading. Mote Config is a Windows-based GUI utility for programming Motes. This utility provides an interface for configuring and downloading precompiled XMesh/TinyOS firmware applications

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onto Motes. MoteConfig allows the user to configure the Mote ID, Group ID, RF channel and RF power. The user can also enable the over-the-air-programming feature present on all XMesh - based firmware. Highpower and low-power XMesh applications are available for each sensor board and platform for fig
2.8

Fig9. MoteConfig programming

The thermistor, sensor is a highly accurate and highly stable sensor element. With proper calibration, an accuracy of 0.2 °C can be achieved. The thermistor's resistance varies with temperature in fig 2.9 and graph in fig 2.10. The sensor is connected to the analog-digital converter channel number 1 (ADC1) through a basic resistor divider circuit. In order to use the thermistor, the sensor must be enabled by setting digital control line INT2 high in table 1.

Table 1Thermistor Specifications

Type	YSI 44006
Time Constant	10 seconds, still air
Base Resistance	10 kΩ at 25 °C
Repeatability	0.2 °C

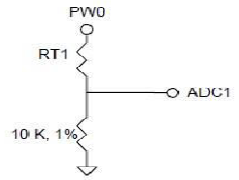

Fig 10. Schematic of the Thermistor on MDA100CB

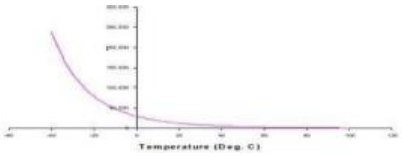

Fig 11.Resistance vs. Temperature

The light sensor is a simple CdSe photocell. The maximum sensitivity of the photocell is at the light wavelength of 690 nm. Typical on resistance, while exposed to light, is 2kΩ. Typical off resistance, while under dark conditions, is 520kΩ. In order to use the light sensor, digital control signal PW1 must be turned on. The output of the sensor is connected to the analog-digital converter channel 1 (ADC1). When there is light, the nominal circuit output is near VCC or full-scale, and when it is dark the nominal output is near GND or zero. Power is controlled to the light sensor by setting signal INT2.

2.7.1.3 Prototyping Area

The prototyping area is a series of solder holes and connection points for connecting other sensors and devices to the MoteConnection and configuration in table 2.

Table 2.2 Connection and configuration for MDA100CB sensor board.

	A	B	C	D	E	F
1	GND	GND	GND	VCC	VCC	VCC
2	OPEN	OPEN	USART1_CK	INT3	ADC2	PW0
3	OPEN	OPEN	UART0_RX	INT2*	ADC1*	PW1*
4	OPEN	OPEN	UART0_TX	INT1	ADC0*	PW2
5	OPEN	OPEN	SPI_SCK	INT0	THERM_PWR	PW3
6	OPEN	OPEN	USART1_RX	BAT_MON	THRU1	PW4
7	OPEN	OPEN	USART1_TX	LED3	THRU2	PW5
8	OPEN	OPEN	I2C_CLK	LED2	THRU3	PW6
9	OPEN	OPEN	I2C_DATA	LED1	RSTN	ADC7
10	OPEN	OPEN	PWM0	RD	PWM1B	ADC6
11	OPEN	OPEN	PWM1A	WR	OPEN	ADC5
12	OPEN	OPEN	AC+	ALE	OPEN	ADC4
13	OPEN	OPEN	AC-	PW7	OPEN	ADC3
14	GND	GND	GND	VCC	VCC	VCC
15	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
16	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN
17	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN

The MIB520 provides USB connectivity to the IRIS and MICA family of Motes for communication and in-system programming. It supplies power to the devices through USB bus. MIB520CB has a male connector while MIB520CA has female connector. The MIB520 has an on-board in-system processor (ISP) which is an Atmega16L located at U14—to program the Motes. Code is downloaded to the ISP through the USB port. Next the ISP programs the code into the Mote.

The "RESET" push button switch resets both the ISP and Mote processors. It also resets the monitoring software which runs on the host PC. The MIB520 has a connector, J3 which connects to an Atmel JTAG pod for in-circuit debugging. This connector will supply power to the JTAG pod and no external power supply is required for the pod. The IRIS is a 2.4 GHz Mote module used for enabling low-power, wireless sensor networks.

V. CONCLUSION

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In this project, WNSs design for outdoor applications, using the Mote Works platform, has been shown. The main advantage of this platform is the simplicity of use through which is possible to create a WSN perfectly working, monitor a given area and store in formation into a database. Now we are working to test network performances in agriculture application with real-time requirements. A smart irrigation system is achieved with the help of Mote View visualisation tool.

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