iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** X **Month of publication:** October 2017

DOI: http://doi.org/10.22214/ijraset.2017.10033

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, October 2017- Available at www.ijraset.com

Global Industrial Process Monitoring and Controlling through ZigBee Technology

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***Abstract:** This is an advanced system for process monitoring and controlling via single board computer called raspberry pi. Thissystem is designed using raspberry pi, ZigBees, and microcontrollers that measure and controls various parameters. The system consists of a single master and multiple nodesconnected through ZigBee. The parameters that can be measured are current, temperature, light intensity (LDR) and water level (LM324). The master (Raspberry pi 3) collects the data from the nodes through ZigBees. This information will be continuously updated on to web page. Monitoring and controlling can be done through mobile or laptop or desktop.*
Keywords: raspberrry pi; wireless; industrial;

I. INTRODUCTION

The industrial process monitoring system is based on just screen at particular machine or industry itself. And that information can't be accessed from outside. The proposing system is for monitoring wirelessly along with control. The system is designed with raspberry pi3 as a master and microcontrollers as the nodes. The node boards include microcontrollers,sensors, and ZigBee. The two nodes are connected to the master board through ZigBee. And other modules are temperature sensor (LM35), light intensity sensor(LDR), water level sensor(LM324), the current transformer(CT). ZigBees present in nodes and master boards provides the communication between them. The ZigBee uses low-power, low data rate based on the IEEE 802.15.4 standard. A ZigBee network supports up to 254 client nodes plus one fully functional device (master).

II. SYSTEM DESCRIPTION

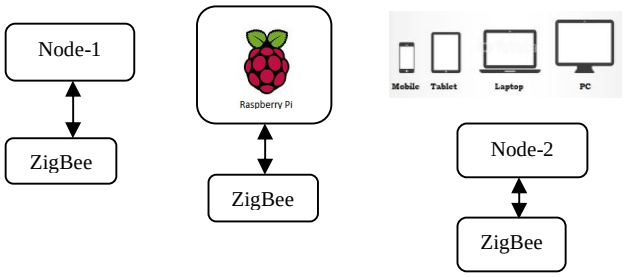

Fig.1. Block diagram of the process monitoring system.

The Fig.1 shows the system consisting of two nodes and a master. The raspberry pi can be operated through remote computing either wired or wireless. The mobile, laptop, tablet and PC can be used for monitoring. The monitoring can be done through wire or wireless.

A. MasterModule

The components of the master module are raspberry pi 3 and ZigBee. Data acquired from the two nodes are transmitted to the raspberry pi via ZigBee. The master can also send data to nodes. The raspberry pi 3 module is the advanced module in raspberry pi series. The raspberry pi has in built Wi-Fi with this feature the system can be easily connected to the internet.

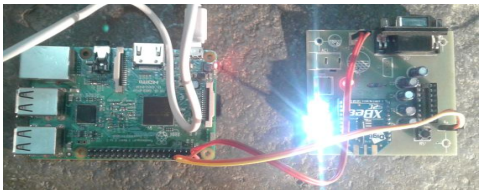

Fig.2.The master module.

B. Node-1

Node-1 consists of LPC2103 (ARM7 microcontroller), temperature sensor (LM35), LDR and water level sensor (LM324). Node-1 acquires the parameters like Temperature, Light intensity, and water level. These parameters are transmitted to master through ZigBee.

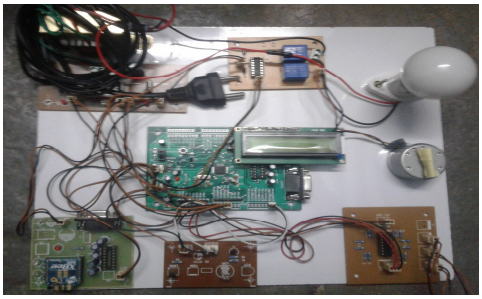

Fig.3.Node-1

C. Node-2

Node-2 consists of LPC2103 (ARM7 microcontroller), current sensor. The current is measured at node-2 module. And that reading is displayed at node-2 and sent to themaster through ZigBee. The relay and alarm are also connected to the LPC2103 for controlling purpose.

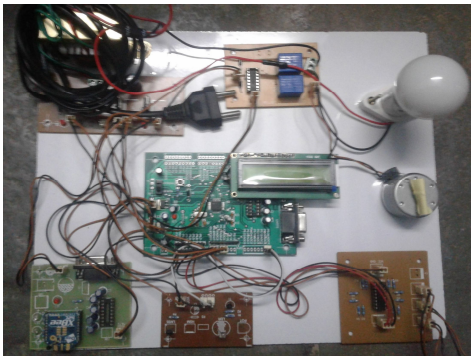

Fig.4.Node-2

III. SOFTWARE SPECIFICATION

The following soft wares are used in designing thesystem

A. Raspbian operating system

Raspbian was created by Mike Thompson and Peter Green. The first package was completed in June 2012.Raspbian is a free operating system. And it is optimized for the raspberry pi hardware. Raspbian has 35,000 packages, and it is easily installed on Raspberry Pi. Raspbian is still under active development to improve stability and performance.

B. Keil software

Keil was founded in 1982 by Gunter and ReinhardKeil.Keil implemented the first C compiler designed from the ground up specifically for the 8051 microcontrollers.Keil development tools are supportive to every level of developers.This software helps to complete the project on schedule. Data base of a microcontroller can be included by selecting that particular microcontroller in Keil window. Many example programs are included. Keil debugger accurately simulates on chip peripherals. Simulation helps to understand hardware configuration. Writing and testing of applications can be done before target hardware available.

C. Apache server

Apache server is an open source. It is a modern operating system including UNIX and windows. This server was launched in 1995. This server is efficient, secure and extensible. HTTP services of this server in sync with the current HTTP standards. This server supports password authentication. Its source code is freely available so that anyone can adapt the server for specific needs.

D. Flash magic

Flash Magic is an application developed by Embedded Systems Academy. It allowsaccessing the features of a microcontroller device. Using this software erasing of individual blocks or the entire Flash memory of the microcontrolleris possible. Some parameters need to be set before loading the program in the flash magic window. The parameters like selecting device, baud rate, com port, etc.

IV. HARDWARE SPECIFICATION

The following are the hardware requirements for this system

A. Raspberry Pi 3

Raspberry pi 3 is the latest version of raspberry pi series. There are two main upgrades in the Pi 3. The first is a next generation Quad Core Broadcom BCM2837 64-bit ARMv8 processor, making the processor speed increase from 900 MHz on the Pi 2 to up to 1.2GHz on the Pi 3.The second upgrade is the addition of a BCM43438 Wi-Fi chip built-in on the Raspberry Pi. There's also Bluetooth Low Energy (BLE) on board making the Pi an excellent IoT solution. It also has switched power source that goes up to 2.5 Amps instead of just 2 Amps - allowing raspberry pi to power, even more use full devices over USB ports.

B. LPC2103

The LPC2103 is an ARM7TDMI-S based microcontroller. It is a 32-bit RISC microcontroller with Thumb extension and high performance. It has 10-bit A/D converters this will helpfull to connect a sensor to microcontrollers without placing any external A/D converters. It has two 32-bit timers/external event counters, low power real–time clock (RTC) with dedicated 32 kHz clock input. It has multiple serial interfaces including two UARTs (16C550) for serial communication. It has two fast I2C-buses (400kbit/s)through these buseslow-speed devices can be connected. For better data transmission and reception it has SPI and SSP with buffering and variable data length capabilities 32KB on chip flash ROM within system programming (ISP) and In-Application Programming(IAP),and it also has 8KB static RAM.

C. ZigBee

ZigBee is a wireless technology. ZigBee operates on the IEEE 802.15.4 standard. It is low-cost, low-power wireless communication device.It is suitable for harsh radio environments and in various isolated locations. ZigBees supports multiple network topologies such as point-to-point, point-to-multipoint and mesh networks.It haslow duty cycle, so this feature provides long battery life. ZigBees will supportup to 65,000 ZigBees per network. It provides secure data connections through 128-bit AES encryption.

V. HARDWARE DESCPRIPTION

A. Master module

The master module is a combination of raspberry pi and ZigBee. ZigBee is used in master to provide communication between master and nodes. No need of any other peripheralor any bridge devices to communicate because it has in built Wi-Fi.Nodesare identified with the symbolsin the transmitting/receiving data. Every time these nodes send data to master module. Themaster module will update that data to the web pages through Apache server. This data can be accessedthrough mobileby connecting to master Wi-Fi. Data can also access through desktop by connecting HDMI cable, mouse, and keyboard to master module.

B. Node-1

Node 1 module uses the LPC2103 microcontroller. The master module identifies this node messages with a special symbol in its communicating messages. The functionalities of node-1 as follows

*1) Temperature measurement :*Temperature is measured using LM35 IC.It measures temperature more accurately than a thermistor.The LM35 produces higher output voltage than thermocouples,so no need of output amplification.It has an output voltage that is proportional to the Celsius temperature.The scale factor is .01V/°C.It does not require any external calibration or trimming and maintains to get an accuratereading.Another characteristic is, it possesses a low self-heating capability.The LM35 comes in many different packages such as the TO-92 plastic transistor-like package, T0-46 metal can transistor-like package, 8-lead surface ount SO-8 small outline package.

*2) Light intensity measurement :*A Light Dependent Resistor or photo resistor. Itsresistance decreases with increasing incident light intensity. It can also be called as a photoconductor. It is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conductionband. As a result free electron conducts electricity, it lowersresistance. A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its charge carriers and is not an efficient semiconductor e.g., silicon. Extrinsic semiconductors have impurities;lower energy photonsare sufficient to trigger the device.

*3) Water level identifier :*LM324 IC works as a comparator, and it has 14 pins. It hasfour independent operational amplifiers. These are Low Power Quad Operational Amplifier, and theyhave high stability, bandwidth which was designed to operate from a single power supply over a wide range of voltages. It operates at supply voltages as low as 3.0V or as high as 3.2 V.

C. Node-2

1) Current measurement : In this node-2 module current is measured through current transformer, bridge rectifier, and voltage divider circuit. Current transformer primary wires are connected to the supplying wires of a particular device. These current transformers secondary wires are connected to the bridge rectifier and its output is given to the voltage divider circuit finally its output is given to the microcontroller. So the measured voltage is given directly to the microcontroller. Whenever the current supplying to that particular device exceeds threshold value,the microcontroller generates an output signal throughwhich buzzer starts and gives notification on the web page. For controlling purpose device supplying current will be stopped manually at the device, or by sending input from WebPages.

VI. RESULTS

Following figures shows the web pages for process monitoring and controlling

Fig.5.web page

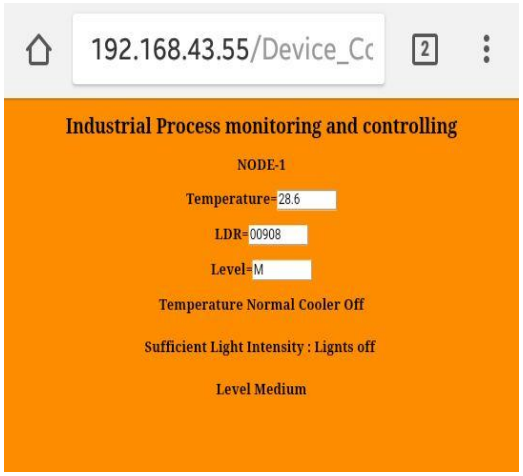

Fig.6.Node-1 web page

Fig.7.Node-2 web page

VII. CONCLUSON AND FUTURE SCOPE

With this system process parameters are easily monitored, because the parameters are displayed at the process location and also updated into a webpage every time. We willget notification when some parameter exceeds the threshold. And controlling can be done by giving input through web page. Auto controlling will be given to control few parameters.

Extension of the project can be done by adding number of the nodes to the system. The number of processes can be monitored and controlled. Monitored data can be stored for further use. Using static IP process monitoring and controlling can be done through internet from anywhere in the world. Authentication can be implemented for accessing the data. Industries at various places can be connected for monitoring and controlling.

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
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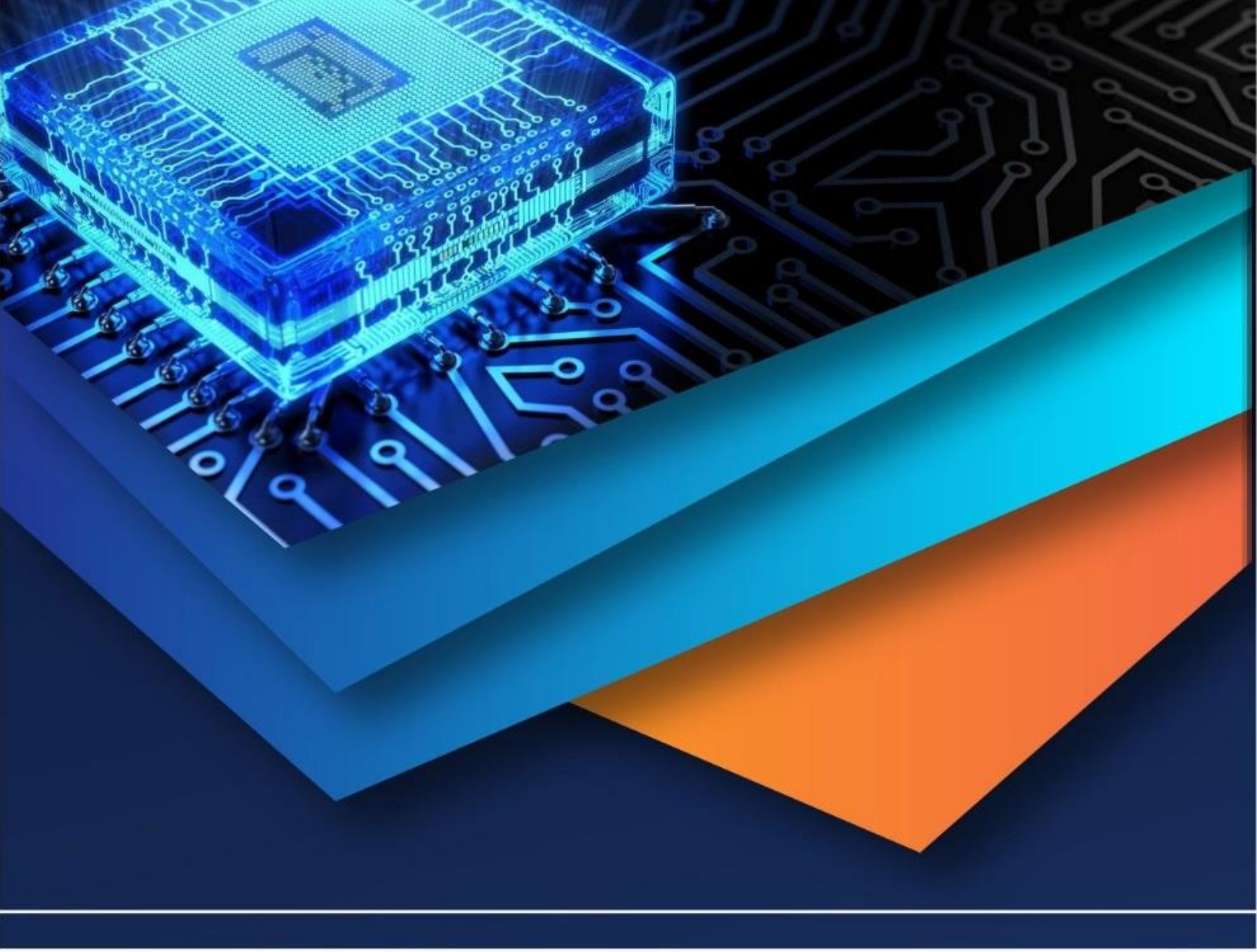

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