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Remote Monitoring and Control of Wireless Sensor Network Using Zigbee

Lipsa Dash[1] , Agnes Maria James[2], Sharat Sajjan[2], Sonal Ganesh Hegde[2]
[1]Senior Assistant Professor, Department of Electronics and Communication, New Horizon College of Engineering, Karnataka, India
[2]Student,B.E. , Department of Electronics and Communication, New Horizon College of Engineering Outer ring road, Marathahalli, Bengaluru, Karnataka, India

ABSTRACT

The idea of the project is to build a prototype for monitoring and control of complex electrical systems. The proposed system includes various system nodes that constantly monitor different parameters such as voltage, current and temperature in an electrical system. The sensed data from node is transmitted using sink node using Zigbee module. the data from sink node send to the Thingspeak cloud and mobile app. This application is a perfect example of IOT based monitoring and control system.
Keywords: Zigbee, ARM7, Thingspeak cloud, Arduino, Wifi, Blynk app

I. INTRODUCTION

The technology used in the system is wireless sensor network. Wireless sensor network refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organising the collected data at a central location. Sometimes they are called as dust networks, referring to minute sensors as small as dust. The proposed system consists of two nodes(substations) with inhouse voltage, temperature and current sensors connected to a sink node(Base station) through ZigBee module which acts as a data transfer device.The sink node in turn interacts with the thingspeak cloud for continuous updation of system parameters.An administrator uses a mobile app for monitoring the cloud and subsequently control the adverse condition existing in substation. Three sensors are connected to Arm7 microcontroller to measure voltage, temperature and current from transformer which is connected to load through relay. The temperature sensor used is LM35.Three zigbees are used here. Two zigbees are used as routers and one is used as coordinator. The data from the routers is transferred to the coordinator using serial communication. The ZigBee routers function as ZigBee transmitters and the coordinator functions as ZigBee receiver. ARM7 is used in the transmitter side in both the nodes. It is an advanced RISC machine which is 32 bit microprocessor. It is high performing, low power consuming with Von Neumann architecture. The sensed data is transferred from the ZigBee receiver to the thingspeak cloud using WiFi module. The data is stored in the thingspeak cloud which can easily be viewed by the administrator.

If any of the values exceed the threshold values, immediately the buzzer alerts, notification is sent to cloud and mobile app. Administrator turns off the relay as soon as notification is received . By doing so,the node and load are protected.

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II. WORKING

Two nodes are taken in this project. Various parameters such as voltage, current and temperature are sensed. Since these parameters are analog in nature, they are converted into digital values by ARM7 Controller. The pins P0.4 used for temperature, P0.28 for voltage, P0.29 for temperature are used. The measured values are sent to zigbee transmitter via UART communication(serial communication).

The digital values are received by the zigbee receiver. The receiver values are further sent to the arduino microcontroller board. The values are sent to the thingspeak cloud from arduino via a in built wifi module.The various parameter values are displayed and stored in thingspeak cloud and mobile app.

The values can be viewed in the mobile by the Blynk App in real time. A threshold values is set to all the parameters. If any of these parameters exceed the threshold level, the buzzer will
alert and alert notification message is sent from node to sink node from sink node to thingspeak cloud and alert notification will be displayed in blynk app. Administrator turns off the relay as soon as notification is received . Thus preventing the nodes from any electric damage.

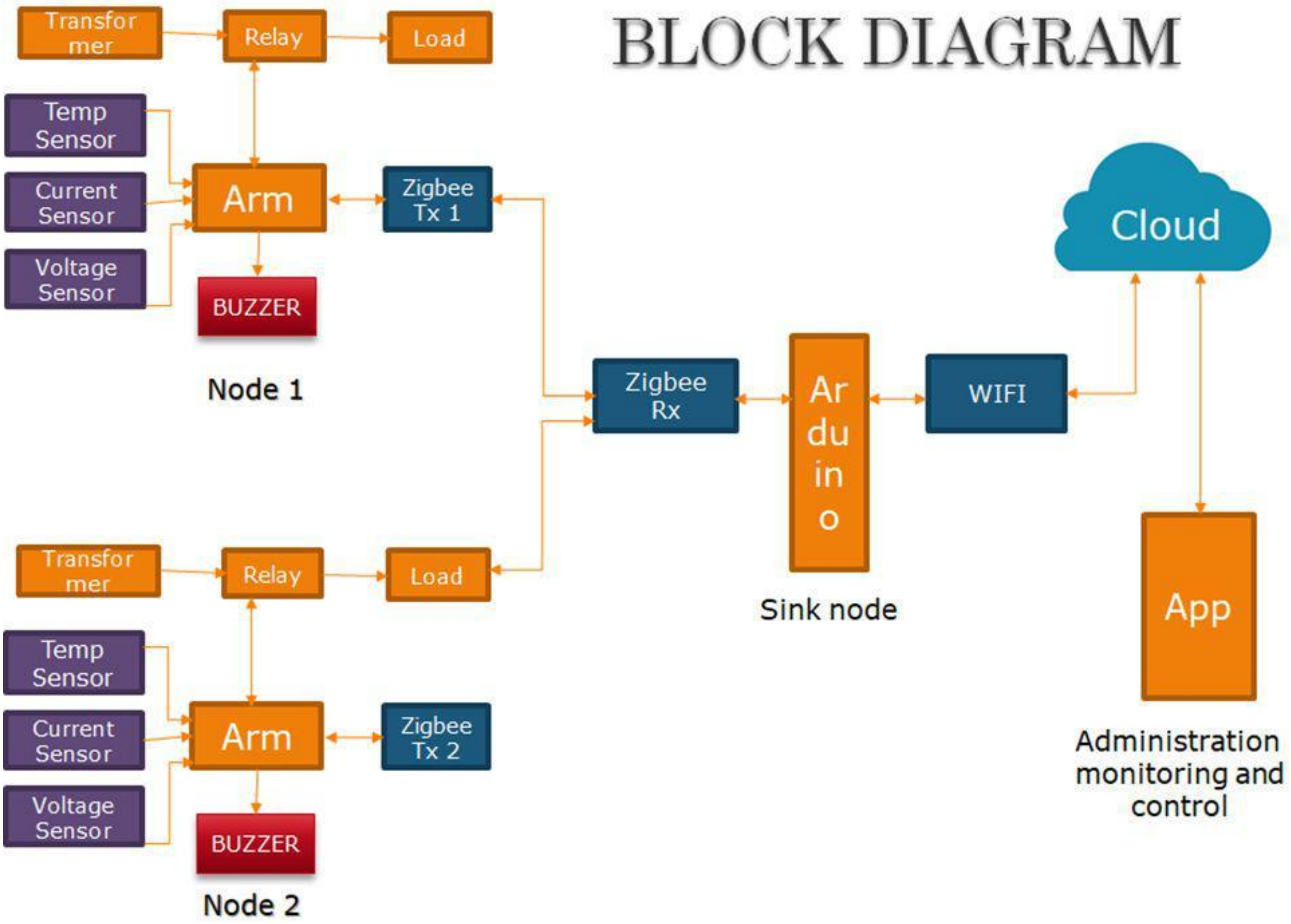

Figure 2.1

A **current sensor** is a device that detects electric current in a wire, and generates a signal proportional to that current. The generated signal could be analog voltage or current or even a digital output. The generated signal can be then used to display the measured current in an ammeter, or can be stored for further analysis in a data acquisition system, or can be used for the purpose of control.

Temperature sensor:

Figure 2.1

III. PROTOTYPE CONSTITUENTS

Voltage Sensor :

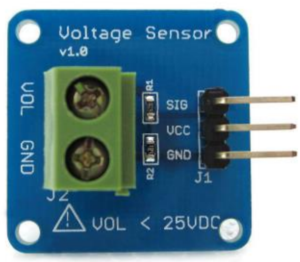

Figure 3.1

In general,a **temperature sensor** is a device which is designed specifically to measure the hotness or coldness of an object.**LM35** is a precision IC temperature sensor with its output proportional to the temperature (in °C).With LM35,the temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 °C temperature rise in still air. The operating temperature range is from **-55°C to 150°C**.The LM35's low output impedance,linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.It has find its applications on power supplies,battery management,appliances.

ARM7 board :

Figure 3.2

Voltage sensors are basically a device which can sense or identify and react to certain types of electrical or some optical signals. Implementation of **voltage sensor** and current sensor techniques has become an excellent choice to the conventional current and voltage measurement methods

Current sensor:

ARM, previously **Advanced RISC Machine**, originally **Acorn RISC Machine**, is a family of reduced instruction set computing (RISC) architectures for computer processors, configured for various environments. British company ARM
Holdings develops the architecture and licenses it to other companies, who design their own products that implement one of those architectures—including systems-on-chips (SoC) and systems-on-modules (SoM) that incorporate memory, interfaces, radios, etc. It also designs cores that implement this instruction set and licenses these designs to a number of companies that incorporate those core designs into their own products.

Processors that have a RISC architecture typically require fewer transistors than those with a complex instruction set computing (CISC) architecture (such as the x86 processors found in most personal computers), which improves cost, power consumption, and heat dissipation. These characteristics are desirable for light, portable, battery-powered devices—including smartphones,laptops and tablet computers, and other embedded systems.[3][4][5] For supercomputers,which consume large amounts of electricity, ARM could also be a power-efficient solution.[6]

ARM Holdings periodically releases updates to architectures and core designs. All of them support a 32-bit address space (only pre-ARMv3 chips, made before ARM Holdings was formed, as in original Acorn Archimedes, had smaller) and 32-bit arithmetic; instructions for ARM Holdings' cores have 32-bit fixed-length instructions, but later versions of the architecture also support a variable-length instruction set that provides both 32- and 16-bit instructions for improved code density.Some older cores can also provide hardware execution of Java bytecodes. The ARMv8-A architecture, announced in October 2011,[7] adds support for a 64-bit address space and 64-bit arithmetic with its new 32-bit fixed-length instruction set.

With over 100 billion ARM processors produced as of 2017, ARM is the most widely used instruction set architecture in terms of quantity produced.[8][9][10][11][12]Currently, the widely used Cortex cores, older "classic" cores, and specialized SecurCore cores variants are available for each of these to include or exclude optional capabilities.

Arduino board :

Figure 3.3

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontroller and microcontroller

kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[1] permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processinglanguage project.

Zigbee :

Figure 3.4

Zigbee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios,such as for home automation, medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection. Hence, Zigbee is a low-power, low data rate, and close proximity (i.e., personal area) wireless ad hoc network.

The technology defined by the Zigbee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or more general wireless networking such as Wi-Fi . Applications include wireless light switches, home energy monitors, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer.

Its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics.[1] Zigbee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. Zigbee is typically used in low data rate applications that require long battery life and secure networking (Zigbee networks are secured by 128 bit symmetric encryption keys.) Zigbee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device.

ThingSpeak cloud :

Figure 3.5

According to its developers, "**ThingSpeak** is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates".[2]

ThingSpeak was originally launched by ioBridge in 2010 as a service in support of IoT applications.[3]

ThingSpeak has integrated support from the numerical computing software MATLAB from MathWorks,[4] allowing ThingSpeak users to analyze and visualize uploaded data using Matlab without requiring the purchase of a Matlab license from Mathworks.

ThingSpeak has a close relationship with Mathworks,Inc. In fact, all of the ThingSpeak documentation is incorporated into the Mathworks' Matlab documentation site and even enabling registered Mathworks user accounts as valid login credentials on the ThingSpeak website.[5] The terms of service[6] and privacy policy[7]of ThingSpeak.com are between the agreeing user and Mathworks, Inc.

Blynk app :

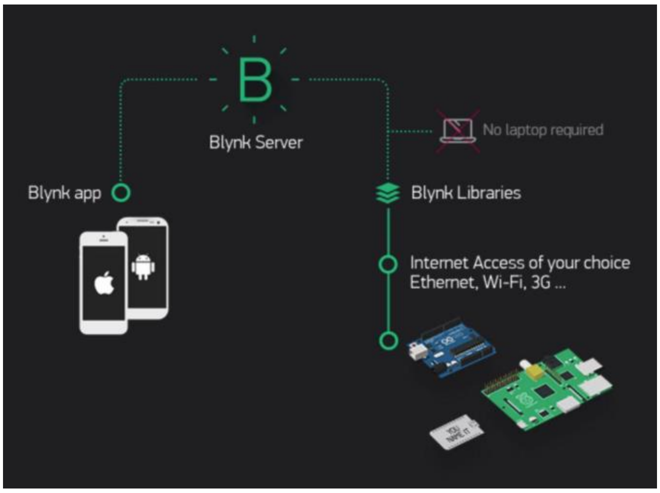

Figure 3.6

Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets.

It's really simple to set everything up and you'll start tinkering in less than 5 mins.

Blynk is not tied to some specific board or shield. Instead, it's supporting hardware of your choice. Whether your Arduino or Raspberry Pi is linked to the Internet over Wi-Fi, Ethernet or this new ESP8266 chip, Blynk will get you online and ready for the **Internet Of Your Things**.

IV. PROTOTYPE BUILDING/RESULTS

Following is the prototype for the proposed system:

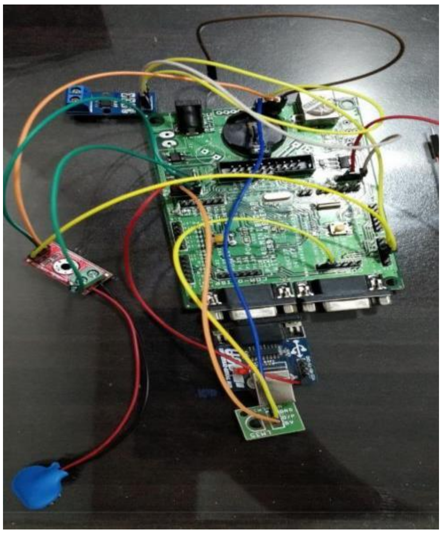

Figure 4.1

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Figure 4.2

The above figure shows the values of sensed parameters at sensor nodes.

V. CONCLUSION

A prototype is built for monitoring and control of complex electrical system. The system constantly monitors different parameters such as voltage, temperature and current in an electrical system. The supervision and control of substation using Internet of Things(IOT) has been experimentally proven by connecting relay to transformer. This control system is modelled for multiple output and input arrangements for substation applications. There are different drawbacks of existing system like difficulty in wiring, high maintenance cost and limitations of control range of the system. This system overcomes the limitations of the existing system. This system is suitable for real time monitoring of substation parameters. Remote monitoring and controlling is possible. The measured parameters are displayed and stored in the Thingspeak cloud and mobile app(Blynk app). Threshold level is set for the parameters. If any of these parameters exceed the threshold level, buzzer is alerted and the relay is turned off. Hence, the load is prevented from electrical damage.

VI. FUTURE SCOPE

The future work includes increasing the distance between monitoring and control section by increasing the number of nodes i.e. creating star, mesh topology etc. The other parameters of substation such as circuit breaker can also be monitored and automatic control of the system can be included in future work.

Using this system as framework the system can be expanded for energy monitoring, or weather stations. This kind of a system can be the best alternative where human invasion is impossible or dangerous, and it can also be implemented for environmental monitoring with respective changes.

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