ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

Wireless Radiation Detectors for Environmental Monitoring

Marwa Mekki, Moez Eltayeb, Osman Abdallah, Amin.Babiker, Magdi B. M. Amin

PhD Student, Dept. of Computer Engineering, Faculty of Engineering, University of Gazira, Wad Medani, Sudan

Researcher, Instrumentation Center, Atomic Energy Commission, Khartoum, Sudan

PhD Student, Instrumentation Center, Atomic Energy Commission, Khartoum, Sudan

Assistant Professor, Dept. of Electrical and Electronics Engineering, Faculty of Engineering,Alneelain University, Khartoum, Sudan

Assistant Professor, Dept. of Computer Engineering, Faculty of Engineering, University of Gazira, Wad Medani, Sudan

ABSTRACT:This paper proposes a wireless radiation detector network for environmental monitoring. A pin diode is used as a silicon semiconductor detector, which is well suited for X-rays, Alfa particles, Bita radiation, and High-energy charged particles. The proposed network topology enables densely sensor-populated regions with short-range communication capabilities for low-energy consumption (and consequently long lifetime). The regions are connected by a global to a global communication infrastructure (GSM network) through gateways. SIM900 GSM\GPRS module is used to send SMS to an administrator phone when a wasted radiation is detected by the sensor tag. It is used for global communication. For short range applications the wireless communication is achieved by using RF technology.

KEYWORDS: Radiation detector; X-rays; RF; GSM

RELATED WORK

Ravishanker and Pandian used the WSN to detect and control the failure in industrial environment. Four types of sensors are used: gas, radiation, temperature, and smoke sensors. The error occurrence is controlled by the ARM controller. The proposed system is defined two modes: failure mode and normal mode. The system consist of base station and controller station, it performed a synchronous communication. Ravishanker and Pandian used Proteus 8.2 tool to simulate the circuit diagram and check the design performance [9]. Barrenetxea, Ingelrest, Schaefer, and Vetterli focus in this paper on the particularities of environmental monitoring through their experience with SensorScope. In their first study they described the requirements of environmental monitoring and their consequences for WSN design, and how these requirements are addressed in SensorScope.

Several networks have been deployed, some of them in very harsh conditions and the results of these deployment presented. The important requirements for the networks deployed in difficult-to-access places are: Autonomy, Reliability, Robustness, and flexibility. Four different layers are used in SensorScope communication stack: Application layer, Transport, Network, and MAC layer. Six outdoor deployments have been performed. Their locations were carefully chosen. The deployment took about one month and a half. One of the most important deployments located between Switzerland and Italy, which took place at the Grand Saint Bernard. The networks have been tested in real outdoor conditions, and it has proven to be robust and well-fitted for environmental monitoring [10].

I. INTRODUCTION

The rapid development in wireless technology, low-power electronics, and radiation detectors made the deployment of sensor networks to monitor various aspects of environment increasingly feasible. Different types of environmental sensor networks have been implemented such as glacial monitoring [1], habitat monitoring [2], and deserts monitoring [3]. This article presents a wireless radiation detector network which monitors and detects low levels of wasted

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

radiation in our environment. A wireless sensor network comprises of different technologies, development of such approach requires three different research areas: Sensing, processing, and communication [4].

Smart environments represent the next evolutionary development step in building,houses, industrial, shipboards, and transportation systems automation. (Like any sentient organism, the smart environment relies first and foremost on sensory data from the real world), sensory data comes from multiple sensors of different modalities in distributed locations.

Smart environment needs information about its surroundings as well as about its internal workings. The system procedure steps include:detecting the relevant quantities, monitoring, and collecting the data, assessing and evaluating the information, formulating meaningful user displays, decision-making and alarm functions initiation.

The wireless sensor device block diagram in Figure 1 shows the different functions of the proposed sensor node. RF technology is used for short-range communication (up to two km) [5]. SIM900 is a complete Quad-band GSM/GPRS. It is used for global communication. It supportsvoice uses850/900/1800/1900MHz frequency ranges, SMS, Data, and Fax application in a small form factor and with low power consumption. SMS specifications are used in our network. Remote sensing provides a broad view of landscapes and can be consistent through time, making sure that it is an important tool for monitoring and managing protected areas. An impediment to broader use of remote sensing science for monitoring has been the need for resource managers to understand the specialized capabilities of an ever-expanding array of image sources and analysis technique

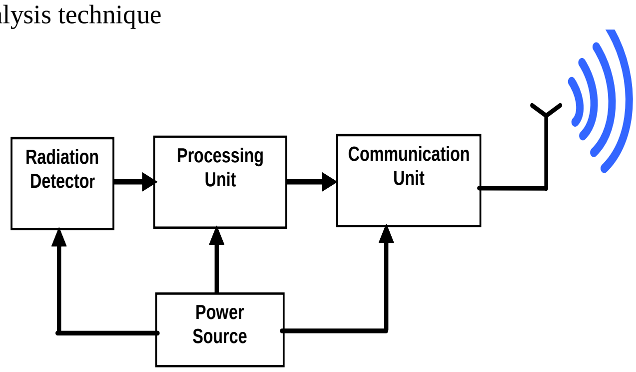

Fig.1.The functions of wireless sensor node

II. SPECIFICATION

A. *Radiation Detection:*

There are two common semiconductor materials used for radiation detection, Silicon and Germanium [6]. They are used to detect and measure alpha particles, beta particles, x-ray, and gamma-ray radiation. In order to detect low levels of radiation a silicon PIN diode (QSE973) is selected from Fairchild as a radiation sensor in the proposed system [7].

B. *Data processing:*

The processing unit is based on microcontroller with built-in peripherals for communication and analogue to digital conversion. The microcontroller is programmed using embedded C programming language to perform the different tasks needed to achieve the data question and transmission. MSP430FG4617 microcontroller from Xilinx is used [8].

C. *Communication:*

Local communication network: RF technology is implemented for the communication between sensor nodes in the wireless detector network. This technology is a low cost and low power consumption technology. It provides low data rate (maximum 250 kbps), but it is high enough for sensor applications. Figure 2 shows the RF system which is composed of an RF transmitter, RF receiver, microcontroller, PC monitoring system, and the radiation source.

Global communication: The development and deployment of GSM (Global System for Mobile communications) over the past two decades and its digital nature makes it suitable for data transmission. The basic service supported by

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

GSM systems is telephony and the capability of handling data was added to the GSM by GPRS (General Packet Radio Service) technology [9].

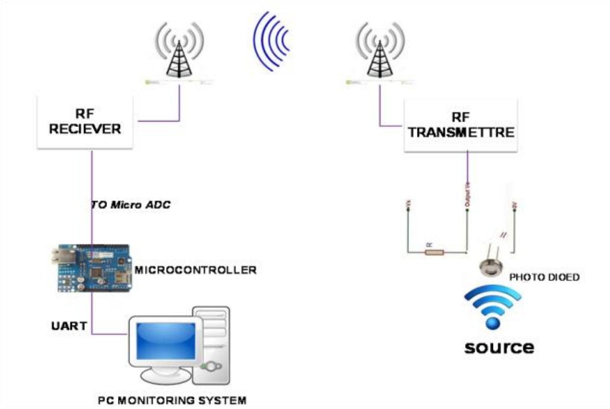

Fig.2. RF system

GPRS is essentially a packet switched protocol for data applications in GSM system. The local sensor networks in the proposed design are communicating using GPRS/GSM gateways. Figure3 shows the proposed wireless radiation detector with global communication.

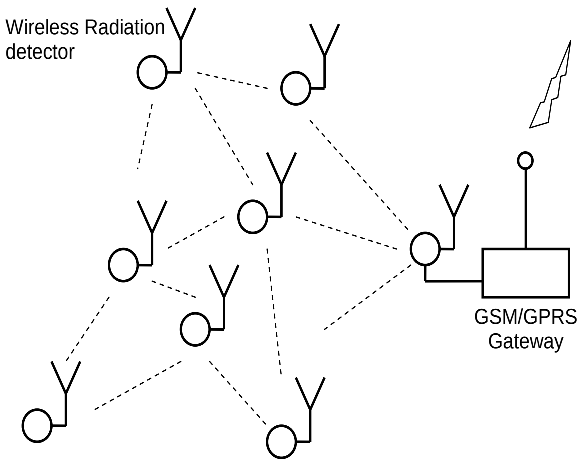

Fig.3. Global communication

This network topology presents densely sensor-populated regions with short-range communication capabilities for low-energy consumption (and consequently long lifetime). The regions are connected by a global to a global communication infrastructure (GSM network) through gateways.

D. *Communication unit:*

A low power Wireless Sensor Platform (WISP) from Mid Sweden University is used. The main purpose of it is to connect sensors and send the data via RF or GSM/GPRS. The main power saving idea of the platform is to stay in sleep mode for most of the time and only wake up if an action is required.

A huge number of interfaces provide the user with comfortable debugging connections such as the JTAG connector, pushbuttons, LEDs, and a lot of measuring pins. To connect sensors to the platform there is a connector which provides a connection to the microcontroller for different interfaces such as I2C, SPI, ADC and a connection to the interrupt ports of the microcontroller. Figure 5 shows the Wireless Sensor Platform.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

For normal program execution, there is a 4MHz crystal and for high precision the 32 KHz crystal with an accuracy of +/- 20ppm is mounted. It is possible to use the internal temperature sensor to compensate for temperature drift of the crystals. This compensation has to be done in software. For debugging and testing purpose there is a pushbutton, the JTAG connector and several I\O pins connected to jumper rows on the Printed Circuit Board (PCB).

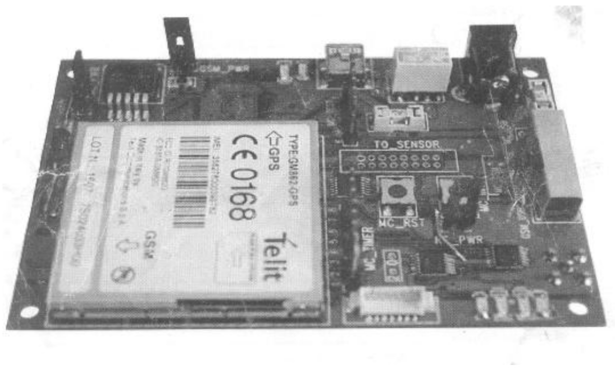

Fig.4.Multi-Functional low power Wireless Sensor Platform

Specification of the GSM module

- GSM, GPRS and GPS
- Input current peaks up to 3A
- Python script interpreter
- 850/900/1800/1900MHz frequencies
- SIM card
- Approx.250mA average operating current
- 2x MMCx antenna connectors
- UART port
- GPS-USART port(use the NMEA GPS protocol)

III. APPLICATIONS

Environmental monitoring: The capability of global communication of the wireless detector networks makes it suitable to use in environmental monitoring applications such as vehicle monitoring radiation detection systems.

Personal safety: The wireless detectors network is suitable to be used for monitoring and measuring the radiation dose that the people work in nuclear stations can expose. It can also be used by engineers who maintain the radiation instruments.

Building monitoring: Some buildings such as radiation and isotope hospitals contain huge radiation instruments which may release nuclear radiation. In addition to measure the amount of radiation in such buildings, the wireless detector network can also measure the radiation released by electrical equipment (e.g. computer wireless networks, mobile phones, and microwaves).

Airport monitoring: The wireless detector network can be used for monitoring the released radiation in the airport. It can detect the waste radiation from the in ported instruments and passenger's chattels.

IV. RESULT

Figure 5 shows the output pulse from the silicon detector when shielded with aluminum to block the visible light and sense the radiation. According to the sensor properties it should sense low radiation levels, the first test with radiation does not show good result. A second test performed with more amplification stages.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

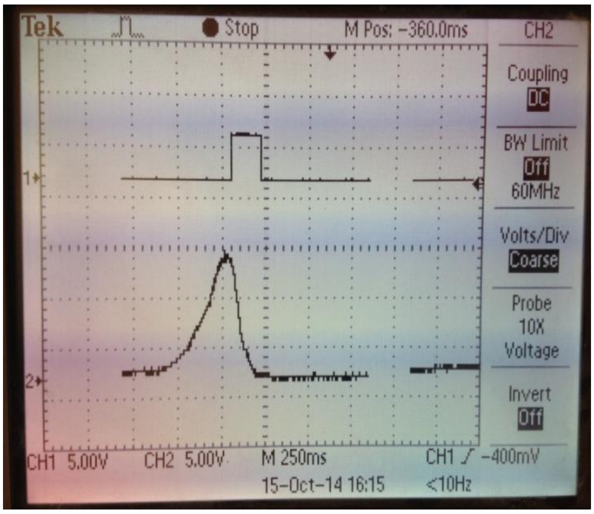

Fig.5. Output pulse from the detector

The detection of the signal achieved by programming the microcontroller and designing a graphical user interface to view the warning radiation message from the transmitter. Figure 6 shows the different components of the hardware including the sensor circuit, the wireless communication platform, and the GSM module. The warning message displayed on computer and sent via GSM to the administrator mobile phone.

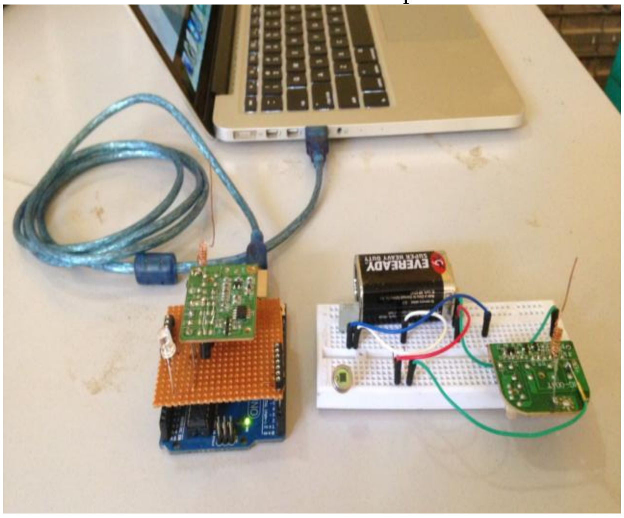

Fig.6The hardware circuit connecting with graphical user interface

V. CONCLUSION

The task of this project is to demonstrate a self-powered wireless radiation detector with global communication capabilities. The proposed wireless detectors can operate independent of maintenance and human intervention for several years. Low cost and high spatial resolution can be achieved. To verify the concept of the proposed wireless detectors a field test will be performed and a sensor network will be deployed at sites of national interest.

REFERENCES

1. K. Martinez, P Padhy, A. Riddoch, H.L. Ong, J.K. Hart, "Glacial Environment Monitoring using Sensor Networks".
2. Alan Mainwaring, Joseph Polastre, Robert Szewczyk, David Culler, John Anderson, "Wireless Sensor Networks for Habitat Monitoring".

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

3. K.A. Delin, S.P. Jackson, D.W. Johnson, S.C. Burleigh, R.R.Woodrow, M. McAuley, J.T. Britton, J.M. Dohm, T.P.A. Ferré, Felipe Ip, D.F. Rucker, and V.R. Baker, "Sensor Web for Spatio-Temporal Monitoring of a Hydrological Environmental," 35th Lunar and Planetary Science Conference, 2004.
4. C.Y. Chong and S.P. Kumar, "Sensor networks: Evolution, opportunities, and challenges," Proceedings of the IEEE, vol. 91, n.8, 2003, pp. 1247-1256.
5. RF device datasheet
6. A. Kastalsky, S. Luryi, B. Spivak, "Semiconductor high-energy radiation scintillation detector," Nuclear Instrument and Methods in Physics Research, 12 May, 2006.
7. http://pdfserv.maxim-ic.com/en/an/AN3757.pdf
8. Audrey Selian, Lara Srivastava, Ben Petrazzini,"3G Mobile Licensing Policy From GSM to IMT -2000 A COMPARATIVE ANALYSIS".
9. Ravishanker A , Pandian R. (2014). Embedded system based sensor failure detection and industrial environment control over wireless network. International journal of engineering research, Volume /no.3, Issue No. 12, 01 Dec. 2014.
10. Guillermo Barrenetxea, Francois Ingelrest, Gunnar Schaefer, and Martin Vetterli(2007). Wireless sensor networks for environmental monitoring: The sensor scope experience 2007

BIOGRAPHY

Marwa A. Mekkiobtained her B.Sc. in Computer Engineering, 2000 from the Faculty of Engineering and Technology, University of Gezira, Sudan. She has obtained her M.Sc. Degree in Electronics Engineering in 2006 from the Mid Sweden University, Sundsvall, Sweden. She was a teaching assistant in the department of Computer Engineering, Faculty of Engineering and Technology since 2001, University of Gezira. She has become a lecturer in 2006 in the same faculty and university. She is doing her Ph.D. at the University of Gezira.

MoezAltayebobtained his B.Sc. in Electronics Engineering, 2005, Faculty of Engineering Sudan University for Sciences' And Technology, MSc in Electronic Engineering Sudan Academic of Science, He has been employed as a Researcher in the Energy Research Center, Solar Energy from (2008-2012), He has been employed as a Researcher in an Electronics Engineer in the department of Electronics and Instrumentation at the Sudan Atomic Energy Commission (SAEC). His research focuses on embedded system, microcontroller, GUI software designer, Gps tracking systems &map, Gprs Modem, Automation systems, Satellite tracking, and solar energy systems.
[1]

Amin Babiker A/NabiMustafa, obtained his B.Sc. and M.Sc. from the University of Khartoum in 1990 and 2001 respectively. He obtained his Ph.D. from Alneelain University in 2007. He was the head of Computer Engineering Department from 2001 to 2004 at Alneelain University. Then he became the vice-dean in the same university. He is the dean Faculty of Engineering, Alneelain University since 2009. His research areas include QoS in Communication Systems, Traffic Engineering, Service Costing Disciplines & Networking. Associated Prof. Dr. Amin is a Consultant Engineer.

He is a member of the Sudan Engineering Council. He is also a member of the Executive Committee of the Federation of Sudanese Engineers. Dr. Amin supervised or supervising more than 30 Ph.D. or M.Sc. students.

Osman Abd Allah Osman,obtained his B.Sc in Electronics Engineering- Communication- from Sudan University of Science and Technology in 2003, and the M.Sc in Electronics Engineer from Sudan Academy of Science in 2010. His M.Sc research was in the design of Robotic Arm using Microcontroller. Now he is a Ph.D student in the same academy. He is employed at Sudan Atomic Energy Commission (SAEC) as a researcher in Electronics and Instrumentations from 2006 up to date His major research field is digital systems design and embedded systems, including microcontrollers, FPGAs, PSoCs. He is in charge of research and development unit.