ISSN (Online): 2455-7838

SJIF Impact Factor : 6.093

EPRA International Journal of

Research & Development

(IJRD)

Monthly Peer Reviewed & Indexed
International Online Journal

Volume: 4, Issue:4, April 2019

Published By
EPRA Publishing

SJIF Impact Factor: 6.093 Volume: 4 | Issue: 4 | April | 2019 ISSN: 2455-7838(Online)

EPRA International Journal of Research and Development (IJRD)

Peer Reviewed Journal

IMPLEMENTATION OF MAGNETIC INDUCTION BASED COMMUNICATION FOR ENVIRONMENTAL OBSERVATION USING WUSN

Mrs.P.K.Poonguzhali[1]

[1]*Assistant Professor-ECE, Hindusthan College of Engineering and Technology, Coimbatore-32*

Dr.N.P.Ananthamoorthy[2]

[2]*Professor-EEE, Hindusthan College of Engineering and Technology, Coimbatore-32*

ABSTRACT

Wireless Underground Sensor Networks (WUSN) is a specialized kind of WSN which mainly focus on the use of sensors at the subsurface region of the soil. In this work, we have used the technology of Internet of Underground Things (IOUT) which uses soil as the medium of communication instead of air. This type of communication through the underground medium has been a challenging area and it was done using EM waves which can be applied only for a very short transmission range due to the heterogeneous nature of the soil medium and it has path loss along with attenuation because of the moisture content in the soil. The communication is also done using MI with more number of relays as antenna which has high complexity of space. In this work, we propose a communication using Magnetic Induction (MI) where a rod shaped conductor is used as antenna, which establish an efficient wireless connection between the transceivers in the underground medium for the real time sensing of forest areas. This system works by placing the sensor node consisting of required sensors for our application and the sensed data is given to the WUSN transmitter and it is received by the WUSN receiver through soil using MI. The received information is sent to the centralized server through IOT for monitoring in the user end. This proposed MI system overcomes the issues caused by EM waves and MI using relays. The objective of our proposed MI based communication system is to reduce the complexity of space when compared with the existing MI and to transmit the information without path loss and attenuation to the user end.

KEYWORDS: *WUSN, EM waves, Magnetic Induction, reduced path loss.*

I.INTRODUCTION

Wireless Underground Sensor Networks (WUSNs) is a special type of WSNs where some of the nodes are deployed below the ground, either in soil or in a similar confined environment. A variety of novel applications are enabled by the use of WUSNs, initially categorized [1] as follows: environmental monitoring, infrastructure monitoring, location determination, and security monitoring. The existing wireless communication system utilizes a dipole antenna to transmit and receive propagating electromagnetic (EM) waves. But this method is not suit for underground environment since the underground environment is more complicated than the above ground. The main drawback of using EM waves for underground communication is: high level of attenuation due to absorption, path loss, and operating frequency must be in lower range for transmission.

The solution for this is the use of alternative communication technique using MI.MI based solutions are being proposed as the potential answer especially for large and sparse WSNs [2]. Magnetic induction based communication has been already investigation in various works, mostly in context of near-field communication (NFC) [3] and wireless power transfer (WPT) [4]. MI utilizes induction coils which generates quasi-static magnetic field. These magnetic fields generated by a transmitting coil can be sensed by the receiving coil, such that a signal transmission link can be established [5]. MI – WUSNs have been first introduced in [6]. This technique has been shown to be less vulnerable to the losses in conductive medium (soil), such the transmission range and coverage of the sensor network can be significantly improved by using MI based transceivers.

II.WIRELESS UNDERGROUND SENSOR NETWORKS

Wireless Underground Sensor Networks (WUSNs) [1] are the networks of wireless sensor nodes operating below the ground surface. As a natural extension to the well-established wireless sensor networks (WSNs)[7] paradigm, WUSNs are envisioned to provide real-time monitoring capabilities in the underground soil environments. In WUSNs, the networks of wireless nodes are buried underground and communicate through soil. The key properties and challenges for the development. WUSNs have been addressed in [3].Comparing to the current underground sensor networks which use wired communication methods for data retrieval, WUSNs have several merits such as concealment, ease of deployment, timeliness of data, reliability and coverage density. WUSN will lead to potential applications in the fields of agriculture, forest, border patrol, intruder detection and infrastructure monitoring. These applications are possible because WUSN can provide localized and real-time data about a specific soil region and its surrounding area. The process of getting data by using EM waves are strongly affected by the multi path effects, soil composition, burial depth and more specifically by the volumetric water content of the soil. The issues are caused by the following ways [8].

(1)Soil Texture: EM waves exhibit attenuation when incident in soil medium because soil is composed of pore spaces, clay, sand, and silt particles. Water holding capacity of each soil type is different because of its pore in which the lower water holding capacity of soil result in lower attenuation whereas higher water holding capacity of soil will result in higher attenuation.

(2)Soil Moisture: EM waves also suffer attenuation by soil water content and its variations. Soil dielectric spectra and its conductivity depends on the soil moisture.

(3)Depth Variations: Sensors are usually buried in the top sub-meter layer and its channel capacity depends on the deployment depth because of the impacts of the soil-air interface causes refraction of EM waves and nodes experience higher attenuation at higher burial depths.

(4)Frequency Variations: The path loss caused by attenuation is frequency dependent because it is associated with water. When EM waves propagate in soil, their wavelength shortens due to higher permittivity of soil than the air, hence the channel capacity in soil is also a function of operating frequency.

The above are the issues during communication using EM waves and this can be overcome using MI communication.

III. MI BASED COMMUNICATION

MI based transmission have been proposed to overcome the issues in EM. MI between two coupled coils will not be influenced by the complicated underground medium because the magnetic permeability of the soil is almost the same as that in air and MI communication can effectively transmit and receive wireless signals using a small coil of wire [5].MI techniques utilize the near field of the low frequency EM field. This communication has the combination of low power and low frequency that causes a radiation effect to be extremely minimized.

In this communication the data are transmitted and received using induction coils. The process is that the effect of magnetic induction on the secondary coil of the transformer is responsible for transferring majority of the energy and hence by turning on or off the alternating current at the primary coil, the effect is communicated to the secondary coil of the transformer [9].

Though MI has a better communication than EM, it has a limited communication range due to high attenuation rate in the near region and the channel gain is also decreased. In order to increase the channel gain we can either enlarge the size of the coil or increase the number of turns or we can select high conductivity wires [10].

V. RELATED WORK

In 1997, unidirectional and high-power MI communication at 3KHz and data rate of 300 bps for military operation in the coastal region was investigated and successful results were reported [11].

In 2001, a comparison with high frequency RF system RF systems was given [12] and smaller power consumption and complexity were singled out as main features of MI-based solutions and uses 11-15MHz carrier for MI communication systems.

In 2002, the theoretical model of a simple electric circuitry for MI devices was discussed [13]. Here both the transmitting and receiving coils have a capacitor in parallel, thus forming a resonant circuit. At the center frequency of resonance, the maximum magnetic field is achieved at both the transmitting coil and the receiving coil; the inductor carries a resistance due to wiring. Thus, by doing this process we can higher bandwidth.

In 2007, MI was considered for communication between implantable devices in human body [14].

In 2009, the communication model for underground to underground links in WUSN was proposed [15] and it has reported that MI system had similar performance as EM based system when simulated at 300 and 900MHz.

In 2010, the detailed version of MI models, simulated at 10MHz was proposed and also MI communication using waveguides was proposed [16].

In 2011, WUSN architecture for underground pipeline monitoring using MI was proposed.

In 2012, point to point communication based on MI is presented for rescue system which has a communication range of up to 30m and it is achieved by low power devices and tri axial antenna loops was presented.

In 2015, a test bed of different MI based UG communication system was developed [5].

IV. PROPOSED SYSTEM

In our proposed system we have used rod shaped conductor as the transmitting and receiving coil instead of the rectangular coil that are in use for a long time, and as we have proposed the system for forest surveillance we have included the sensors like IR sensor, PIR sensor, Fire sensor, Soil moisture sensor, Alarm sensor. The reason for the inclusion this sensors in our project and the working process are as follows:

IR sensor: Here this sensor is used to detect the range of the animal like large animal or small animal.

This will be useful to take necessary actions if a large animal cross the surveillance area.

PIR sensor: This sensor is used to detect the human interruption in the surveillance area.

Fire sensor: This sensor is used to detect the forest fire. This will be helpful to the officers to detect the forest fire in its initial state.

Soil moisture sensor: This sensor is used to detect the moisture content in the soil.

Alarm sensor: This sensor is used to notify the changes observed by other sensor by producing the sound as its output.

Here we have used WUSN module as the transceiver.

The following figure shows the blocks inside the WUSN module

.

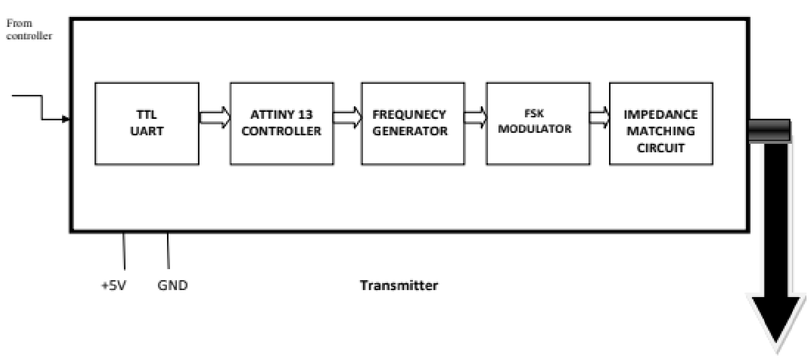

Fig. 1. WUSN transmitter module

The computed data from the controller reaches the WUSN module. TTL UART is used to encode the data bits serially into a standard format with a star bit, stop bit, speed, etc. As the input to the microcontroller should be in 5V, TTL module is used prior to the ATTINY controller 13.ATTINY are the subfamily of the popular 8-bit AVR microcontrollers, which typically have fewer features, fewer I/O pins, and less memory than other AVR series chips. They have internal oscillator with a clock frequency of 9.6 MHz (default). Then we have a frequency generator, which is an electronic device used to generate repeating or non repeating electronic signal in either the analog are the digital domain. Here Pulse width modulation technique is used for reducing the average power delivered by an electric signal, by effective chopping it up into discrete part. The average value of voltage fed to the load is controlled by turning the switch between supply and load on and off at a fast rate. Then we have FSK modulator. It is a frequency modulation scheme in which digital information is transmitted through discrete frequency changes of a carrier signal. Finally we have Impedance matching circuit, impedance matching is the practice of designing the input impedance of an electrical load or the output impedance of its corresponding signal source to maximize the power transfer or minimize signal reflection from the load.

Thus the data is finally transmitted through the rod into the soil and reaches the receiver side which is a sink node and the reverse process takes place to retrieve the data. To verify the proper reception of data we will be provided a 16*2 LCD in bot transmitter and receiver side. And then the data from the sink node reaches the user end using IOT module.

The user can thus monitor the surveillance area by public server created using the PHP.

The simulation results obtained for the hardware using Proteus software is shown below with various kinds of sensors required for our application for the purpose of surveillance.

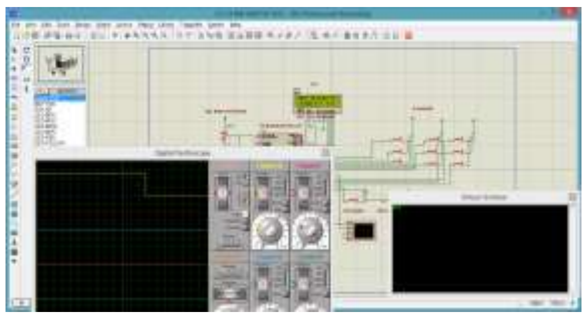

Fig.4.1 Sensors detection and displaying the results as set in embedded c program using Proteus software

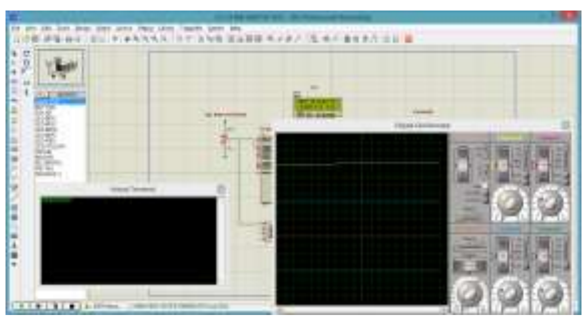

Fig. 4.2 Soil moisture sensor detects high moisture and displays the value of moisture level

Fig. 4.3 Data sent to the user end using IOT module

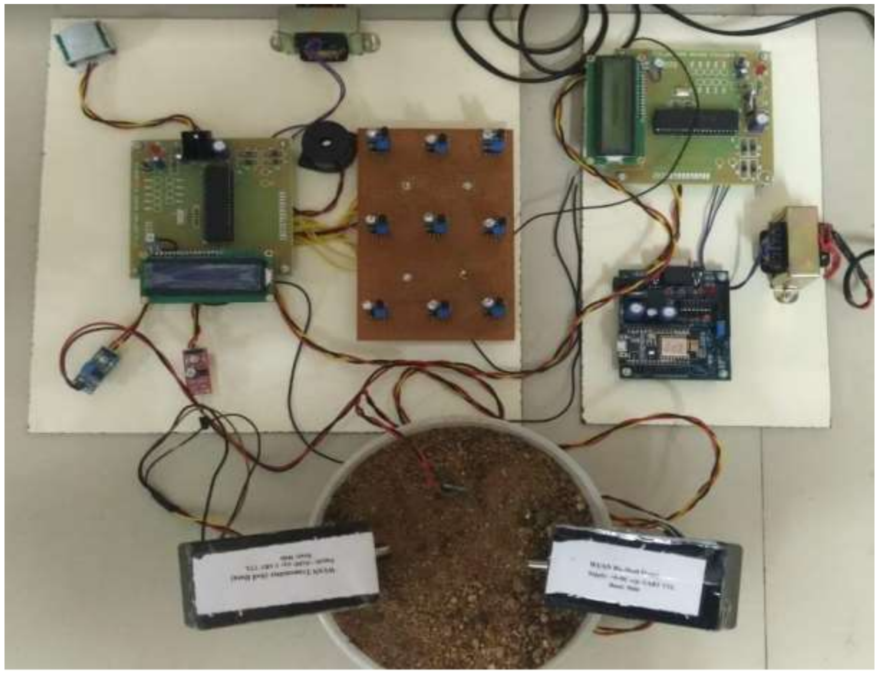

Fig. 4.3 Proposed Module

V.CONCLUSION

Working on the proposed system, we came to conclusion that, this technology can be very effectively used for nature purpose. We have introduced Internet of Underground Things (IOUT) for real time sensing in forest areas. Through Wireless Underground Sensor Networks the collected data transferred to the user by EM waves causes data loss and attenuation due to moisture content. This detriment is overcome by MI-WUSN and gives the real time processing for the forest field conditions.

VI.REFERENCES

1. *I.F. Akyildiz, E.P. Stuntebeck,Wireless underground sensor networks: research challenges. Ad Hoc Netw. J. (Elsevier)* ***4****, 669–686 (2006)*
2. *Sun Z, Akyildiz I F (2009) Underground Wireless Communication using Magnetic Induction.In Proc. IEEE ICC 2009, Dresden, Germany.*
3. *R. Bansal,"Near-field magnetic communication",in IEEE Antennas and Propagation Magazine, vol. 46, no. 2, April 2004, pp. 114-115.*
4. *Karalis, J. Joannopoulos, and M. Soljacic, "Efficient wireless non-radiative mid-range energy transfer", Annals of Physics, vol. 323, n0. 1, pp. 34-48, Jan. 2008.*
5. *Steven Kisseleff and Wolfgang H.Gerstacker, "Survey on advances in MI based WUSNs", JIOT.2018.2870289.*
6. *Z. Sun and I. Akyildiz, "Magnetic induction communications for wireless underground sensor networks," IEEE Trans. AntennasPropag., vol. 58, no. 7, pp. 2426–2435, Jul. 2010.*
7. *F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, \Wireless sensor networks: A survey," Computer Networks (Elsevier) Journal, vol. 38, no. 4, pp. 393{422, March 2002.*
8. *Mehmet C.Vuran,Abdul Salam Rigoberto Wong,"Internet of Underground Things:Sensing and Communication on the Field for Precision Agriculture",NE 68588.*
9. *S.Kisseleff,W.Gerstacker,R.Schober,Z.Sun and I.Akyildiz,"Channel capacity of magnetic induction based Wireless Underground Sensor Networks under practical constraints",in Proc. Of IEEE WCNC 2013,April 2013.*
10. *M.Domingo,"MI for Underground Wireless Communication Networks",IEEE Trans.Antennas Propag.,pp.2929-2939,April 2012.*
11. *J.J. Sojdehei et al., Magneto-inductive (MI) communications, in Proceedings of OCEANS,2001 MTS/IEEE Conference and Exhibition, vol. 1, pp. 513–519 (2001)*
12. *C. Bunszel, Magnetic induction: a low-power wireless alternative. RF Des.* ***24****(11), 78–80(2001)*
13. *E. Shamonina et al., Magneto-inductive waves in one, two, and three dimensions. J. Appl.Phys.* ***92****, 6252–6261 (2002)*
14. *J. Agbinya, M. Masihpour, Excitation methods for magneto inductive waveguide communicationsystems, in Proceedings of Fifth International Conference on Broadband and Biomedical Communications, Malaga, Spain, pp. 1–6 (2010)*
15. *S.A.Meybodi et al., Magneto-inductive communication among pumps in a district heating system,in 2010 9th International Symposium on Antennas Propagation and EM Theory (ISAPE),pp. 375–378 (2010)*
16. *Z. Sun, I.F. Akyildiz, Magnetic induction communications for wireless underground sensornetworks. IEEE Trans.Antennas Propag.* ***58****(7), 2426–2435 (2010)*