MAGNETIC INDUCTION BASED WIRELESS UNDERGROUND SENSOR FOR LOCALIZATION OF PEOPLE IN UNDERGROUND DISASTER

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Abstract: Many areas of world are getting affected due to natural calamity. Disasters are exceptional & unstoppable events that are either man made or natural, such as terrorist attacks, earthquakes, wildfires and floods etc. [1]. Disasters create emergency situations to provide basic services to the victims must be coordinated quickly. Many times we observe that many people dies by trapping in these disasters but the people also dies on large scale just because they didn’t get help at instant time or the help provided to them is late. This paper propose an magnetic induction based on Wireless Underground Sensor Network (WUSN) which is designed for human existence & detection in an unmanned area can be done only by wireless sensor. This system proposed a monitoring human body localization function and communicates over the WSN. Wireless sensor network is composed of a large number of micro-sensors nodes which have small volume, low cost, good compatibility & battery powered. At the same time due to the special nature of the wireless network is that it can spread the wireless signal, we can easily locate human. By sensors like humidity, temperature, visibility we will get all the weather reports
The main objective of this Paper is to rescue more & more number of people from the adverse condition.

Keywords: Natural calamity, Magnetic Induction, Wireless underground sensor, Disaster.

1. Introduction
This article based on wireless underground sensor network technology to help the people on time which are trapped in landslide, mine and tunnel. It gives timely & accurately reflect dynamic situation of human in disaster region like in the underground regions to control room, so that rescue team of Experts & doctors can be sending to the victim’s location for primary treatment and can be sent to the safe place or hospital. Wireless underground sensor network (WUSNs), which can be used in a wide variety of novel applications including intelligent agriculture, pipeline fault diagnosis, mine disaster rescue, concealed border patrol, crude oil exploration, among others [1-7].

Underground is more complicated than the terrestrial environment, which contains not only air but also sand, rocks, and water with electrolyte. It is challenging to realize wireless communication in such complex environments. Classic techniques based on electromagnetic (EM) waves are widely used in terrestrial environment. However, those techniques do not work well in underground. First, EM waves experience high levels of attenuation due to absorption by soil, rocks, and water in the underground [8]. Second, the electrolyte in underground medium becomes the dominating factor that influence the path loss of EM waves. As a result, the content of water, density and makeup of soil, can change the performance of communication unpredictably since these factors are different in places and vary dramatically with time. Third, operating frequencies in MHz or lower ranges are necessary to achieve practical transmission range [8, 9]. Thus, compared with the communication range, the antenna size will become too large to be deployed underground.
Magnetic Induction Communications in Soil Medium

It is clear that the underground is not an optimal environment for wireless communication using EM waves. High attenuation caused by soil particles and water in the ground make communication over practical distances difficult. One possible alternative to EM waves for underground communication is Magnetic Induction (MI). Using MI for the physical layer of a WUSN could have several benefits.

- Dense media such as soil and water cause little variation in the rate of attenuation of magnetic fields from that of air, since the magnetic permeabilities of each of these materials is similar.
- Multi-path fading is not an issue for MI communication since the magnetic field is generated in the near-field and is non-propagating
- MI communication solves the issue of antenna design

However, MI is generally unfavorable for open-air communication since magnetic field strength falls off much faster than the EM waves in terrestrial environments. Although the material absorption does not affect MI communication in the soil medium, the total path loss of the MI is still too high. The communication ranges of the EM wave system (4 m) and the ordinary MI system (10 m) are too short for efficient deployment in practical applications.

One solution is to employ some relay points between the transmitter and the receiver, as shown in Fig.5. Those relay coils form an MI waveguide in underground environments, which act as a waveguide that guides the so-called MI waves. The MI waveguide has three advantages in underground wireless communications:

- By appropriately designing the waveguide parameters, the total path loss can be greatly reduced. The maximum communication range between two transceivers can achieve several hundred meters.
- MI waveguide is not a continuous structure like traditional waveguide. It is only required to deploy one relay coil every 5 meters (or even longer) between the transceivers. Hence it is very flexible and easy to deploy and maintain.
- The relay coils do not consume any energy and the cost is very small
Several passive relays can be deployed between two transceiver nodes in order to extend the transmission range. This idea was originally proposed in context of MI based metamaterials. Using the same strategy as for the direct MI, the current flow in the second coil yields a secondary magnet field, which influences the third coil and induces a voltage there. Hence, this signal propagation can be seen as a so called traveling MI wave. Since misalignments and limited precision of the system deployment are inevitable, power reflections at every device need to be considered, which makes the concept of the "wave" not very practical.

MI-waveguide includes additionally \((k-1)\) passive relays, which are placed equidistantly between the transceivers. The optimal resonance frequency can be chosen much higher in order to increase the magnetic induction between each two relay coils, yielding much lower pathloss between these coils and for the whole waveguide in general. However, the choice of the resonance frequency is not trivial (in general non-convex) and constrained by the physical elements of the system:

- parasitic effects in coils, e.g. capacitances (especially in multi-layer coils), resistance;
- parasitic effects in loaded capacitors (resistances);
- minimum capacitance of the loaded capacitor, e.g. \(C \geq 1 \text{pF}\).

These constraints have a strong impact on the signal attenuation and frequency-selectivity of the pathloss functions and can lead to a significant performance degradation.

3. **Wireless Power Transfer in underground Sensor**

![Wireless power transfer using resonant magnetic induction](image)

In addition, a novel technique to wirelessly, supply power to the underground sensor networks using the magnetic induction principle.

4. **System model of WUS In Underground**

In wireless underground sensor network (WUSN), sensor nodes are buried in soil. Electromagnetic wave propagates in soil medium between sensor nodes, and propagation characteristics are decided by soil properties. Soil is a light dense medium compared to the air, which produces great absorption and attenuation to the electromagnetic wave. Wireless underground sensor networks have been investigated in many contexts recently. The sensor was buried at a depth of 0.5 m. The horizontal distance between sensor nodes was 1 m. The soil was carefully evaluated with a conductivity of 0.1 and a dielectric constant of 10. Moreover, the volumetric water content of the soil changed from 5% to 30%, and the proportion of sand and clay soil was also different. In the near surface wireless underground sensor networks system used for golf course was developed which included acquisition Nodes, sink nodes and a gateway node. Each acquisition node consisted of a soil moisture sensor, a controller, a wireless transceiver with a carrier frequency of 868 MHz, an antenna, a memory unit and a battery power module. It could be connected with several moisture sensors. The sink node was the same as the acquisition nodes but with no sensors connected. The sink nodes collected the data from the acquisition nodes, communicated with other sink nodes if needed, and transmitted the data to the gateway node.
5. **WUS Network System Model**

Basically, the main task of the WUSNs is related to data collection. Therefore, the tree-based network architecture seems to be best suited for this purpose. We restrict ourselves to the simply connected spanning trees, since it is preferable to avoid circulating data in the network due to the limited data rate in the underground communication systems. As it is common in WSNs, each sensor (root) node not only transmits its own sensed data, but also relays the data from the (leave) nodes connected to it. For this, we apply a decode-and-forward relaying scheme in our works. The data from the whole network is then guided to the sink node, which either stores it or retransmits to an aboveground device. An example of the network deployment is given in the Figure.

![Fig 4: system model](image)

**Fig 5: WUSN with Sensor Node**

The monitoring will involve keeping track of location and human body in underground. The system should be capable of providing real-time data regarding the level and how much number of peoples from underground like landslide and tunnel to the base station for monitoring. The Proposed solution is to design the prototype for the system model and identifying the appropriate components required for the system. Designing and developing a human detection sensor.
6. CONCLUSION

The application of wireless sensor network will improve the saving of many lives by using WUSN in disaster. In this paper we design an effective & safe system to ensure that there are no human left behind in rescue operation. This system can detect existence of human, temp, humidity, visibility in order to monitor weather report & trace the location of victim in disaster area. It will greatly improve the performance & efficiency of data transmission. It is convenient to expand & reduce the cost of extending system. The application of wireless sensor network can realize the real-time monitoring of affected area by the natural calamities.

7. References

1] Z. Sun and B. Zhu, —Channel and energy analysis on magnetic induction-based wireless sensor networks in oil reservoirs,‖ in Proc. 2013 IEEE ICC.


