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Secure Defense Communications Based on Magnetic Induction using Underground Wireless Networks

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ABSTRACT: Underground is a challenging wireless communication environment, as the propagation medium is no longer air, but soil, rock and water. Due to three problems: High path loss, dynamic channel condition and large antenna size, well - established wireless communication techniques using electromagnetic (EM) waves do not work well in this environment. New magnetic induction (MI) techniques can solve the problems (dynamic channel condition, large antenna size and the problem of high path loss with the relay units).. The defense communication system is designed in this paper by using magnetic induction topology using a wireless underground network.

KEYWORDS: WUN-Wireless Underground Network, MI-Magnetic Induction, NFC-Near Field Communication, WPT-Wireless Power Transfer, PTE-Power Transmission Efficiency, ATMEGA-328 Microcontroller.

I. INTRODUCTION

Everyone wants to be safe and secure in this world. When it comes to the safety and security of multinational companies, the military and the army, the situation becomes more complicated. Even a common man makes every effort to protect his data. The popular methods to securely protect the data are to encrypt the data while sending and receiving it, to decrypt the data to retrieve the original message. Before transmitting the data, the data will be converted into an unreadable form and sent. On the receiver side, the opposite encryption operation is performed to recover the original message. The data is therefore protected in every way by standard formats of encryption and decryption.

The underground soil medium can consist of rock, sand and even water sheds. In particular, the water content of the soil has a major impact on the communication range and the overall performance of the WUNs. Traditional wireless signal propagation techniques using EM waves can only be used in many realistic cases for very small transmission distances due to a large loss of track and vulnerability to soil moisture changes. Among different alternatives to EM waves, techniques based on magnetic induction (MI) were considered. In various works, magnetic induction-based communication has already been investigated, mainly in the context of close-field communication (NFC) and wireless power transfer (WPT). In contrast to traditional EM-based signal transmission, MI uses induction coils (sometimes referred to as magnetic antennas), which generate quasi-static magnetic fields. These magnetic fields generated by a transmitting coil can be sensed by the receiving coil, so that a signal transmission link can be established. It has been shown that the MI - WUN technique is less vulnerable to losses in the conductive medium (soil), so that the transmission range and coverage of the area can be significantly improved using MI - based transceivers.

In underground environments, traditional techniques using electromagnetic (EM) waves face three major problems: First, EM waves suffer from high levels of attenuation due to soil, rock and underground water absorption. Secondly, the loss of track depends heavily on numerous soil properties, such as water content, soil composition (sand, silt, or clay) and density, and can change dramatically with time (e.g. increased soil water content after rainfall) and space (soil properties change dramatically over short distances). Consequently, the Bit Error Rate (BER) of the

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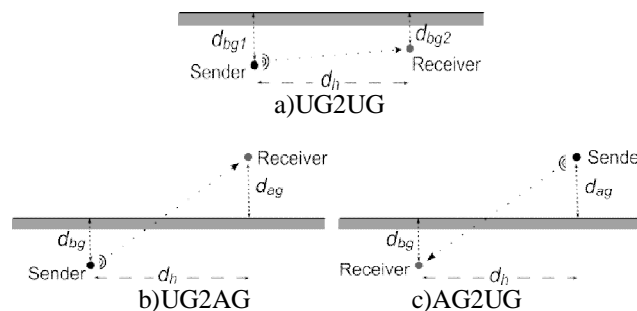
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communication system also varies dramatically in different times or positions. The unreliable channel presents design challenges for underground devices and networks to achieve both satisfactory connectivity and energy efficiency. Third, antenna design conflicts exist for underground communication using EM waves. On the one hand, it is expected that the antenna size will be as small as possible to facilitate network deployment. Operating frequencies in MHz or lower ranges, are necessary to achieve a practical transmission range. To efficiently transmit and receive signals at this frequency, the antenna size is too large to be deployed in the soil.

Magnetic induction (MI) is a promising alternative technique for underground wireless communication in the physical layer. It solves the dynamic channel condition problem and large antenna size problem of the EM wave techniques. In particular, the dense medium such as soil and water causes little variation in the magnetic field attenuation rate from air, since the magnetic permeability of each of these materials is similar. This ensures that the conditions of the MI channel remain constant. In addition, the MI communication solves the problem of antenna size, since the transmission and reception are carried out with the use of a small wire coil.

II. SOIL COMMUNICATION TYPES



• **Underground to underground (UG2UG) Link:** Both the sender and the receiver are underground buried and communicate via soil. This type of communication is used for multi-hop information delivery and is the main focus of this work.

• **Underground-to-aboveground (UG2AG) Link:** The sender is buried and the recipient is above the ground. Monitoring data is transferred via these links to overground relays or sinks.

• **Aboveground to underground (AG2UG) Link:** Aboveground sender node sends messages to underground nodes. This link is used to provide management information to the underground sensors.

III. EXISTING SYSTEM

NFC: Near - field magnetic wireless systems have distinct advantages over their conventional far - field counterparts in water - rich environments, such as underwater, underground and biological tissues, due to lower power absorption. Philips and Sony jointly developed NFC technologies in 2002. These were based on RFID and contactless communication smartcard technology. NFC is a short-range half-duplex communication protocol that uses inductive coupling and an operating frequency of 13.56 MHz. It is commonly used with mobile NFC devices, NFC tags, and NFC readers, and NFC's operating modes include reader / writer, card-emulator, and peer-to-peer mode. The data stored in the NFC tag can be read and written by an active NFC mobile in the reader / writer operating mode. This mode follows ISO / IEC 14443 Type A, Type B and FeliCa, and data exchanges are conducted in accordance with the NFC Forum Near Field Data Exchange Format (NDEF). In card emulation mode, NFC readers and NFC mobiles act as traditional RFID readers and as a contactless, read-only RFID smart card based on ISO / IEC 14442 Type A, Type B and FeliCa. The NFC technology can be integrated with existing types of RFID infrastructure in card-emulator mode. Peer-to-peer mode is unique to NFC and unlike RFID, as RFID can only read card or tag data. Two NFC mobiles can exchange information in both directions in peer-to-peer mode as NFCIP-1 in accordance with ISO / IEC 18092. The

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NFCIP-1 protocol basically operates a "request-response model" and uses the acknowledgement (ACK) character frame to include an error handling function. NFC usually has high cost, privacy, security and recognition challenges.

WPT:

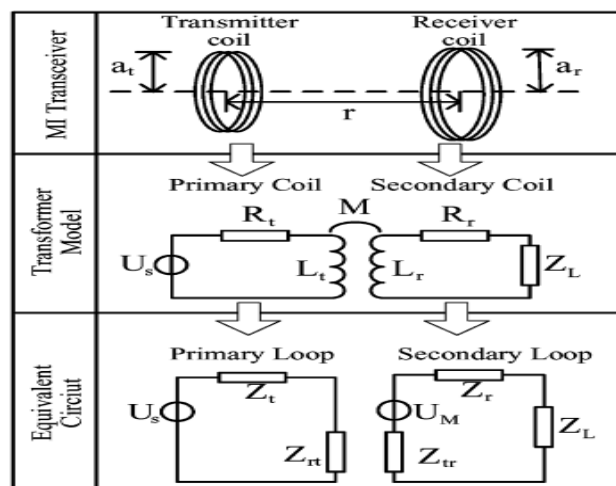
Beginning in the late 1990s, SONY developed the wireless IC card "FeliCa," which used magnetic induction as an IC chip power supply and for data transfer purposes. The most traditional near - field magnetic WPT system works by magnetic induction. In this system, a resonant condenser can be used to compensate for the power factor due to the leakage flux. However, the load impedance is determined by the load power demand. As a result, when the transmission distance increases, the transmission efficiency decreases according to the magnetic coupling coefficient.

In a WPT system that uses a coupling coil and a resonant condenser, the coupler mainly has an inductive reaction, while the capacitive reaction of the coupler itself is rather small. Therefore, the realization of resonance requires an external form of reaction. During the energy exchange between the external capacitive reactivity and the inductive reactivity, energy loss occurs, which reduces the system's Q-factor and therefore degrades the PTE.

In a WPT system with a self-resonant antenna, the antenna itself has both inductive and capable reaction capabilities. Therefore, resonance can be achieved without the use of a resonant condenser. By using a self-resonant system, a high Q-factor is achieved because the loss in the resonant condenser is avoided. In the magnetic-coupling self-resonant system, the electric field is not negligible due to its resonant nature. By using electric field coupling, the transmission distance can be extended with a repeater consisting of a single-wire conductor.

IV. PROPOSED SYSTEM

In MI communication, the transmission and reception is carried out by the use of a wire coil, where the radius of the transmission coil and the receiving coil are a_t, a_r ; r is the distance between the transmitter and the receiver; and $(90 - \alpha)$ is the angle between the axes of two coils.



Different from the relay points using the EM wave tech, the MI relay point is a simple spindle without a source of energy or a processing device. The transmitter coil sinusoidal current at the first point of the relay induces a sinusoidal current. This sinusoidal current induces another sinusoidal current at the second relay point in the second relay, and so on and so on. These relay coils form an underground MI waveguide, which acts as a waveguide to guide the so-called MI waves. In a typical MI waveguide structure where, n relay coils are equally spaced along one axis between the transmitter and the receiver; r is the distance between the neighbor coils; d is the distance between the transmitter and the receiver and $d = (n + 1)r$; a is the radius of the coils. In fact, there is a mutual induction between any pair of coils. The value of mutual induction depends on the closeness of the coils. In underground communication, the practical

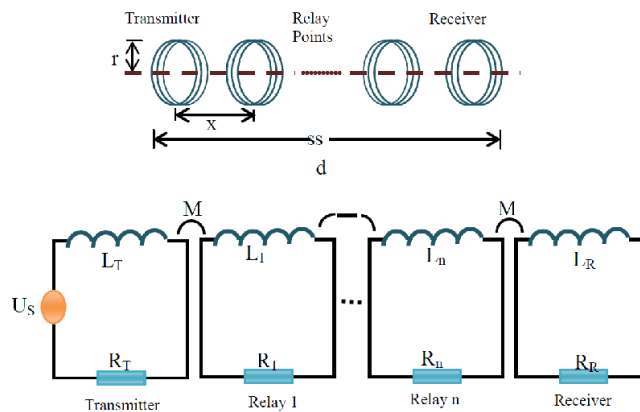
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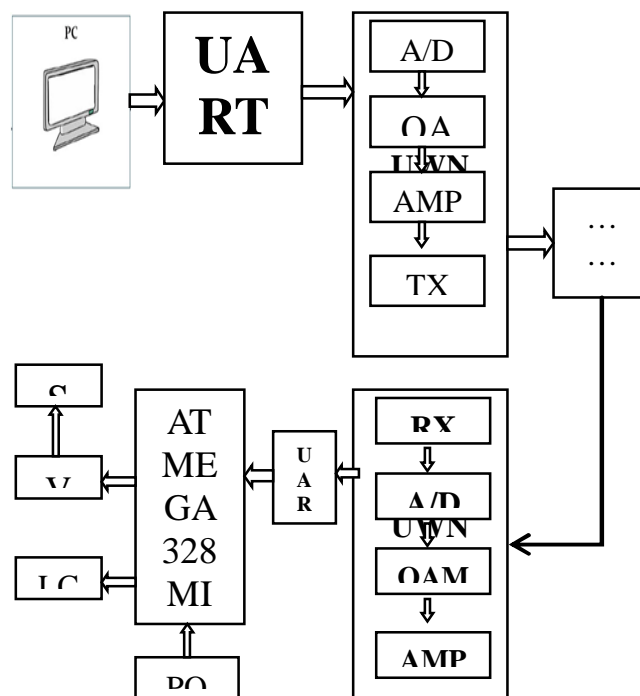
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distance between two relay coils is about 1 m, and the radius of the coil is not more than 0.1 m. We therefore assume that the coils are far enough and only interact with the nearest neighbours. It is therefore necessary to take into account only the mutual induction between the adjacent coils. The MI waveguide is modeled as a multi-stage transformer, in which only adjacent coils are coupled. In practical applications, transceivers and relay points usually use the same type of coils.



V. HARDWARE DESIGN

The secured communication system of WUN includes WUN transceiver and power distribution module. The detection system also contains a control module and a status indicator. The metal sample detects an information carrying a soil signal and communicates it to the decoder. The decoder extracts event data from the ground signal and sends it to the microcontroller. The control module processes and stores the event data in a memory. The control module optionally downloads the stored event data to an external device.



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One RS232 converter is used on the transmitter side to convert the transmitted message from PC to WUN transmitter. The messages can be sent from any module and the message can be broadcast or sent to a particular module. After the data has been encoded, it is sent to free soil for transmission. We have designed a wireless device to transmit and receive messages from and to the main base station on the remote soldier side. To display the message, a 16* 2 LCD is used. For voice message, we have designed a 32-voice playback module. Here we also used one ATMEGA 328 microcontroller and one WUN receiver for communication purposes.

WUN TRANSMITTER SPECIFICATION:

PARAMETER	SPECIFICATION
Data Rate	250 kbps
No. of Channel	16
Operating frequency	2.4 Ghz
Channel spacing	5 Mhz
Spread spectrum	Magnetic Induction
Modulation	16 QAM

VI. CONCLUSION

The "Secure Wireless Communication for Military Application" is an effective security and safety system that integrates advances in wireless and embedded technology. It helps to achieve a successful secret mission. This system can be used under critical conditions. By implementing this system, we can improve the safety and security of our country.

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