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Dual Band Magnetic Textile Antenna for Body Area Network Application

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***Abstract* - Wireless Body Area Network (WBAN) is one of developed technology that supports telemedical services. WBAN provides low power consumption, mobile, and easier monitoring. This application needs a wearable device especially a textile antenna for implementation. So far, the antenna's performance is mainly affected by a human body when it is applied near to the human body. In this paper, we propose a novel magnetic antenna that works in dual-band operation (924 MHz and 2.45 GHz). The proposed antenna is simulated and measured for validating the basic performances. The validation shows that the measured result is well suited with the simulation in terms of S_{11} and radiation patterns.**

***Index Terms* — Dual band, magnetic textile antenna, medical monitoring, WBAN.**

1. Introduction

Health monitoring in out-of-hospital conditions has been interested for researchers and healthcare practitioners in current years. Telemedicine provides health care services, clinical information, and education over a distance using telecommunication technology [1]. Wireless body area networks (WBAN) including communication within and around the human body, has been under an intensive study recently.

WBAN has a great potential to revolutionize the future of healthcare technology. The current IEEE 802.15.6 standard defines three physical (PHY) layers for WBAN, namely narrowband (NB), ultrawideband (UWB) and human body communications (HBC) layers. The selection of each PHY depends on the application requirements [2]. In Indonesia, narrowband or ultrawideband technology may possibly become candidates for medical monitoring. RFID and ISM based-technology have been studied for medical application [3].

WBAN supports both implant and wearable antenna. We have to consider the presence of human body tissues to antenna performance. Basically, human body tissues are heterogeneous material, which are formed of water, electrolytes, and dissolved organic molecules and ions. Molecules have a dipolar momentum, which is able to interact with the electric field. In addition, the presence of ion plays an important role in the interaction with an electric field, providing means for ionic conduction and polarization effects. This means the human body extracts the energy from electromagnetic field mainly by its ionic activity. To avoid those interaction, antenna has to radiate dominant magnetic field to avoid such a problem [4].

The development of wearable antenna have grown rapidly with enhancement for monitoring system, which involves the human body, which is popularly called a textile antenna, since a textile material is embedded as a substrate for the sake of flexible structure, comfortable and adaptable to users [5].

The previous research about textile antenna shows that low resistive material provides better performance near human body. Then, the conductivity of textile material is equal with inefficiency of the antenna because of electrical power loss [6]. Electric textile antenna has poor performance for wearable antenna. When the antenna was obtained near human body, the frequency resonant decreased smoothly [7]. Some researchers have investigated a magnetic antenna for the best option to wearable application due to its independence to human body effect, which are mainly for a single band magnetic antennas [8][9]. We have also investigated for a single band antenna [10]. In this paper, a novel dual band magnetic textile antenna that works at 924 MHz and 2.45 GHz is proposed for dual band applications.

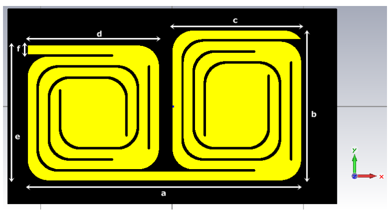


Fig. 1. The proposed antenna's structure

2. Antenna Structure

The proposed antenna configuration is described in Fig. 1. The antenna structure is a dual spiral type, at which its size is different. At the right side spiral is designed for 924 MHz resonance, and at the left side spiral aimed at 2.45 GHz band resonance. The antenna's size is 50×30 mm with 3 mm thickness of cotton fabric as a substrate. Its permittivity is approximately by 1.47. A 0.1 mm thickness of copper is constructed for a patch and ground of the antenna.

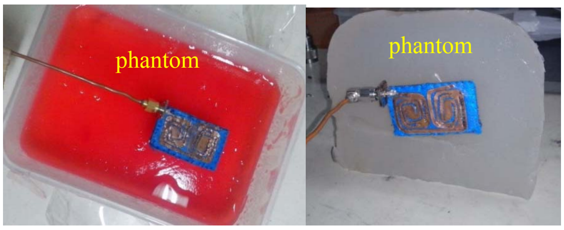
The proposed antenna is numerically simulated in free space condition and on a three layer phantom model (skin, fat and muscle) by using CST Microwave Studio to investigate the performance in the presence of human body. The phantom thickness is set by 2 mm of skin, 4 mm of fat, and 54 mm of muscle, where each value is based on *Federal*

Communication Commission (FCC) for 924 MHz and 2.45 GHz . The proposed antenna is fabricated on a cotton fabric and measured for validate the antenna performances as depicted in Fig 2.

3. Results and Discussion

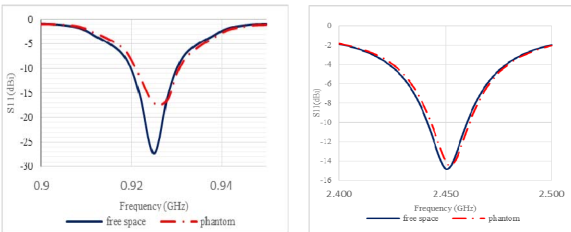
(1) *S*-Parameter

Simulated result in free space and on phantom is shown in Fig. 3 at 924 MHz and 2.45 GHz, where in the proximity to the phantom there is no significant shifting of the resonant frequency. The S_{11} achieves -27.31 dB at 924 MHz with 11 MHz of bandwidth and -14.8 dB at 2.45 GHz with 20 MHz of bandwidth, in case of free space. When the antenna is close to the phantom are S_{11} changes a bit by -17.07 dB (@924 MHz) and -15.51 dB (@2.45 GHz). The bandwidth does not significantly change, namely 9 MHz and 21 MHz for 924 MHz band and 2.45 GHz band, respectively. The results are shown in Fig. 3. A 2/3 muscle equivalent phantom is fabricated for validation the antenna's performances. The measured relative permitivity and conductivity is by 55 and 1.06 S/m, respectively at 924 MHz, and 35.15 and 1.16 S/m respectively at 2.45 GHz as shown in Fig 2. The measured and simulated results of S_{11} are depicted in Fig. 4.



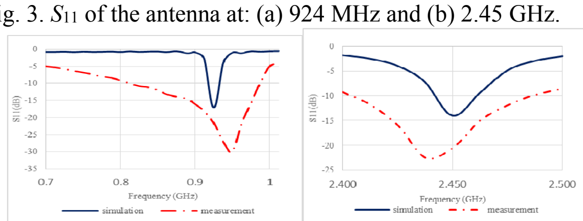
(a) (b)

Fig. 2. Antenna in proximity to phantom model at: (a) 924 MHz and (b) 2.45 GHz.



(a) (b)

Fig. 3. S_{11} of the antenna at: (a) 924 MHz and (b) 2.45 GHz.

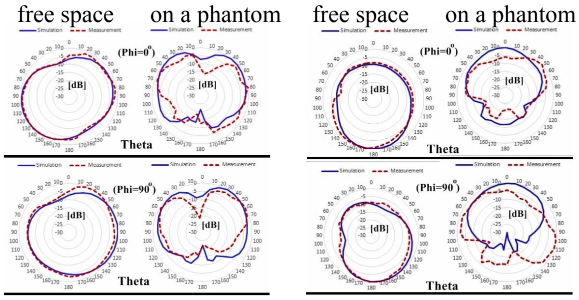


(a) (b)

Fig. 4. Measured and simulated S_{11} of the antenna at: (a) 924 MHz and (b) 2.45 GHz.

(2) Radiation Pattern

The pattern of the antenna is depicted in Fig 5 for *xz*-(*phi*=0) and *yz*-plane (phi=90°). The measured pattern is well suited with the simulation results in free space (left side) and proximity to the phantom (right side) at each operating frequency, 924 MHz and 2.45 GHz.



(a) (b)

Fig. 5. Measured and simulated radiation pattern of the antenna at: (a) 924 MHz and (b) 2.45 GHz.

4. Conclusion

The paper has proposed a novel dual band magnetic textile antenna operated at 924 MHz and 2.45 GHz bands. The proposed antenna has been measured in free space and phantom condition to validate the simuated results. The validation shows that the antenna is well suited with the simulation. The antenna will be applied for wireless monitoring system in the further research.

Acknowledgment

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