Analysis of EMF and Interference in the Wireless Charging Robot System

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Abstract— In this paper, the analysis of EMF and interference in the service robot with the wireless charging system is presented. The magnetic resonance was used to transfer the high power energy into the service robot. The resonance frequency and transfer distance is about 1.80 MHz and 20 cm, respectively. The wireless charging system is composed of the spiral type resonators, transceiver with communication module, and Pb-battery. Both resonators are made of litz wires to decrease the loss and have two layers to increase inductance.

For the analysis of EMF and interference, the uniform body model defined in IEC 62369-11 and the near-field analysis of the resonators was used. Finally, the strength of the electromagnetic field and SAR (Specific Absorption Ratio) nearby the service robot was obtained.

1. INTRODUCTION

Many researchers have developed the wireless charging system since the magnetic resonance technology was presented from MIT in 2007 [1]. Especially, the wireless power company consortiums such as WPC, A4Wp, and PMA have been developing the standard. As a result, many kinds of the wireless power charging devices for mobile phones are presented in the market and the high-power technology is being applied to charge the electric vehicles [2, 3].

Even though the middle-power solutions are needed to charge the home applications and small robot, EMF (Electro and Magnetic Field) on the energy transfer path, interference with nearby electric devices and SAR (Specific Absorption Ratio) should be considered before use [4]. In this paper, the simulated EM analysis for the wireless charging robot system using middle power is demonstrated and the comparison results according to the presents of the EM shielding are also shown.

2. THE WIRELESS CHARGING ROBOT SYSTEM FOR ROBOT

As shown in Fig. 1, to transfer the high power energy into the service robot, the wireless power transmission technology using magnetic resonance was used. The resonance frequency and transfer distance to obtain more than 70% transfer efficiency is about 1.80 MHz and 20 cm, respectively. And the maximum transmitting power level is 100 W. The wireless charging system is composed of the spiral type resonators, transceiver with communication module, and Pb-battery. Both resonators

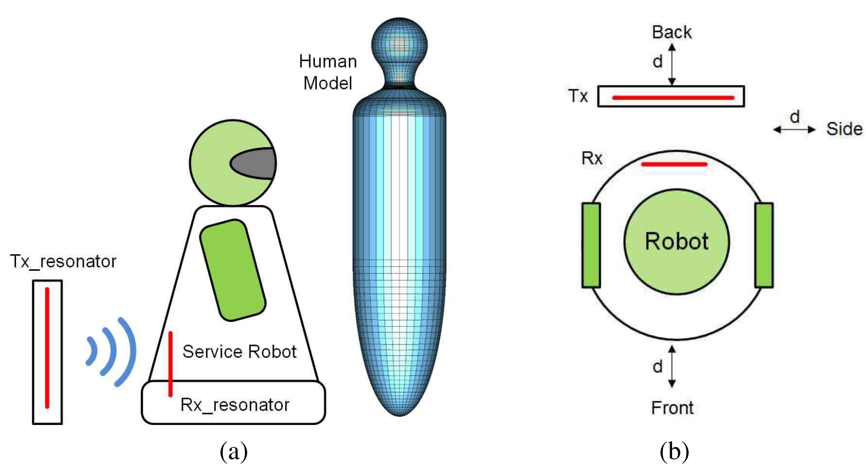

Figure 1: Wireless Charging Robot model. (a) Side view. (b) Top view.

are made of litz wires to decrease the loss and have two layers to increase inductance. The diameters of tx and rx resonator is 40 cm, 30 cm, respectively [5].

For the analysis of EMF and interference, thee uniform body model composed of muscle and defined in IEC 62369-11 was used [6]. The cover contained receiver module, the frame of robot and battery was considered as metal having electric loss. And the other part of robot was done as ABS (acrylonitrile-butadien-styrene resin) material. Three observation points denoted as front, side and back were selected. The distance (d) is from 5 cm to 100 cm and the height of points for averaging the results is 30 cm, 60 cm, and 90 cm, respectively. Finally, the ferrite sheet and rectangular metal plate were located on the back of each resonator to confirm the shielding effect.

3. THE EM ANALYSIS OF WIRELESS CHARGING SYSTEM

Figure 2 shows the EMF strength SAR nearby robot. As shown in figure, the maximum value is calculated on the back of tx-resonator and the minimum is done on the front of robot. Especially, the maximum value is more than 10 times stronger than ICNIRP guidelines (electric field 64.8 V/m, magnetic field 405 mA/m at 1.8 MHz). These results can influence human and electronic devices within the certain zone. Therefore the ferrite sheet and rectangular metal plate were applied to the system for reducing the EMF and the comparison results were shown in figure.

As results, the electric field is decreased to a tenth part of the original value and the magnetic field is done to a fifth part of that. Considering the more suitable shape and location of ferrite sheet and metal plate, significant reduction in EMF could be obtained. And the reasonable power level to satisfy the guide line and the power control function are required on this system. For SAR, very low values were simulated due to the high permittivity of the Body on the low resonant frequency. This means that and low frequency has an advantage in SAR when wireless power transfer technique is applied to high power solutions.

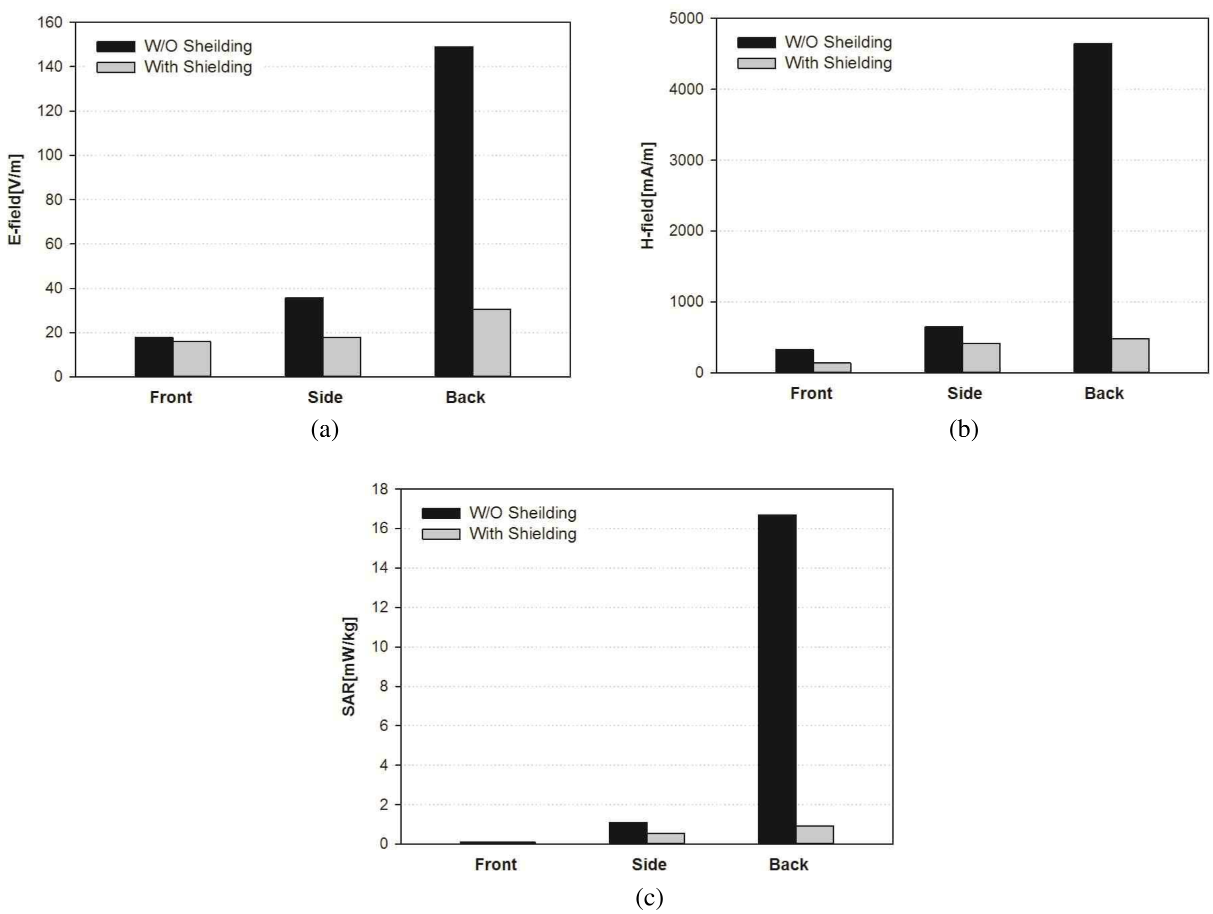

Figure 2: The comparison results of EMF and SAR. (a) E-field, (b) H-field, (c) SAR.

4. CONCLUSIONS

This paper presented the analysis of EMF and interference in the service robot with the wireless charging system is presented. The magnetic resonance was used to transfer the high power energy into the service robot. For the analysis of EMF and interference, the uniform body model defined in IEC 62369-11 and the near-field analysis of the resonators was used. Finally, the strength of the electromagnetic field and SAR (Specific Absorption Ratio) nearby the service robot was obtained and the guided level of the transfer power is suggested.

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