POS2-53

RFID Tag Antenna for Managing Surgical Instruments

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1. Introduction

Recently, wireless communication technology has been expected to apply various fields [1]. Radio frequency identification (RFID) system is one of these technologies. This is a communication system using the electromagnetic wave. Mainly this system is used for management such as entry and exit of important facilities or logistics in warehouse. Also, in recent years, the healthcare system and the medical management have become very active research areas. These areas have been expected to be applied various technology. One of this is managing surgical instrument system using RFID system. With this system, details of surgical instruments can be accurately managed, for instance history of using or disinfection. In addition this system may prevent some artificial medical accidents, such as confusions of surgical instruments and misplace in human body. Moreover, this system may reduce the load of staffs in the hospital.

An antenna plays an important role in RFID system [2]. The antenna is sensitive to the environment, such as water, metal and temperature. In case, the tag antenna is attached on the object, the antenna characteristics may change. At worst, the antenna can be impossible to communicate with Reader/Writer [3]. We need to understand precisely the suitability of RFID tag antennas to the metal because the surgical instruments managing system by use of RFID tag antennas which can be placed in the vicinity of the metal. Further, how to attach the RFID tag on the surgical instrument is important. The method is required less harmful for human and heat resistance for disinfection, also that the tag does not come off easily. In addition, since the antenna may be affected not only surgical instrument but also RFID tag attachment tools, we need to understand precisely the suitability of RFID tag antennas to the RFID tag attachment tools.

Therefore in this paper, we evaluated the change of the antenna characteristics by numerically calculation when an RFID tag mount on three positions (the centre, and both ends) of the long surgical instrument and an RFID tag is attached with two materials (the metal and the dielectric) of RFID tag attachment tools.

2. Calculation Model

The structure of the RFID tag antenna is shown in Figure 1. The proposed loop antenna is 10 mm × 1.5 mm × 1.0 mm in size. A dielectric (ε_r = 2.36; σ = 0 S/m) is wrapped inside the loop antenna. A tag has an IC chip in general, however this case we calculated as it has a feeding point there. In addition, the operation frequency of this antenna is 950 MHz. Next, the structure of the surgical instrument is shown in Fig.2. This instrument has a blunt hook to keep open the skin at the surgery. Three positions to mount the RFID tag antenna are shown circles. One is the centre of the instrument (Position1), another is 10 mm from the end (Position2), and the other is 10 mm from the other end (Position3). Finally, the structure of the RFID tag attachment tools are shown in Figure 3. One of these is made of the dielectric (Fig.3(a)) and the other is made from the perfect conductor (Fig.3(b)). In our study, we all calculated by Finite Element Method (FEM).

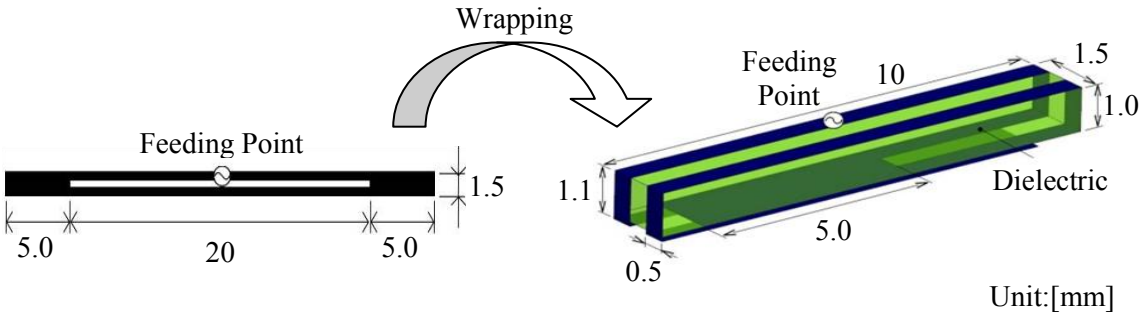


Figure 1: Structure of the proposed tag antenna.

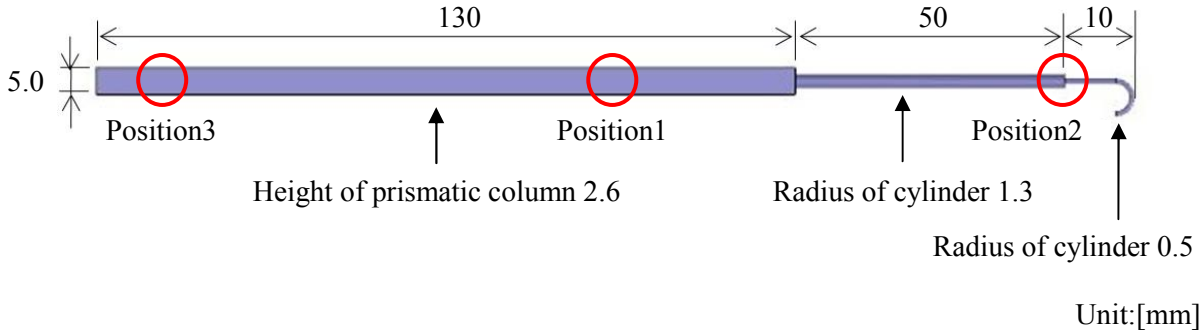
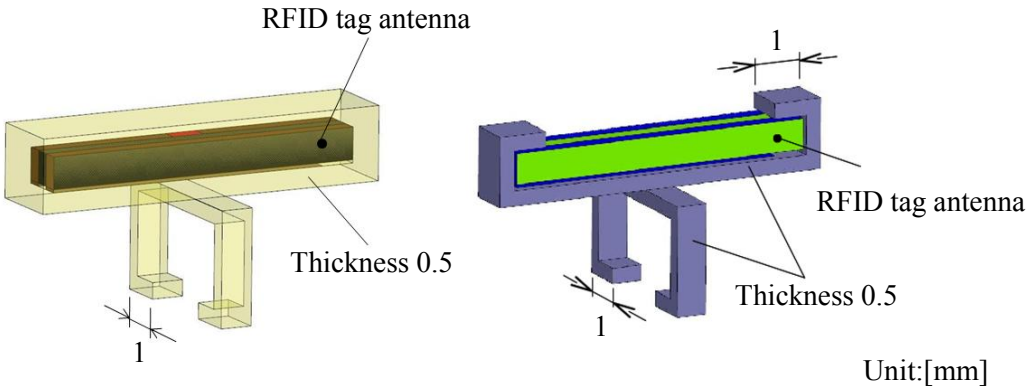


Figure 2: Structure of the long surgical instrument.



(a) Made of dielectric (b) Made of perfect conductor

Figure 3: Structure of the RFID tag antenna attachment tools.

3. Calculated Results

3.1 Result of difference of RFID tag positions

The result of the antenna impedance is shown in Fig.4. From the result, resistance of Position1 is the highest and Position2 is the lowest though the trend is almost the same. The reactance of Position1 and Position3 are fairly equal and Position2 is higher than the formers.

The result of the electric field strength distribution is shown in Fig.5. From the result, in all cases, the electric fields distribute along the surgical instrument. In Position1 particularly, the electric field of both ends of surgical instrument is the most strong. Further in Position3, the electric field distribution is the strongest in all conditions.

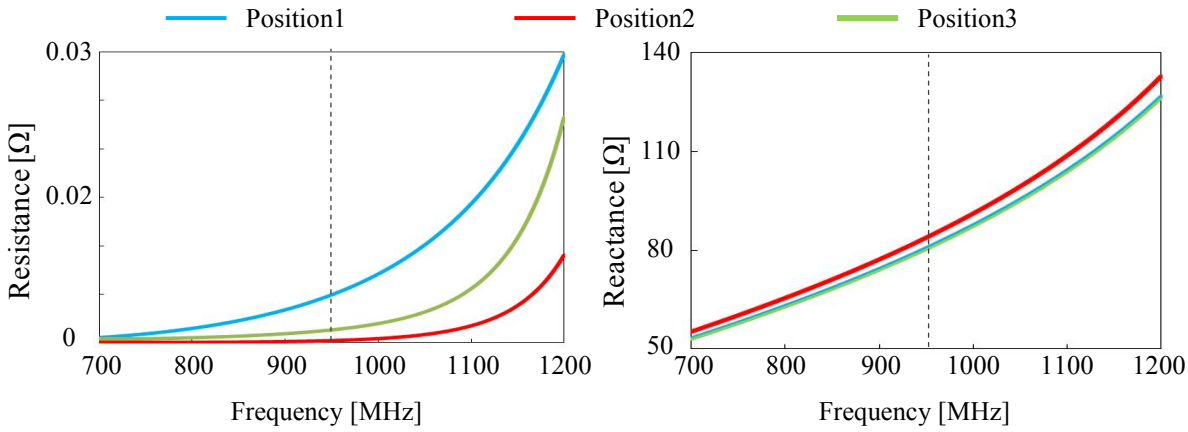


Figure 4: Impedance of RFID tag antenna.

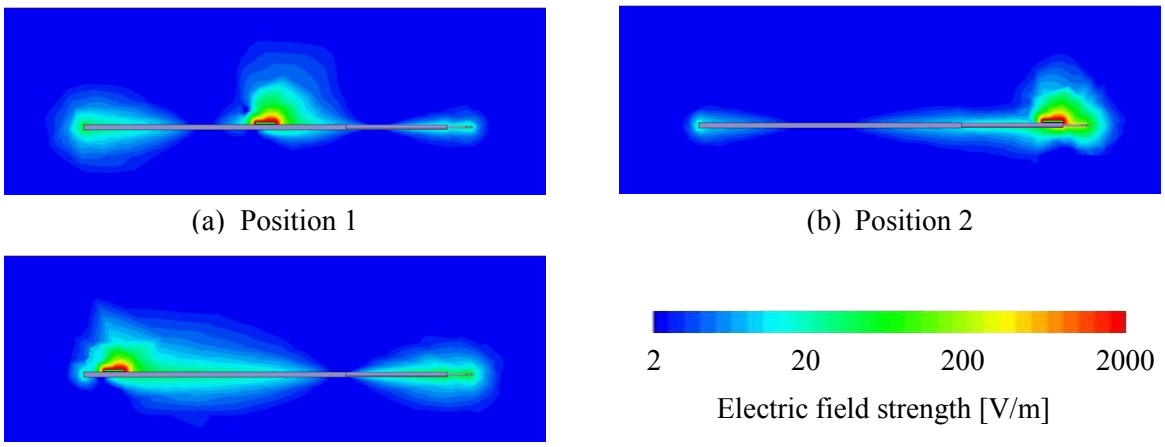


Figure 5: Electric field strength distribution.

3.2 Result of difference of tag attachment tools

The result of the antenna impedance is shown in Fig.6. From this result, the growth rate to frequency of the resistance with dielectric attachment tool is the highest. Though, the highest value at 950 MHz, the operation frequency, is when the RFID tag antenna is attached with metallic attachment tool. On the other hand, the reactance with metallic attachment tool is the lowest. In addition, the values of reactance when RFID tag antenna is attached the surgical instrument directly and attached the surgical instrument with dielectric attachment tool is almost same.

The result of the electric field strength distribution is shown in Fig.7. From this result, the electric field is not slightly different from the tag only and the tag with dielectric attachment tool. Moreover the electric field of the tag with metallic attachment tool is the narrowest and the weakest in all cases.

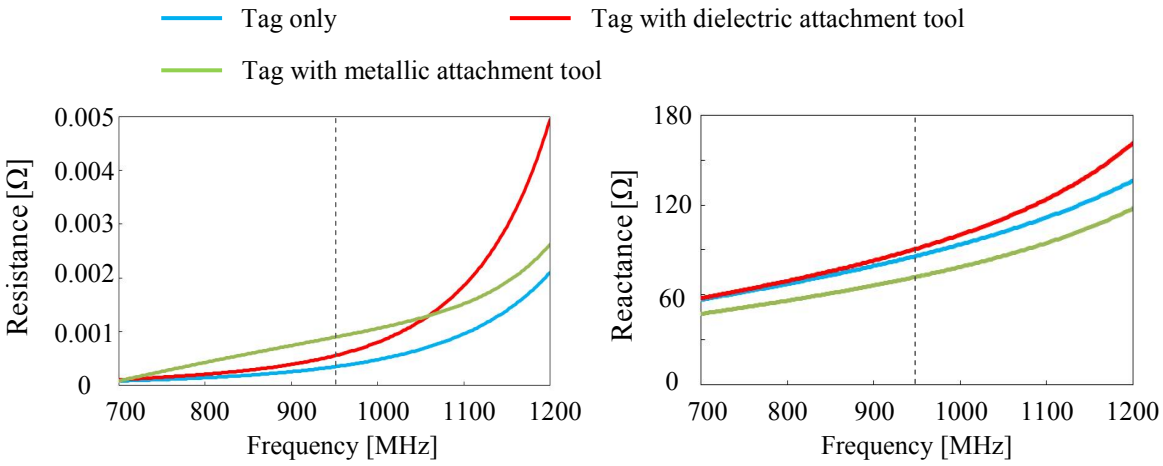


Figure 6: Impedance of RFID tag antenna.

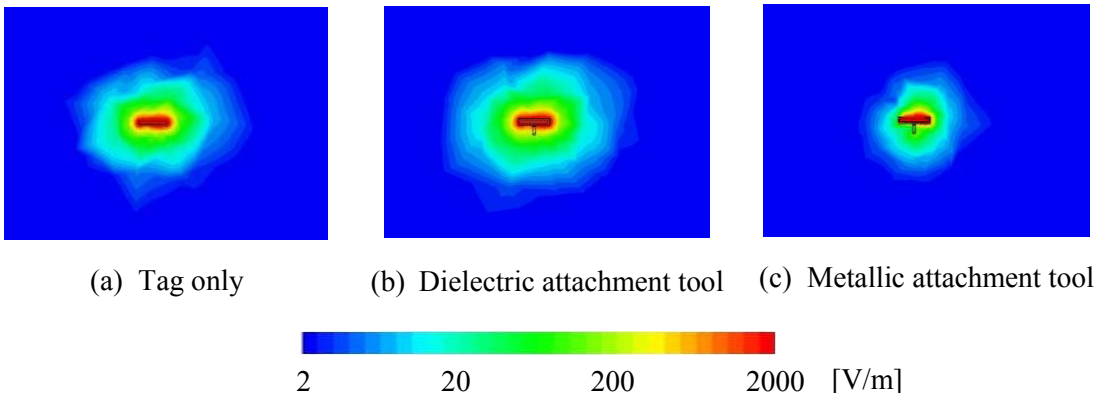


Figure 7: Electric field strength.

4. Conclusion

In this paper, the change of the antenna characteristics calculated when an RFID tag mount on three positions of the surgical instrument and an RFID tag is attached with two materials of RFID tag attachment tools. The results of difference of the RFID tag positions show that the resistance and the electric field strength changes by positions. The results of difference of tag attachment tool show that the impedance changes by the material of attachment tool. In addition, the electric field strength of tag only and dielectric attachment tool is almost same. However, the electric field strength of metallic attachment tool becomes very weak. In the future, we will validate these calculated results by experiment. Furthermore, other surgical instrument will be studied.

References

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