Evaluation of Monitoring system for Removing IV Needles using RFID

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***Abstract* - This paper suggests a monitoring system for removing intravenous injection (IV) needles by patients using radio frequency identification (RFID) technology. In our proposed system, an RFID tag is attached to each tape for securing an IV on arms of the patients. In addition, some reader antennas are set at the bottom of the mattress pad. If the patients remove their IV needles, the communications between the RFID tag and the reader are stopped because the IC chip is come off the RFID tag. Therefore, removing IV needles are detected by whether the RFID tag can communicate with the reader or not. For our proposed system, the tag antenna and the reader antenna are designed and the characteristics of the proposed antennas are calculated. In addition, the communication area between the proposed RFID tag and the reader are measured by use of an examinee. The results show that our proposed system can detect removing IV needles.**

***Index Terms* — RFID, antenna, remote patient monitoring, intravenous injection.**

I. INTRODUCTION

The various medical accidents are happened in the hospital. The third-ranked medical accident is removing intravenous injection (IV) needles by patients in Japan. Some patients remove their IV needles because of dementia, deliria, and so on. If these accidents are happened, the bleeding has to be stopped and the IV has to be started again. Therefore, this paper suggests a monitoring system for removing IV needles.

In our proposed system, radio frequency identification (RFID) technology [1] is used. The RFID system is consisted of a RFID tag and a reader. The RFID tag has no battery, so that the structure of the tag can be designed compact and flat. Hence, if the RFID tag is attached to patients, they do not feel major stress.

The diagrammatic illustration of our proposed system is shown in Fig. 1. The patients cannot remove their IV needles without removing the tapes from their arms. Thus, the RFID tag is attached to the tape and the reader antennas are set at the bottom of the mattress pad. If the patients remove their IV needles, the communications between the RFID tag and the reader are stopped because the IC chip is come off the RFID tag. Therefore, removing IV needles are detected by whether the RFID tag can communicate with the reader or not. Furthermore, it is possible to care the patients soon to inform nurses about the accident.

In the proposed system, antennas are very important so that the tag antenna and the reader antenna are designed. In addition, the characteristics of the proposed antennas are calculated. Moreover, the communication area between the fabricated tag and the reader are measured by use of an examinee.

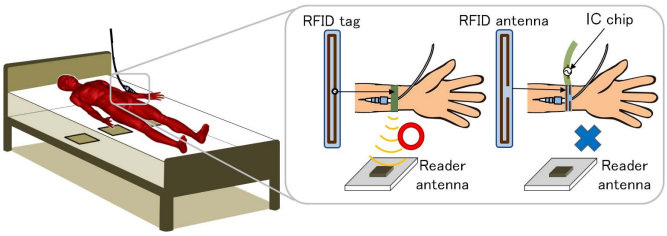

Fig. 1. Proposed monitoring system for removing IV needle.

II. CALCULATION

Fig. 2 shows the calculated models. Our proposed RFID tag is consisted of a tag antenna, an IC chip, felts, a reflector and tapes. It is worn on the arms of patients. By use of the reflector the effects of the arm are reduced and the communication area is expanded. The proposed reader antenna is used a patch antenna. This antenna is made of the conductive sheets and felts [3]. By use of soft materials our proposed system can be used on a recliner bed. In addition, the reader antenna is a circular polarized antenna by cutting the two corners of the radiating element. The electrical properties of these models are listed in Table 1 [2]. In addition, the operating frequency of these antennas is 920 MHz which is allowed to be used in many countries. The characteristics of the proposed antennas and the transmission coefficients between the proposed tag antenna and the reader antenna are calculated by finite-difference time-domain (FDTD) method.

Fig. 3 shows the electrical distribution of the proposed reader antenna. The reader antenna has strong distribution toward the tag antenna. Table 2 shows the transmission coefficients between the proposed tag and the proposed reader. From Table 2 the proposed system may detect the removing IV needles by use of the difference between the values of transmission coefficients.

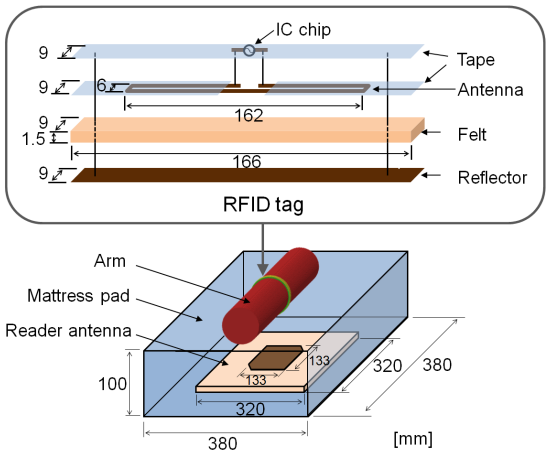

Fig. 2. Calculation model.

TABLE I
ELECTRICAL PROPERTIES OF CALCULATION MODELS

	Relative permittivity	Conductivity[S/m]
Arm (2/3 muscle)	37.3	0.65
Tape	1.50	0
Felt	1.36	0

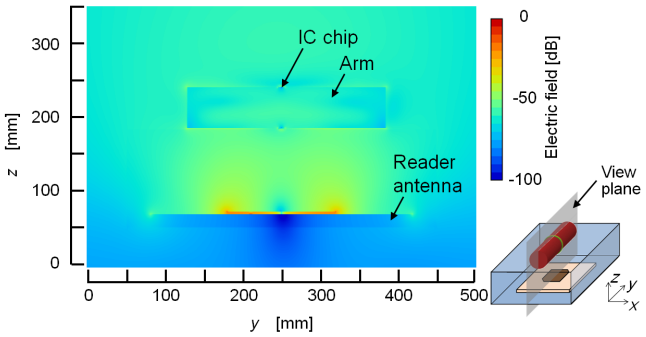

Fig. 3. Electric field distribution.

TABLE II
TRANSMISSION COEFFICIENT BETWEEN READER AND TAG ANTENNA

	Transmission coefficient [dB]
With arm (x direction)	-31.9
With arm (y direction)	-31.7
Without arm	-51.1

III. MEASUREMENT

Our proposed system is also evaluated by measurements. The experimental environment is shown in Fig. 4. The examinee with the fabricated RFID tag lies down on the mattress pad. In addition, the fabricated reader antenna is set at the bottom of the mattress pad. Then, the communication areas between the proposed RFID tag and the proposed reader are measured. The radiated power of the proposed reader antenna is 250 mW which is equal to the maximum power of a third-generation mobile phone. Now, mobile phones are allowed to be used in a hospital room. Thus, our proposed system can be used.

Fig. 5 shows the communication area between the proposed RFID tag with the arm and the proposed reader. From Fig. 5 the fabricated tag can communicate with the fabricated reader within the range of 350 × 350 mm^2. It is enough area for a monitoring of removing IV needles. On the other hand, if the IC chip is come off the RFID tag by removing the IV needle, the IC chip cannot communicate with the reader. Therefore, our proposed system can detect removing IV needles by whether the proposed tag can communicate with the proposed reader or not.

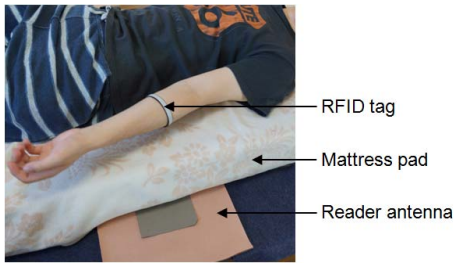

Fig. 4. Experimental environment.

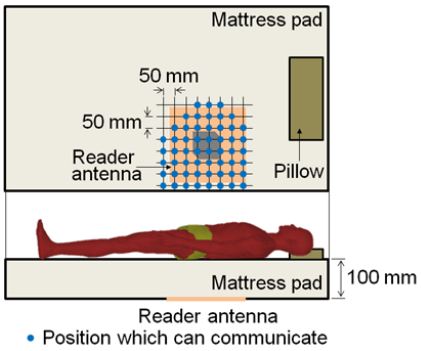

Fig. 5. Communication area between tag and reader.

IV. CONCLUSION

This paper presented a monitoring system for removing IV needles by patients using RFID technology. For our proposed system the tag antenna and the reader antenna were designed by calculations. In addition, the transmission characteristics between the proposed tag antenna and reader antenna in a real situation were shown. Moreover, the communication area between the RFID tag and reader were measured. From these results, this paper shows that our proposed system can detect removing IV needles by whether the proposed tag can communicate with the proposed reader or not.

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