Automatic Identification and Tracking in Blood Supply Distribution Using RFID System

Jin-Suk kang, Young-Jun Jeon, Mee Young Sung, Seung-Ho Shin and Taikeong T. Jeong, *Member, KIMICS*

Abstract—The distribution of donated blood for medical purpose is an area that presents many challenges. In order to establish a comprehensive solution, the current patterns of distribution must be reviewed and problems related to it need to be clearly understood. This paper introduces 'Radio Frequency Identification (RFID) System', as a potential solution to some of the problems which arise in the process of blood supply distribution, and a way to systematically manage the blood supply. For the various possible RFID systems, the reader and tag must be suitable for the purpose of blood distribution. A database has been designed that can recognize tags and objects in a ubiquitous RFID blood distribution system. In this paper, we design the real-time software to control the RFID reader system and transponder, using the EEPROM memory by RFID. The experimental results confirm that the transmission rate of 3.9kbps for RF is 125 KHz. The electric power usage of transponder chip is 100 μW, with the recognition distance is about 7cm range.

Index Terms—RFID, Ubiquitous, RFID-Reader, Transponder, Blood Distribution.

I. INTRODUCTION

IN general, the word 'Ubiquitous' is synonymous with omnipresent. The omnipresent network does not just mean the inclusion of the desktop PC in the network, but also the inclusion of all other embedded-enabled computers such as cellular phones, TVs, game machines, car navigators, and sensors [3, 10]. All these foresee the use of radio frequency identification (RFID) as the application range for ubiquitous communication. RFID is a system that provides the RF readers, which are used for interpretation as well as deciphering and RF tag (RF transponder) that provides the flow of information [1, 4, 6]. The ubiquitous real-time RFID system, which facilitates information exchange (IE) through remote sensing by using telecommunication, can serve various aspects of human life and industrial activity [2, 7]. In addition, as information networks and electro-communication technology rapidly advance, it is possible to automatically recognize a certain object or person. In particular, it is expected that RFID card system may be spread over various facets such as entrance-exit control, charge collection, electronic settlement, health card, etc [5, 9, 10].

This paper alludes to the development of a passive tag system (passive RFID). A passive tag system is one that grafts the capacitive method based on electromagnetic field onto the antenna part of RFID tag system. This is a departure from the inductive method. Moreover, in a case where the system is applied to the automatic tracking and distribution of blood, people's health and welfare may be advanced. The RFID Reader and Tag, which can be used with RFID system, were developed through comparing RFID technology with the bar code, which had been the prevalent technology. Some experimental results will show their functionality and the time related flow of distribution of blood.

II. UBIQUITOUS REAL-TIME RFID BLOOD DISTRIBUTION SYSTEM

These are tags that store identifiable data (ID), a reader that reads the tags, and an application using a host computer (server, middleware), and applications programs (ERP, SCM, etc.). The contents of each part specify the international standards authorized by international standard organization, ISO/IEC [7, 8]. It is impossible to precisely estimate exactly how much donated blood is available or inventoried. Problems in this area are in fact on the increase. Blood donations are tested to make sure they are safe for use, and all the blood donations that qualify are kept refrigerated at a temperature specific for blood storage [2]. Recently, many problems have been detected in the process of blood distribution, and there have been blood-related accidents and mismanagement. The problem is in getting the blood to patients who need a transfusion. There have been improvements with hemanalysis on blood donors, which has solved most of these problems; even so, a blood management system must be established, more systemically and more specifically. This paper generally represents the flow of ubiquitous-based RFID blood-distributing services [2, 6].

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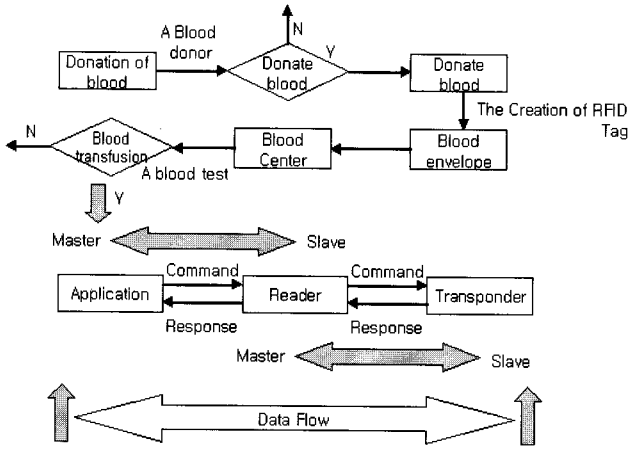
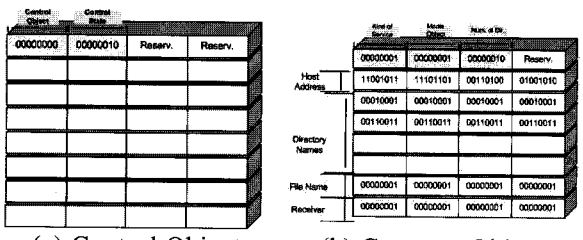


Fig. 1 A Flow Diagram of Automatic Blood Identification System

The real-time RFID system provides the flow of information to identify objects such as humans, automobiles, freight, and animals. By interpreting additional information using a communication medium without physical contact of the objects it can automate the various kinds of applications such as barcode that used to depend manually on humans. The range of the usage for the application system is expanding [2, 3, 9].

A. RFID Tag Design

Fig. 2 shows the pattern for embedded RFID tags with information on control objects and contents objects, or control information, in real objects [1, 3]. Control objects include the RFID tags directly related to the control information for contents of real objects (Fig. 2(a)). These RFID tags contain control information for operation functions such as stop, pause, play, fast forward, rewind, etc. and volume controls. The content objects include blood information (name of donator, donation place, time and date), blood type, some requirement for distribution, and normality of the blood (Fig. 2(b)). They embed the RFID tags containing the file name and directory name for type of service, directory label, host IP, contents URL and recipient information.



(a) Control Objects (b) Contents Objects

Fig. 2 Objects with embedded RFID Tags

B. RFID Reader System

The real-time RFID system is basically divided into reader and transponder sections. Readers supply magnetic fields to the transponder and transmit the data by means of an antenna coil. The transponder is composed of an LC tank section and an on-chip transponder IC, and creates the power to operate the IC circuit of the transponder from the magnetic fields, then transmits the data to the reader [3, 4, 11].

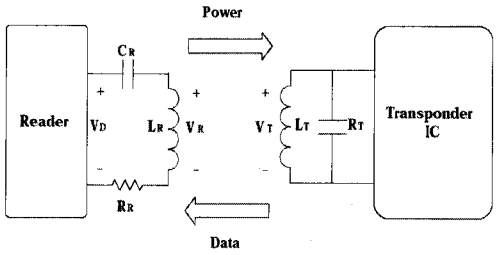


Fig. 3 Circuit Diagram of a Real-time RFID System

The reader used for this study is an RFID reader that can recognize a tag using the 13.56 *Mhz* band (ISO-18000 part 3). It has a frequency of 13.56 *Mhz*, and is designed to be capable of reading ISO 14443, UID of Mifare type, and ISO 15693. It can be activated by using the application program [7, 10].

Likewise, the RFID system (S6000 Reader/Antenna Set R1-K01-320A) of Texas Instrument was used as the RF module that functions as the ubi-sense of reader. A smart-type label, which is the most suitable for use on vinyl resin-type exsanguination bags, was adopted as the tag. In addition, capacitive method-based passive-type tags cost less than existing barcode. Besides, since EEPROM was used, it can be semi-permanent, and reading and writing is also speedy.

1) Power Supply

The reader part is composed of a RLC serial resonance type circuit so it can supply adequate energy with only low voltage. The resonance frequency is f_0 and f_B of the circuit are as follows.

$$f_0 = \frac{1}{2\pi\sqrt{L_R C_r}}, \quad f_B = \frac{f_0}{Q_R} \tag{1}$$

where, Q_R is the Q factor of the reader coil.

$$Q_R = \frac{2\pi f_0 L_R}{R_R} \tag{2}$$

Hence the frequency of the signal V_D for the reader coil must be the same as resonance frequency f_0. At the time of resonance the voltage on each end is $V_R = Q_R V_D$. If Q_R becomes too small, the voltage of reader coil V_R also diminishes so the energy transferred to the transponder also reduces, hence, the recognition distance narrows. On the other hand, if the value of Q_R is too high, the frequency range deceases and becomes more sensitive to changes of the frequency. Hence, these must be considered when choosing Q_R. The greatest factor on the magnitude of the power V_T _is the coupling coefficient k, which can be denoted as follows.

$$V_T = k\, Q_T \sqrt{\frac{L_T}{L_R}} V_R \quad (3)$$

Q_T, here, is the Q-factor of the coil. The transponder generates V_{DD}, the power used for the circuit, from the signal that is directed to the coil. Therefore, as the distance between the transponders increases the value of k decreases, and when the V_T becomes smaller than the minimum of V_{DD} to operate the transponder, the transponder stops working.

2) Data Transmission

The most common method for data transmission using the transponder is the front-end impedance modulation model. This modulates impedance on each end of the coil depending on the data that it wants to transmit using the damping circuit. Therefore the voltage on each end of the coil will change, and this leads to the impedance change on the reader antenna.

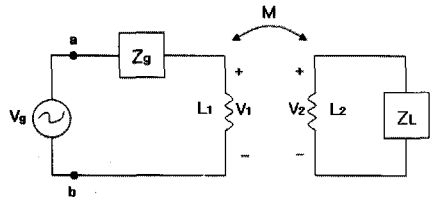


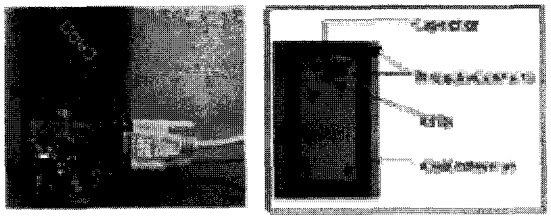
Fig. 4 Basic Inductive Coupled Circuit

The change in voltage will be detected in the reader section. To analyze the transmission procedure between reader coil and transponder coil, we examined the operating characteristics of the basic inductive coupled circuit in Fig. 4 and did the modeling according to mathematical formulas.

3) Design of RFID Reader

The wireless signals of reader and tag, as a various modulation method that changes amplitudes, frequency, or phase, are transmitted after they transform base signals to high frequency signals using Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK).

Fig. 6 shows the design of the RFID reader board. And Pictures of the reader board and antenna coil are shown in Fig. 5 (a) while Fig. 5 (b) shows the manufactured transponder IC and the transponder made of antenna coil. The portability of the transponder should be considered, so that the IC card could be used like credit cards.



(a) Reader board (b) Transponder

Fig. 5 Graphical Picture of Blood Distribution RFID System

III. AUTOMATIC IDENTIFICATION AND DISCUSSION

In general, the RFID is an automatic identification method, that relies on storing and remotely retrieving data using devices called RFID tags or transponders. A RFID tag is a small object that can be attached to or incorporated into a product, animal, or person. RFID tags contain silicon chips and antennas to enable them to receive and respond to radio-frequency queries from an

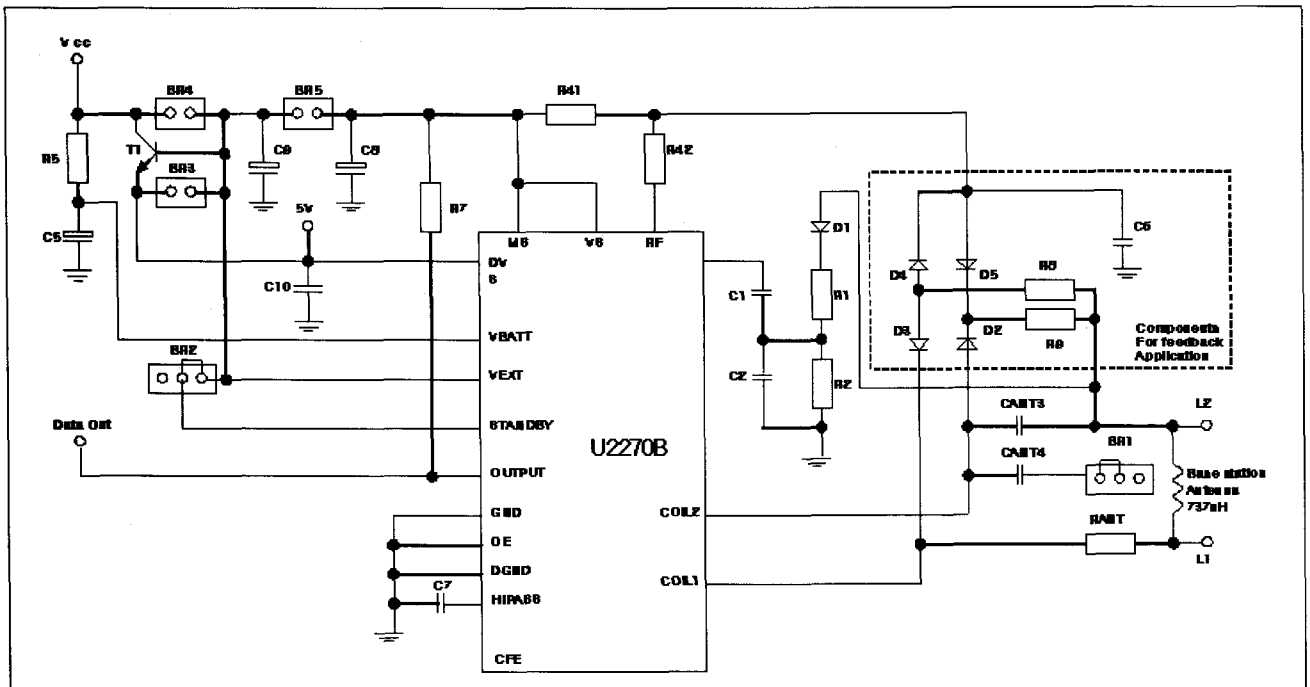


Fig. 6 Circuit diagram of the RFID reader board

RFID transceiver.

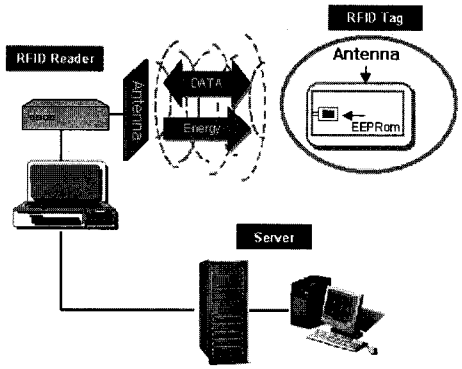
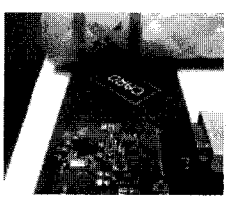
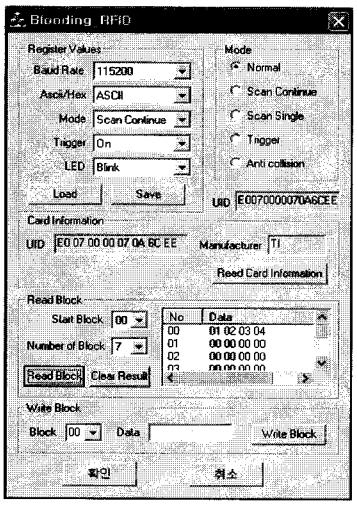


Fig. 7 Automatic Identification of Passive RFID System

Fig. 7 shows the design of the service for a capacitive method-based passive RFID system. Since the problem of range is very important in RFID, the system operates within a limited range and has many problems that need correction. Nevertheless, the system can be improved with ongoing supplementation and tuning process. The principle of this paper is that this research covers all embedded systems such as PDAs, micro chip network, etc. and that the blood distribution service will be served by the network in all areas, to create a smooth system flow for both wired and wireless systems. In doing this, the tag needs to have the power to communicate with the reader through a power supply. Since it is not feasible to use a battery as the power source, the Carrier signals from the reader serve as the power source for the tag.

In designing the micro controller, we used PIC16F84. This stores data like the ID of the tag in EEPROM from the inside of PIC micro controller and sends it out through I/O port after reading and coding the data with PIC program. In this paper, the signal has an amplitude of 13.56 *MHz* and is designed to be sent back to the return antenna through the tag antenna, causing a change in impedance in the resonance area.





(a) (b)

Fig. 8 The Prototype of Passive RFID(a) and Real-time Data Transmission of RFID Design Results(b).

The outcome of RFID, as seen in Fig. 8, works with 13.56 *MHz* frequency bandwidth which can be operated without any special processes. The transmitting rate is 26*Kbps* and a data transmission range up to 140*mm* between reader and tag is possible. It also enables the reading and writing of data and can be transferred and used in the PCs, laptops, PDAs, etc. The transferred data is designed to be searchable anywhere and anytime, and it is accessible widely in a ubiquitous environment simply by being kept in the database. Reader service communicates using the serial port (COM1). The application set up was built using VC++6.0 MFC in Windows XP Professional platform.

IV. CONCLUSION REMARKS

In this paper, the RFID software tool was designed to control the RFID reader system and ASIC design in the results section, as well as the transponder design with reading and writing features using the EEPROM memory by RFID.

A performance test on RFID system showed a transmission rate of 3.9*kbps* for RF (Radio Frequency) of 125 *KHz*. The electric power usage of transponder chip is 100 μW when read and the recognition distance is about 7*cm* range. With the RFID technology introduced in this paper, the blood distribution network can be improved substantially, and made much mire efficient. This technology will increase the safety in medical services and reduce accidents. Also, it is important to set up the RFID application system as quickly as possible, and to check the effectiveness of the system. Reinforcement and improvement after performing the test runs are needed. Supplying blood to the right places through the unified networks of blood distribution management, and systemization with computers have merit in that it not only directly helps the people in need of blood, but reduces dramatically the cost by exchanging distribution records speedily and accurately, while eliminating unnecessary bookkeeping.

In addition to development of tags and readers, further research is needed for improvements on recognition distance, speed of recognition, and accuracy in obtaining the source RFID technology on hardware and software that will fit the blood distribution network.

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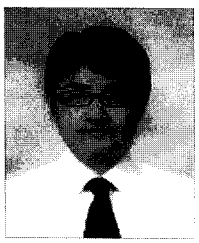

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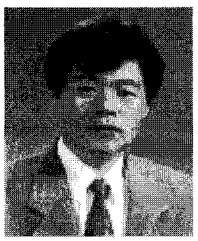

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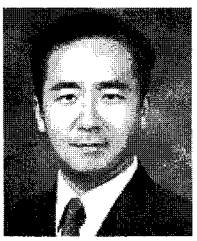

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