International Research Journal of Advanced Engineering and Science
ISSN: 2455-9024

Application of ZigBee Enabled RFID Technology in Advanced Health Care System

R. Sruthy[1], R. Karthik[2]
[1, 2]EC Department, Anna University, Thondamuthur, Tamil Nadu, India-641109
Email address: [1]sruthyr1987@gmail.com

***Abstract*—** *The paper addresses the application of ZigBee and Radio Frequency Identification (RFID) technologies in a healthcare environment. ZigBee is a wireless networking standard aimed at remote control and sensor applications. ZigBee is targeted at applications that require a low data rate, long battery life and secure networking. ZigBee has a defined rate of 250 Kbit/s, best suited for periodic or intermittent data or a single signal transmission from a sensor. There are a huge variety of different operating principles for RFID systems. The most important principle is inductive coupling. RFID used in this paper has a frequency of 2.45 GHz and cover distances up to 6 meters. RFID uses radio frequency waves to transfer data between a reader and a movable item to identify, categorize and track the tags. Xilinx ISE 8.1, Tanner 13 and Visual Basic 6.0 are the soft wares used in the paper. For realizing the system, a hardware model has been developed. A GSM module has been used in the proposed system to enhance the health care system.*

***Keywords*—** *GSM, healthcare, RFID, ZigBee.*

I. INTRODUCTION

Health is a primary human right and has been accorded due importance by the Constitution through Article 21. The World Health Organization’s detailed description and definition of a health system identifies four main functions of health systems: stewardship, financing, resource development and distribution and service delivery. The paper aims in implementing an enhanced health care system .The technology used here is Zig-Bee enabled RFID.

ZigBee is a wireless communication standard aimed at remote control and sensor applications. ZigBee is a communication standard which is suitable for operations in harsh radio environment. It uses IEEE standard 802.15.4.The main merits of using ZigBee standard are its low power consumption. ZigBee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows ZigBee networks to be formed ad-hoc.

RFID embedded application have explored a special window for Health care system. RFID uses radiofrequency waves to transfer data between a reader and movable item.

II. RELATED WORKS

P. Medagliani, G. Ferrari, M. Marastoni reviewed the importance of ZigBee as the standard of choice in wireless personal area networks with low power consumption like sensor and control wireless networks. Since nodes may be positioned in non-easily accessible places, high energy efficiency is required in order to maximize the network lifetime and minimize the maintenance costs. A simple and straightforward solution to maximize the network lifetime consists in turning off all nodes which are not needed. System model consists of a network where ‘N’ nodes are deployed to monitor a particular phenomenon of interest. Algorithm used in this concept is deep sleep algorithm. When an RFD is in the sleep state the associated RFID tag receives the signaling message from the reader and switches on its RFD, which enters into the active state and starts communicating. When an RFD is active and its residual energy becomes lower than a threshold value, the RFD communicates it to the ZigBee coordinator

P. Busnel, P. E. Khoury, A. Saidane, and N. Zannone studied about the security and dependability issues in health care system. They developed a prototype for remote health care system. The objective of this typology of systems is to monitor the patient health status and provide the necessary assistance. To this end, healthcare systems should support the interaction and collaboration between doctors, pharmacists, patients, social workers and emergency medical teams especially during emergency situations. Patient health condition can be monitored through various ways.

S. Y. Lee, L. H. Wang, and Q. Fang presented low-power radio-frequency identification (RFID) technology for intelligent healthcare systems. With attention to power-efficient communication in the body sensor network, RF power transfer was estimated and the required low power ICs, which are important in the development of a healthcare system with miniaturization and system integration, are discussed based on the RFID platform. To analyze the power transformation, they adopted a 915-MHz industrial, scientific, and medical RF with a radiation power of 70 MW to estimate the power loss under the 1-m communication distance between an RFID reader (bio information node) and a transponder (bio-signal acquisition nodes). The key features are Body Sensor Network, Local Sensor Network and Intelligent Healthcare Service.
Authors estimated the power budget and feasibility in the implementation, budget from BIN to BANS and the power consumption of ICs in a BAN.

Joyashree Bag, Rajanna K M, and Subir Kumar Sarkar presented a paper titled 'Design and FPGA Implementation of Zig-Bee Enabled Processor for RFID Reader Suitable for Power Efficient Home/Office Automation'. The goal of this paper is to develop home automation system using RFID, Wireless Sensor Network (ZigBee) technology and GSM. RFID technology is used for automatic door opening &

R. Sruthy and R. Karthik “Application of ZigBee enabled RFID technology in advanced health care system”, *International Research Journal of Advanced Engineering and Science*, Volume 1, Issue 2, pp. 126-130, 2016.

closing. Authors proposed use of wireless sensor network for temperature, lighting, smoke detection and automatic door opening & closing. The technology used in the paper is RFID, WSN & GSM. RFID uses radiofrequency waves to transfer data between a reader and movable item. Other components used in automation of home safety are Smoke Detectors, Temperature sensors and Optocouplers. Further security measures can be taken by sending information to the emergency call center using GSM technology.

R. Steele, C. Secombe, and Y. K. Wong, carried out an exploratory study carrying out qualitative research into the perceptions, attitudes and concerns of elderly persons towards wireless sensor network (WSN) technologies in terms of their application to healthcare networks to assist healthcare. This work aimed to provide guidance on the dimensions and items that may be included in the development of a more in-depth questionnaire to further validate the importance of the identified factors as well as the relationships between them. This study aimed to contribute to opening up a communication channel between users and researchers, informing the research community in relation to applications and functionalities that users deem as either desirable, inadequate or in need of further development. Authors findings indicate that participants' attitudes towards the idea of wireless sensor networks for health monitoring are generally positive. The exploratory findings along with the literature suggest a number of relationships which can be used in future survey design and model building.

Shih-Sung Lin & Min Hsiung Hung developed An Ease-Of-Use Remote Healthcare System Architecture Using RFID and Networking Technologies. Specifically, the codes in RFID tags are used for authenticating the patient’s ID to secure and ease the login process. The patient needs only to take one action, i.e. placing a RFID tag onto the reader, to automatically login and start the remote healthcare system. The proposed RHS architecture possesses the characteristics of ease to use, simplicity to operate, promptness in login, and no need to preserve identity information. The research results can be used as an add-on for developing future remote healthcare systems. A prototype RHS is constructed to validate the effectiveness of designs

III. PROPOSED WORK

Circuit diagram of proposed system’s transmitter is shown in figure 1. The temperature sensor LM 35, whose output is linearly proportional to Celsius temperature, feeds the instantaneous temperature to the inbuilt ADC of PIC Micro controller. The gas sensor is designed to sense the gas leakage. In the gas sensor the supply voltage is given to input terminal. The gas sensor output terminals are connected to non-inverting input terminal of the comparator. Here the comparator is constructed with operational amplifier LM 358. The reference voltage is given to inverting input terminal. The reference voltage depends on the desired gas intensity. When there is no leakage the non-inverting input is greater than inverting input so the output of the comparator is positive voltage which is given to the base of the switching transistor BC 547. Hence the transistor is conducting.

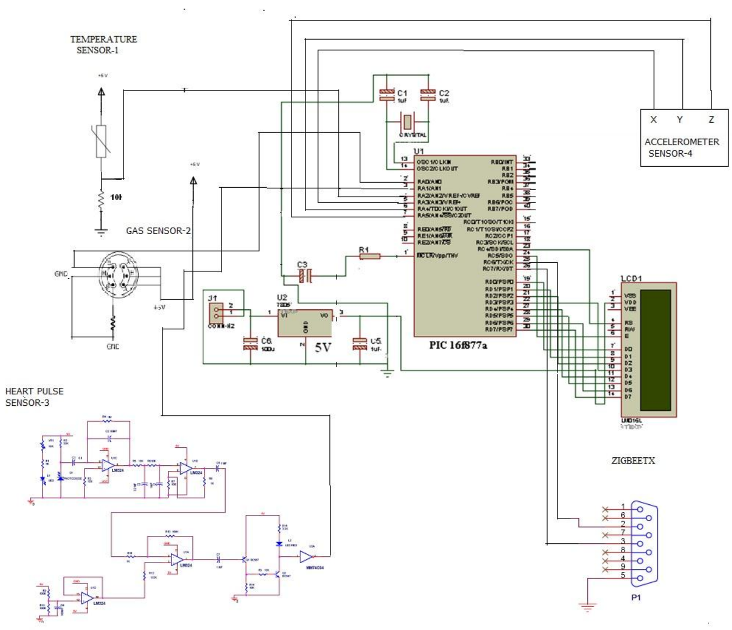

Fig. 1. Circuit of transmitter

The transistor act as switch so the collector and emitter will be closed. The output is taken from collector terminal. Now the output is zero which is given to HEX inverter 40106.When there is gas leakage the inverting input voltage is greater than non-inverting input. Now the comparator output is -12V so the transistor is in cut-off region. The 5V is given to HEX inverter 40106 IC. Then the final output data is directly given to microcontroller to determine the gas leakage. Pulse meter circuit is designed to measure the heart rate. The heart rate is measured by IR transmitter and receiver. Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. Both IR transmitter and receiver should be placed straight line to each other. The IR transmitter and receiver are placed in the pulse rate sensor. The pulse rate sensor has to be clipped in the finger. The IR receiver is connected to the Vcc through the resistor which acts as potential divider. The potential divider output is connected to amplifier section.

When supply is ON the IR transmitter passes the rays to the receiver. Depending on the blood flow, the IR rays are interrupted. Due to that IR receiver conduction is interrupted so variable pulse signals are generated in the potential divider point which is given to A1 amplifier through the capacitor C1. The coupling capacitor C1 is used to block the DC component because the capacitor reactance depends on the frequency. For DC component the frequency is zero so the reactance is infinity .So capacitor acts as open circuit for DC component. The amplifier section is constructed by the LM 324 quad operational amplifier. It consists of four independent, high gains and internally frequency compensated operational amplifiers named as A1, A2, A3 and A4 amplifiers. The varying pulse from the potential divider is amplified by the A1 amplifier. In this amplifier the capacitor C2 is connected in parallel with feedback resistor to filter the DC component in the amplified signal. If any spikes in the amplified signals, they are further filtered by the C3 and C4 capacitors. After filtration the signal is again amplified by the A2 amplifier. Then amplified signal is given to inverting input terminal of comparator. The comparator is constructed by the A4 amplifier in which the reference voltage is given to non-inverting input terminal. The reference voltage is generated by the A3 amplifier. Then the comparator compares the two signal and delivered the +12v to -12v square wave pulse at its output. The square wave signal is given to base of the BC 557 and BC547 switching transistors in order to convert the TTL voltage 0 to 5v level. Finally the TTL output is given to MM 74C04 inverter to invert the square pulse. Then the final square wave signal is given to microcontroller or other interfacing circuit in order to monitor the heart rate.

Accelerometers measure acceleration. That is acceleration due to movement and also acceleration due to gravity. Accelerometers are often used to calculate a tilt angle. Thus the patients movement can be sensed by accelerometer. The microprocessor will process the values.

ZigBee protocol is utilized in the paper. The AC voltage, typically 220V RMS, is connected to a transformer, which steps ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. The resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies. This voltage regulation is usually obtained using one of the popular voltage regulator IC units. Thus the PIC Microcontroller will obtain 5V dc as Vdd.

Circuit diagram of proposed system's receiver is shown in figure 2.

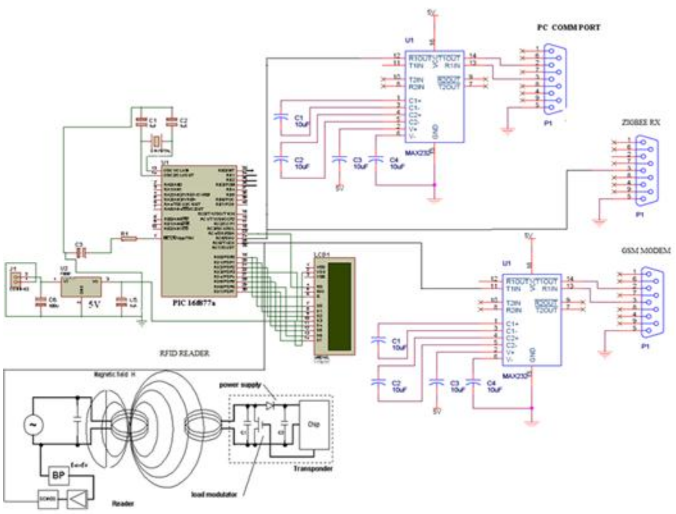

Fig. 2. Circuit of receiver

The patients, medical staffs etc. uses RFID TAG. An inductively coupled transponder comprises of an electronic data-carrying device, usually a single microchip and a large area coil that functions as an antenna. Inductively coupled transponders are almost always operated passively. For this purpose, the reader's antenna coil generates a strong, high frequency electro-magnetic field, which penetrates the cross-section of the coil area and the area around the coil. Because the wavelength of the frequency range used is several times greater than the distance between the reader's antenna and the transponder, the electro-magnetic field may be treated as a simple magnetic alternating field with regard to the distance between transponder and antenna. A small part of the emitted field penetrates the antenna coil of the transponder, which is some distance away from the coil of the reader. By induction, a voltage Vi is generated in the transponder's antenna coil. This voltage is rectified and serves as the power supply for the data-carrying device (microchip). A capacitor C1 is connected in parallel with the reader's antenna coil, the capacitance of which is selected such that it combines with the coil inductance of the antenna coil to form a parallel resonant circuit, with a resonant frequency that corresponds with the transmission frequency of the reader. Very high currents are generated in the antenna coil of the reader by resonance step-up in the parallel resonant circuit, which can be used to generate the required field strengths for the operation of the remote transponder. The antenna coil of the transponder and the capacitor C1 to form a resonant circuit tuned to the transmission frequency of the reader. The voltage V at the transponder coil reaches a maximum due to resonance step-up in the parallel resonant circuit.

If a resonant transponder (i.e. the self-resonant frequency of the transponder corresponds with the transmission frequency of the reader) is placed within the magnetic alternating field of the reader's antenna, then this draws energy from the magnetic field. This additional power consumption can be measured as voltage drop at the internal resistance in the reader antennae through the supply current to the reader's antenna. The switching on and off of a load resistance at the transponder's antenna therefore effects voltage changes at the reader's antenna and thus has the effect of an amplitude modulation of the antenna voltage by the remote transponder. If the switching on and off of the load resistor is controlled by data, then this data can be transferred from the transponder to the reader. This type of data transfer is called load modulation. In the transmitter part one power supply system is used. But in the receiver part, two step down transformers and associated devices are used. This happens due to the incorporation of GSM module in the receiver side which also needs power for its working.

In this circuit the MAX 232 IC used as level logic converter. The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA 232 voltage levels from a single 5v supply. Each receiver converts EIA-232 to 5v TTL/CMOS levels. Each driver converts TLL/CMOS input levels into EIA-232 levels. In this circuit the microcontroller transmitter pin is connected in the MAX232 T2IN pin which converts input 5v TTL/CMOS level to RS232 level. The temperature and gas level through zig bee network reaches the receiver side. The ADC will convert these analog values to digital logic. Here the PIC Microcontroller uses embedded C Programming. If the particular temperature or gas level is above threshold, microcontroller activates GSM module. Correspondingly an information will be sent to higher authorities. Another enhancement proposed in the proposed circuit uses RFID. For example, if a condition arises such that a patient condition is abnormal (pulse count, temperature etc.) and also he is unattended by any doctor, a message will be sent to the higher authorities. In this way a patient's life can be saved. LCD is used as a display device in the project. LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is used in the hardware section.

IV. SYSTEM IMPLEMENTATION AND RESULTS

The simulation software used is Tanner EDA and Xilinx ISE. Tanner Eda Includes S-Edit (Schematic Edit) W-edit (Waveform Edit) and T-SPICE. In the paper, Tanner software is used to simulate the presence of patient, doctor and nurse. The symbolic schematics are shown below. If a particular entity is present at the ward, a value zero (0) would be assigned to it. And if an entity is not available, correspondingly one (1) would be assigned.

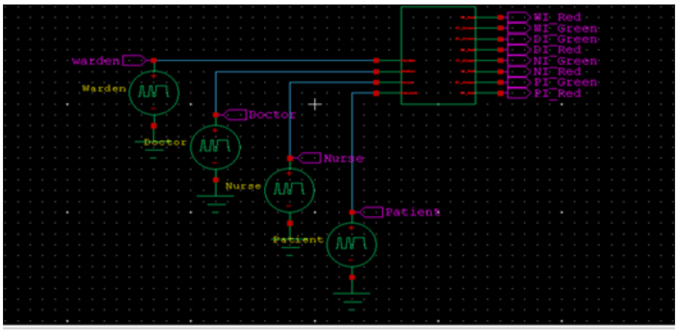

Fig. 3. Symbolic diagram

From the symbolic diagram transistor level diagram can be developed. CMOS transistors are designed using pick and place components. The simulation output is shown in the figure below.

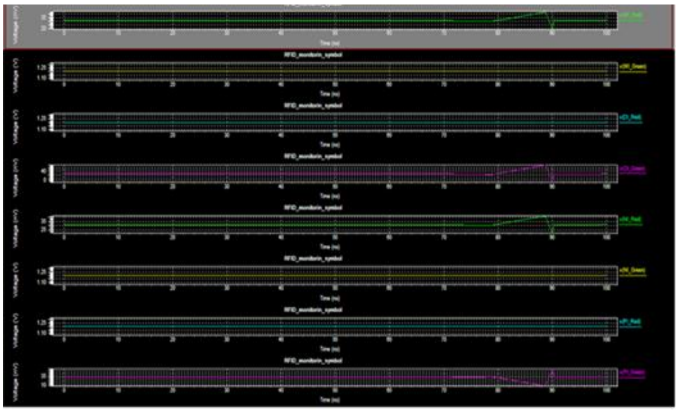
Fig. 4. Tanner output showing the presence of patient, doctor and nurse

The absence of a doctor, nurse or patient is given voltage of Nano volts. This value can be approximated to zero. The availability of a doctor, nurse or patient within the ward is expressed in volts. Using Xilinx software along with the availability of patients, doctors and nurse, their non-availability time is also obtained. The device specification is XC2S600E in the family Spartan 2E.The particular simulator used is ISE simulator.

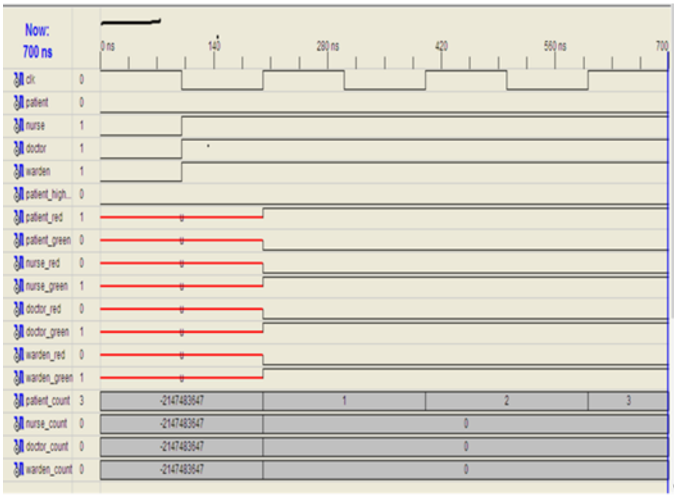

Fig. 5. Output showing the occurrence of doctor, patient, nurse and warden

The figure shows the status (availability or non-availability) of patient, doctor, nurse and warden. The output waveform also shows the occurrence time of each entity. Visual Basic 6.0 software has been used in the paper to obtain health status of the patient. Using Visual Basic software, a display which updates the current temperature, pulse, position of the patient and also the gas level of his premises is obtained. Clicking on details button shows the history of patient's health details for prescribed timings which is shown in figure 6.

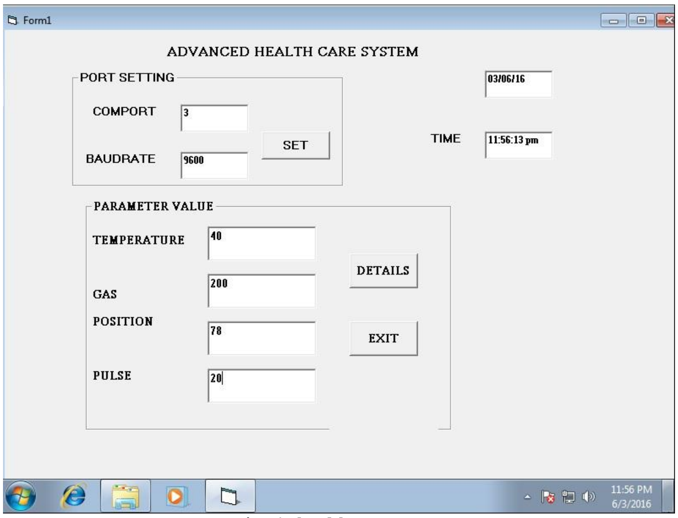

Fig. 6. Patient's health status using VB 6.0

V. CONCLUSION

The emerging trend that uses RFID technology and embedded RFID sensors in medical field has been driven by the need of well-organized and secured health service system for the health units in our world. A literature review has been done to study the issues related to health care industries. Various technologies associated with the enhancement of health care industries were also reviewed. From the various technologies, ZigBee enabled RFID is selected. From the studies it became clear that ZigBee uses less power. RFID can be used in health care industry due to its cost effective behavior and safe patient care environment. To express the system quantitatively simulations were performed. The tanner software has been used to indicate the presence or absence of patients, doctors and nurses. Xilinx simulator is used to display non-occurrence time of patients. Visual Basic 6.0 is used in the proposed system which gives the display of patient's health status. Visual Basic software enabled system shows the body temperature, pulse level of patient. It will also give information about gas level in the particular ward of hospital. An additional unit GSM module has been incorporated in the system for enhancing the system.

REFERENCES

[1] P. Busnel, P. E. Khoury, K. Li, A. Saidane, and N. Zannone, "S&D pattern deployment at organizational level: A prototype for remote healthcare system," *Electronic Notes in Theoretical Computer Science*, vol. 244, pp. 27–39, 2009.

[2] C. M. Chen, "Web-based remote human pulse monitoring system with intelligent data analysis for home health care," *Expert Systems with Applications*, vol. 38, pp. 2011–2019, 2011.

[3] D. Verma and M. Bhasin, "Real time optical heart rate monitor," *International Journal of Computer Science and Information Technologies*, vol. 5, issue 6, pp. 7265-7269, 2014

[4] D. Gu, Z. Zhang, and Y. Zeng, "Access to healthcare services makes a difference in healthy longevity among older Chinese adults," *Social Science & Medicine*, vol. 68, pp. 210–219, 2009.

[5] J. Arora, Gagandeep, N. P. singh, A. Singh, S. S. S. Rawat, and G. Singh, "Heartbeat rate monitoring system by pulse technique using HB sensor," *International Conference on Information Communication and Embedded Systems (ICICES)*, pp. 1-5, 2014.

[6] M. Fezari, M. Bousbia-Salah, and M. Bedda, "Microcontroller based heart rate monitor," *The International Arab Journal of Information Technology*, vol. 5, no. 4, pp/ 153-157, 2008.

[7] N. El-Bendary, Q. Tan, and C. Frederique, "Fall detection and prevention for the elderly: A review of trends and challenges," *International Journal on Smart Sensing and Intelligent Systems*, vol. 6, no. 3, 2013

[8] R. Igual and C. Medrano, "Challenges, issues and trends in fall detection systems," *BioMedical Engineering OnLine*, pp. 1-24, 2013.

[9] S.-Sung Lin, M.-Hsiung Hung, C.-Lung Tsai, and L.-Ping Chou, "Development of an ease-of-use remote healthcare system architecture using RFID and networking technologies," *Journal of Medical Systems*, vol. 36, pp. 3605–3619, 2012.

[10] R. Steele, A. Lo, C. Secombe, and Y. K. Wong, "Elderly persons perception and acceptance of using wireless sensor networks to assist healthcare," *International Journal of Medical Informatics*, vol. 78, pp. 788–801, 2009.

[11] S.-Jin Kim and N.-Su Kim, "An approach for providing healthcare services using RFID technology in the Korean market," *PICMET 2006 Conference 2006 Technology Management for the Global Future*, vol. 4, pp. 1917-1924, 2006.

[12] T. H. Tan, C. S. Chang, Y. F. Huang, Y. F. Chen, and C. Lee, "Development of a portable linux-based ECG measurement and monitoring system," *Journal of Medical Systems*, vol. 35, pp. 559–569, 2011.

[13] S. Tani, T. Marukami, A. Matsuda, A. Shindo, K. Takemoto, and H. Inada, "Development of a health,"

[14] W. O. de Morais, A. Sant'Anna, and N. Wickström, "A Wearable accelerometer based platform to encourage physical activity for the elderly," *Article in Gerontechnology*, vol. 7, pp. 129-181, 2008.

[15] S. Wu, P. Jiang, C. Yang, H. Li, and Y. Bai, "The development of a tele-monitoring system for physiological parameters based on the B/S model," *Computers in Biology and Medicine*, vol. 40, pp. 883–888, 2010.

[16] S. Youm, G. Lee, S. Park, and W. Zhu, "Development of remote healthcare system for measuring and promoting healthy lifestyle," *Expert Systems with Applications*, vol. 38, issue 3, pp. 2828–2834, 2011.

R. Sruthy and R. Karthik "Application of ZigBee enabled RFID technology in advanced health care system", *International Research Journal of Advanced Engineering and Science*, Volume 1, Issue 2, pp. 126-130, 2016.