

RFID based Smart Healthcare System: A Survey Analysis

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Abstract

The advanced enhancements in innovation and the openness of the Internet make it conceivable to connect distinctive devices that can communicate among them. Nowadays smart devices close most of the gaps in different domains including medicine too. Radio Frequency Identification (RFID) adds essence for the uninterrupted communication to these smart devices as well as the technology too. This paper analyses the systems which are being used in medical industry / domain using RFID technology. Ten selected healthcare systems were selected for this analysis and those were analyzed against eight system functionalities. This analysis was concluded with the finding and proposing a new framework as recommendation. In this analysis out of ten systems, only one system more or less reached the standard with considerable shortcomings. In order to fix this problem, a hybrid framework was proposed in combining the functionalities of the few selected systems as a single system. There would be significant improvement could be yielded with this hybrid combination of functionalities in RFID smart healthcare system than the existing systems in medical domain along with its stakeholders such as patients, doctors and other remote systems.

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I. Introduction

The modern improvements in technology and the accessibility of the Internet make it possible to connect different devices that can communicate with others and share information. In the current era's communication technology totally depending on smart devices such as phone, tablet and so forth. After Advancement of wireless communication, current generation hugely influence by Internet of Thing (IoT) everywhere and which connect sensors, vehicle, crops and industrial applications in easy manner. The most important device under IoT is RFID which standard for Radio Frequency Identification and

the technology very similar to barcode system with some advancements. The components of RFID are RFID tag, RFID reader and antenna [1][2]. By using IoT we are able to access anytime from any places with the help of wireless communications. The most applications of IoT are Remote access of Internet, Data sharing, connecting device in constant manner and so on.

Smart Healthcare is a process of monitoring a patient's activities with the concept of e-Health¹ and m-Health². This Healthcare totally depending

¹eHealth is the use of information and communication technologies (ICT) for health

²mHealth (mobile health) is a term for the use of mobile phones and other wireless technology in medical care

on the technologies which give patients to better treatments on time, quality of life with aid of some devices and better diagnostic tools[3]. Total idea behind this smart healthcare is IoT. In rural area most people do not have a proper health monitoring system for precautions of their health relevant problems. With the passage of time and development of society, people recognize that health is the basic condition of promoting economic development. There are many people around the world suffering from different diseases because of not right contact of hospital and patients checking system. So, it is necessary to build a healthcare monitoring system in appropriate manner to protect population from diseases and increase the economic development from that.

The IoT application in medical must provide the patients to provide treatments in cheap cost, it must process in timely manner and it must provide patients satisfaction. The aim of this investigation is identifying the very latest smart healthcare system with the concept of IoT with RFID and find the best system amid them and also find out how to improve the other current word smart healthcare system through analysis.

II. LITERATUREREVIEW

BEJJAM.BABU RAO and G. RAMANA REDDY developed a system called “Health Care Monitoring System in IOT by Using RFID”. This system has four (04) layers namely, Sensor, network, internet and service layer. In sensor layer most of necessary sensors such as temperature, EEG, ECG, blood pressure sensors and etc. are embedded into the human body. These sensors monitoring the changes of human body consistently and transfer the changes to next layer. The output of sensor gets the form of analog so ADC used for converting to digital. In network layer there is a microcontroller (ATmega32) [4] pretends as intermediate device which transfers

the digital sensor output to RFID. The RFID transfers this signal to Internet. This RFID transfers the signal to Static Node Receiver which passes the signal to base station and then internet. Finally, all services such as Doctor, Emergency Team, Ambulance, and Governance agencies are connected in internet layers. All those services get that signal from patient’s and distributes the actions and services according to the signal or problems of patients [5].

Kaleem Ullah et al, proposed a system called “K-HEALTHCARE”. In this system also there are four (04) layers being used as same as previous system. But in this system, in-built phone sensor is used for getting human changes in sensor layer. User of the system needs to use some applications in the phone and it will estimate the changes in human body. This application consists of several in-built sensors, such as blood oxygen, pulse, RFID and so on. Here RFID sensor is used for object identification purpose. The sensor of the phone application identifies the signal from human body and passes the signal with the help of Wi-Fi or 3G. Then the signal goes to internet layer via router. The service layer is already connected to internet via smart devices. Thus the patients can get healthcare services [6].

Long Hu et al proposed a system called “Enabling RFID technology for healthcare”. The architecture of this system has four (04) components, namely tagged objects; RFID information capture and delivery system; the patient-aware contexts querying system; and the medical information central system. The tagged objects have further four objects, namely patients, medical equipment, nurse or physician and medicine. Each of four objects embedded with RFID reader. The purpose of tagged objects is to identify the patients’ relevant information. There are several RFID readers placed for each tagged object and when they use the RFID tags, then the reader reads and sends the signal to RFID information capture and delivery system, which passes that signal to the

medical information central system (MICS) via access point. Patients, drugs and other medical relevant information are carried out by MICS. This has been done by inference engine. All information stored in MICS are managed by this engine and it sends notifications to patients, doctors, drugs, and other specific persons in timely manner with the help of engine physical repository. Patient-aware contexts querying system works with distance. In this system all sensors are placed in patient's body and changes of the sensor pass to the MICS through wireless sensor network rapidly and patients get treatments on time [7].

Toni Adame et al found a hybrid monitoring system called "CUIDATS: An RFID-WSN hybrid monitoring system for smart healthcare environments". Patient of the system needs to wear the wristband. Temperature, pulse and position sensors embedded into that and a RFID tag maintains those sensors. The sensors read the signal of patient and it passes to the RFID gateway which is the combination of RFID reader and WSN (Wireless Sensor Network) beacon. RFID gateway transfers the gathered signal to another gateway until it goes to internet. The data is stored in the Data Application Server (DAS) with the help of middleware. Patients could be monitored from DAS by an authorized individual. Normally WSN give high distance of coverage area thus it minimizes the gap of monitoring of patients from anywhere round the globe which is one of the positive advantages of this system [8].

Debiao He and SheraliZeadally developed a system called "RFID Authentication Schemes for Internet of Things in Healthcare". This system has three (03) parts, namely Tagged objects, RFID-Enable health care system and server part. In each tagged object (patients, drug container, Assets and medical supplies) RFID tags are embedded. The RFID reader can be placed in short distance which has accessible by tag and it connected with a terminal. Whenever changes happen in patients or

other tag objects then reader reads and sends the signal to terminal and it passes that to a data sever and eventually it moves to the Hospital legacy system. RFID-Enable Healthcare System (RFID-EHS) consist of assets tracking system, patient identification system, Drugs administrating system and Access control system. The RFID-EHS connects the server and Hospital Legacy System via internet and gives support to the patients in case of emergency. The communication channel that have been used in the RFID reader and RFID tag are not secured since adoption of wireless transection and it could be intercepted easily but the communication of RFID reader is secure. In order to increase the security "elliptic curve cryptography (ECC)-based RFID authentication schemes" is used and extends better solution to the patients [9].

Hornng-Lin Shieh et al, developed a system called "Emergency care system using RFID and Zigbee". The purpose of this system is assigning nurse to a patient in case of emergency in accurate and timely manner. In this system the RFID tag is equipped with ZigBee and cell for wireless communication with the ZigBee positioning reader. This positioning reader is placed in a small range from the patients. When it is read the signal from Tag, it passes the signal to monitor host via RS232 wireless interface. In monitoring host, there is a GUI application which has been created and the patients' all information monitoring there from when patients used the tag. In case a patient is in emergency he or she can press an emergency button which is placed in RFID tag, produces alert signal in monitoring host thereby a nurse can be allocated that specific patient [10].

Neeraj Kumar et al implemented a system called "An intelligent RFID-enabled authentication scheme for healthcare applications in vehicular mobile cloud". This system specially developed for provide smart healthcare services while travelling. The patient who is in travelling uses a RFID wrist band which identifies the temperature,

pressure, pulse, etc. from wireless body network. The vehicle equipped with RFID reader and the wrist signal send by the reader using Wi-Fi or Bluetooth. In case of Accident, Damage, Unavailability, changes in patients body the reader passes the signal to Road Side Units (RSUs) using ultra high frequency (UHF) Radio wave interface (It take range of road up to 12 meters). Then RSU passes the particular signal to cloud using gateways. The services from clouds check the past history of patients, alert message in emergency situation, check the availability of doctors, suggesting medication, check the nearby hospital and so on. Here the cloud acts as central sever and it synchronized with every hospital which use the cloud thus patients' information will be passed to the nearby hospital where staff is available in real time and also it uploads all past information of patient to the particular doctor so he or she could take necessary measures for treatment when patient arrives to the hospital. Also in case of emergency it will send the alarm to nearest hospital hence the ambulance services reached place timely manner. An authentication scheme is added to this system in addition. In case of communication between RFID tag and reader is not secure (is happening in wireless) elliptical curve cryptography (ECC)-based key generation mechanism is being used to fill this security gap [11].

K. Natarajan et al developed a system called "Smart Health Care System Using Internet of Things". This system contains three layers such as smart medical service (SMS) layer, medical resource management (MRM) layer and sensor data collecting (SDC) layer. All medical facilities are maintaining in SMS layer such as hospitals, emergency centers, and medicine supply chain. From this layer doctor can check the all medical history of the patients, doctors can be allocated for number of patients, emergency services can be done through this layer as well as doctor can monitor the patients in real time. In this layer

there is a software application placed for doing all these actions. The MRM layer acts as intermediate layer which connects the SMS layer and SDC layer with the help of cloud facilities. In SDC layer all changes of human body like as temperature, pulse, pressure and other relevant factors are collected with help of android phone sensor or Raspberry pi. The sensed signal is transferred to the MRM layer with the help of RFID, Bluetooth, Zigbee and 3G/4G network. According to the sensed signal SMS layer will give the feedback to the patients [12].

Yeong-Lin Lai et al developed a system called "An intelligent IoT emergency vehicle warning system with the combination of RFID and Wi-Fi technologies for emergency medical services". The major purpose of this system is to prevent the ambulances from collision in case of emergency situation. This system has three parts. First part includes a system trigger tag on a utility pole about 300 m from an intersection. Second part is RFID system embedded in ambulances which RFID system consist of controller, UHF RFID reader, UHF ID Antenna, Antenna and Wi-Fi module. The controller communicates with the UHF RFID reader module through a universal asynchronous receiver/transmitter (UART) interface and with the Wi-Fi module through an Ethernet interface. Third part is RFID system is at intersection which RFID system consist of same components with additionally an LED module. Whenever an ambulance goes to the road an emergency situation with this structure The RFID reader reads the signal of trigger tag from pole it gives a signal when there is a vehicle straight at 300m. In case of RFID system intersection if there is any ambulance come to that way it read the RFID signal and give a LED Emergency vehicle warning thereby other vehicles stop in some moment for ambulance services. So that the services of ambulance reached the hospital without any collisions [13].

Chun-Hung Cheng and Yong-Hong Kuo developed a system for smart healthcare called “RFID Analytics for Hospital Ward Management”. The intention of this system is to improve the patient’s safety. In this system a RFID tag is attached with medical equipment. There is a RFID wristband is placed in patient and staff’s hand for identify the availability of staffs, emergency situation of patients. There is a RFID reader maintain in between the readable range of RFID tag. And also, there is a middleware can maintaining in this system for transferring the RFID tag signal to ward management system from RFID reader. All staff of the hospital system can be used ward management system information and follow the necessary action in required places. It manages to minimize the unnecessary time allocation and time wastage, changes of drugs by mistakes, and it improves the accuracy of allocating the staffs to the patients in a correct manner, provide better protocol in case of emergency and so on [14].

The followings are the summary of the all health care systems using RFIDs and those are compared with against important system functionality factors it the given Table 1.

- A. Health Care Monitoring System in IOT by Using RFID
- B. K-HEALTHCARE
- C. Enabling RFID technology for healthcare
- D. CUIDATS: An RFID-WSN hybrid monitoring system for smart healthcare environments
- E. RFID Authentication Schemes for Internet of Things in Healthcare
- F. Emergency care system using RFID and Zigbee
- G. An intelligent RFID-enabled authentication scheme for healthcare applications in vehicular mobile cloud
- H. Smart Health Care System Using Internet of Things
- I. An intelligent IoT emergency vehicle warning system using RFID and Wi-Fi technologies for emergency medical services
- J. RFID Analytics for Hospital Ward Management

Table 1 System functionality comparison

Systems	System Functionality							
	Monitoring Patients	Authentication Security	Emergency Response from system	Ubiquitous system	complex	Update of patients record in cloud	Best route finder	Vehicle Collision avoidance system
A	√	×	√	√	√	×	×	×
B	√	×	√	√	√	×	×	×
C	√	×	√	√	√	×	×	×
D	√ (H)	×	√	√	√	×	×	×
E	√	√	√	×	×	×	×	×
F	√	×	√	×	×	×	×	×
G	√ (H)	√	√ (H)	×	×	√	√	×
H	√	×	√	√	√	√	×	×

I	√	×	√	×	×	×	√	√
J	√	×	√	×	×	×	×	×

Note: “H” denotes “High”

III. DISCUSSION

These days a RFID equipped smart healthcare system is becoming very prominent and trustworthy in case of meeting requirements of the parameter of system functionality in Table 1. In other word in this study we try to summarize that, if a system become a best smart healthcare system, it must monitor the patient activities in real time, signal or data from tag (Body changes of patient) need to be secure while transferring to the reader with the help of authentication, it must provide emergency response whenever patients face difficulties, it must be available everywhere and cannot limit up to some certain space, the system must be simple architecture without any complex design, it must update the patients’ all medical relevant documents when a patient reaches a hospital without delay, this system must find the optimum path in case of emergency to bring the patients to the hospitals and eventually the system must be preventive from collisions for emergency ambulance services.

The systems were analyzed across the eight (08) factors where to conclude the better adoption of RFID. All ten systems are with the good adoption of patients monitoring and emergency response where system D and G are very high in monitoring patients meanwhile, system G is high reflection in monitoring patients and emergency responses. Except system E and G, rest of other systems are failing in authentication (security). Systems A, B, C, D and H confirm the availability ubiquitous functionality and less complicated system functionality whereas E, F, G, I and J do not have the ubiquitous functionality and very complicated system architecture. Except System G and H, all other systems do not have the flexibility to update the patient’s record to the cloud. System G and I find the rout very well whereas rest of the systems

don’t. Apart from the all the systems only system I has the “vehicle collision avoidance” functionality.

In this respect, according to the Table 1 there is no any single system meets all requirements to become a better smart healthcare system in this study range. But Neeraj Kumar et al (System – G) found an approximately appropriate system which meets the most requirements for smart healthcare system. Though considerably there are few parameters not filling the gap in this system, partially this system can be accepted as super system for health care industry. In order to overcome this, hybrid model would be proposed in combining few systems.

IV. CONCLUSION

This study concludes that, RFID plays major role in medical industries. There are varieties of RFID smart healthcare systems have been developed for overcoming contemporary issues faced in medical domain. All system of smart healthcare provides monitoring activities of patient perfect manner and provide high responses in emergency situation of patients. Authentication between RFID tag and RFID reader provides a very effective and efficient data transfer thus the reliability of the system will be very high and the patients can get accurate treatment for his/her problem (s).

V. RECOMMENDATIONS

In the discussion it can be identified that “An intelligent RFID-enabled authentication scheme for healthcare applications in vehicular mobile cloud” approximately meet more or less all requirement except the ubiquitous availability and vehicle collision avoidance. To improve the collision

avoidance, we are able to use the concept of “An intelligent IoT emergency vehicle warning system using RFID and Wi-Fi technologies for emergency medical services”. It enhances reduction of the vehicle collisions in emergency situation. In the case of ubiquitous availability, the idea of Body sensor network (BSN – patients no need of use any wristband and sensors embed into the body so the reliability of system high) and wireless sensor network (WSN) could be used, thus this system facility extends to everywhere rather than limiting inside the vehicle. The BSN and WSN replace only the inside infrastructure of vehicle and idea of RFID remains unchanged. RFID signal is passed through the cloud with number of wireless sensors. So, This Hybrid system Provide better RFID smart healthcare system than existing in medical industry along with its stakeholders (patient, doctors, or other systems) as well.

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