RFID-based Body Sensors for e-Health Systems and Communications

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Abstract— Body sensors for e-health applications are involved in patients' health monitoring and risk prediction systems. They can be used with RFID tags in some e-health applications which may be either internal or external. Body sensors are implantable and easy to fit around the particular organ in the human body. Long term diseases such as cancer, diabetic etc. need permanent body sensor. In this paper, RFID based body sensors are considered for e-health system and communications. This paper proposes a theoretical model of e-health system for people with diabetic and other long term diseases. In the theoretical model of risk prediction system, biosensor (glucose sensor) is considered as a body sensor. Quick care and resolution may be considered with latest technologies such as wireless networks, sensors and 2G-RFID system. Through this model, patients will be able to manage their life as normal because it is simple to use.

Keywords-Body sensors; e-health system; RFID; risk prediction.

I. INTRODUCTION

In e-health systems and communications, RFID-based body sensors can be used in many e-health applications not only for risk prediction. This device based on risk prediction system can be used easily with low-cost, and handy because this new system can be integrated within mobile phones. It means that the additional feature will be added to the mobile phone. Body sensors observe all behavior of the body conditions whenever we need. If any abnormal condition is diagnosed, body sensor reports to patient through the mobile phone. If patient's condition gets serious or risk factor is higher than normal conditions, message will be reported to risk monitoring staff who works close to area. Here, patient's location at the time may be different from his normal registered residence, but patient's current location can be identified using latest communication technology.

The body sensor, e-health system and communications, are mainly depending on the e-health applications, which show quick risk predictions. This system is not only for patients but also it fits to others who really want to monitor their body conditions and fitness daily. In addition to these benefits, it could be used anywhere and during the travelling or on the move. Some risks are age dependent, but this paper focuses on common risks predictions for all ages. In the human body, palms and feet have sensible area where prediction system can be used to monitor some risks through the e-health systems and communication.

The proposed theoretical model of e-health system can be applied to people with diabetic and other long term diseases. In this model, communication aspect of risk prediction system is designed with RFID-based body sensor. Through this model, patients' quick care and possible resolutions during the emergency situations can be delivered quickly and accurately. This model is targeted to patients with incurable long term disease such as diabetic and cancer because the risk factor of damaging other organs in the body is very high.

Wireless body sensor network (WBSN) is widely used in patient's monitoring, and risk prediction of e-health system [4]. When patients use WBSN nodes around the body randomly, constraint communication channel (CCC) is considered with transmission latency. In order to provide efficient e-health system, the improvement of CCC depended on resources and delays are necessary in terms of quality and quantity. Wearable sensors are introduced that RFID tags embedded with sensor are allocated to each position where risk is predictable.

Active RFID tags integrated with sensors use battery during the communication. Passive RFID tags integrated with sensor don't use battery because they receive necessary operating power from the RFID reader. In most of the e-health systems, passive RFID tags with sensors are used to implement the wireless environment around the patient. Further, advantages of passive RFID tags such as lower cost, smaller size, longer life time etc. are useful.

The remainder of this paper is organized as follows. Section II explains the RFID-based e-health systems and overall tasks of body sensors. Section III introduces the theoretical model for monitoring and risk prediction system with ADCA techniques. In Section IV, wireless networks for e-health systems are given with general discussions and recommendations. Overall conclusions will be in Section V.

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II. RFID BASED E-HEALTH SYSTEM

The complete e-health systems and communications are divided into few tasks they are body sensors functions, e-health system interfaced with RFID tags, RFID readers and microprocessor, e-health data and signals from e-health applications and relevant communication system which control the emergency and priority situations. To design and develop such communications system, the Adaptive Dynamic Channel Allocation (ADCA) technique for patients' monitoring and risk predicting data transmission is briefly mentioned.

A. Body sensors and functions

Body sensors have many types, which work according to the internal, abnormal and physical conditions of the body. Internal nerves system may affect the body; therefore, body sensor should be able to observe the nerve system. If particular organ is damaged and started to function strangely, it needs to be monitored with a special type of body sensor [13]. Some time same body sensor may be used, but it must be located to near that particular organ. Physical conditions such as weight, height, temperature etc. are observed by basic body sensors. They are easy to use, but functions are changed according to the e-health applications. If it is normal fever, it will monitor the temperature and display the results through the e-health system [2]. If it is high temperature monitored from the body sensor, the e-health systems and communications act quickly to solve the problem straightaway. Here, the priority of the communication is very important rather than the other actions.

B. RFID reader and e-health system

Communication between the RFID reader and dedicated microprocessor is interfaced by few data and control signals. Here, e-health system consists of RFID reader, which connects the external systems, RFID tags embedded with body sensor [15] and microprocessor, which handles relevant signal processing for efficient communication. In e-health system, internal and external communications including interfacing must be efficient and reliable, but their signal properties such as rate, bandwidth etc. are varied according to the requirements. Data and control signals are very useful to make a quick connection or link for emergency e-health applications. RFID tags receive all pulses from the body sensors and pass all information to RFID reader.

C. Data from e-health applications

Data varied with e-health applications [16] need to be analyzed for risk predictions. Analyzed data can be used as reference data or signal which could be even different to individual patient. Communications between the e-health system and e-health application must be accurate. Data can be corrupted between these because many devices may be involved around there without any protections. Same equipment may have more than two features, which may be interfered each other. It is called feature interaction, which is one of the serious issues addressed in e-health systems. However, data must be cleaned and secured throughout the analysis otherwise risk prediction will be wrong. Data and relevant signals used in RFID reader and microprocessor are obtained carefully from the body sensors through the RFID tags.

D. Communications for e-health applications

Reliable and secure communication should be allocated for e-health applications because risk prediction should be able to handle within the fraction of the second. Is it possible? Heart attack needs to be responded within fixed minutes otherwise all communication systems are useless. Responding time for individual prediction depends on the e-health applications. In the next section, channel selection and priority procedures are considered for a theoretical model. As soon as I complete the practical model for the future risk prediction system, I can provide all the limitations and conditions in the next paper.

III. MODEL OF RISK PREDICTION SYSTEM

The theoretical model of risk prediction system can be applied as a general platform to all e-health applications which are either implemented with existing systems or new. This theoretical model should be able to use for multi e-health applications simultaneously.

As shown in Figure 1, patient monitoring and risk prediction are combined with relevant communication schemes.

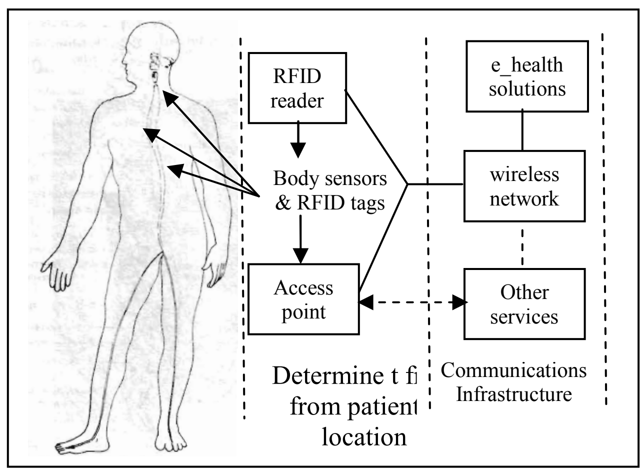

Figure 1. Patient monitoring and e-health system

In addition to this, communication is divided according to the priority. For instance, if patient needs immediate action within fixed time, RFID tag displays necessary procedures as a First Aid steps. Anyone around may provide First Aid before the e-health solution is executed. Through the other services, doctor, ambulance, and solution providers of e-health deliver the practical solution as soon as possible. Doctors don't need to read all the history after he reaches the patient's home. While he is travelling on the way, he must be informed what to do to save the life. Multiple solutions are considered simultaneously within limited time. In order to do such actions, constraint communication should be established.

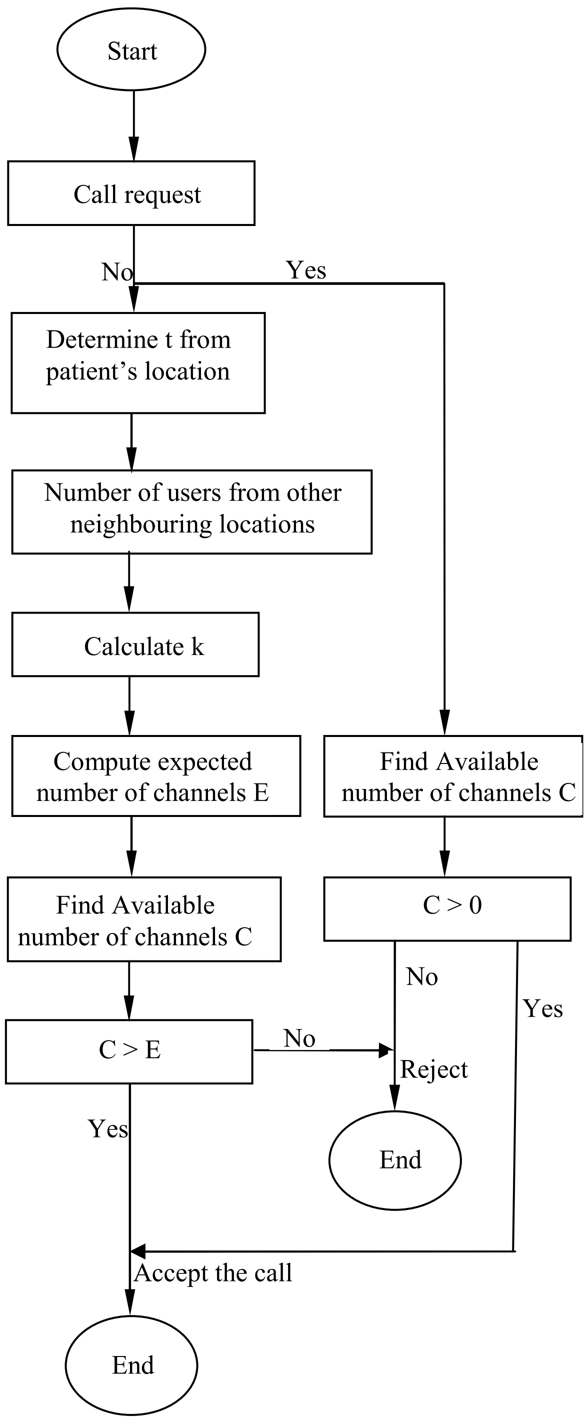

Figure 2. ADCA technique for patient monitoring

A. Sensors for risk prediction system

Sensors are widely used in e-health systems, which monitor and record all necessary information from allocated sensors. In this paper, glucose sensor monitors all the abnormal behavior of blood circulations in the vassal. If the concentration of glucose level is increased in the blood vassal, diabetic patient may take self decision for quick care [1]. If patients are unable to do certain precautions, automatic care will be considered according to the priority.

In this technique, patient's emergency or priority calls are considered for quick decisions. In order to allocate the channel, flow chart depicted in Figure 2, will provide necessary steps [3].

Time t can be calculated from patient's location information where patient requests the call. It is the time interval between the acceptance and departure of the new call.

$$k_i = \frac{v^i}{e^v i!} \tag{1}$$

Equation (1) represents Poisson distribution, which can be used for recording the arrival calls [7].

$$k = \frac{1}{e^{\mu t}} \tag{2}$$

From the equation (2), k is calculated as the probability of calls. Here, μ is the mean value of calls. When patient's call is active during the interval t the probability k, is calculated to compute the expected number of channels.

B. ADCA technique

The ADAC algorithm is used to borrow available bandwidth from neighbours' base stations when they are free to lend for emergency cases [5]. Wireless networks allow patients to use more than base station, but they are within the coverage area. If some base stations get busy than other base stations, channels should be transferred to other available base stations. During the channel allocation, delay is very important and it should be reduced. This situation should be identified and solved with where ADCA algorithm should have appropriate modifications. Hybrid multichannel multi-radio [6] is introduced to enhance the performance which is better than pure ADCA. Moreover, in order to decrease the blocking call probabilities bandwidth and to increase the system's overall performance, degradation and upgrade policies have been considered [14]. Through dynamic channel selection, devices can adaptively move to a clean channel as needed to avoid interference.

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C. *Palm-based risk prediction with sensors*

According to the [9], palms are considered as risk prediction area where we can use our new prediction system. Main sensible area of risks indicated by numbers is clearly shown on each part of the palms given in Figure 3. These areas are represented as risk monitoring points because most of the symptoms linked with particular organ can be identified through these points. Nerve between the particular point and organ is very important. If it is damaged, risk predictions through these points will fail straightaway. In that case, body sensor should be used directly from that particular organ. All points indicated by numbers are linked with each part of the human organ. For instance, assume a human organ is in trouble for some reason and nerve is not damaged. In this case, risk prediction is possible through that point, but efficient body sensor must be used. Generally, if any of an organ in the human body is started with minor problems, sensible areas or points indicated in the palm will be affected with some kind of pain. Sensors will identify the pain including pulses which behave abnormal during the risk time. Pain may be continued for several days or months in regular interval. Risk prediction cannot be confirmed without proper monitoring. It means that each e-health application has certain properties, characteristics and definitions. According to the e-health application, patient's monitoring pattern will change.

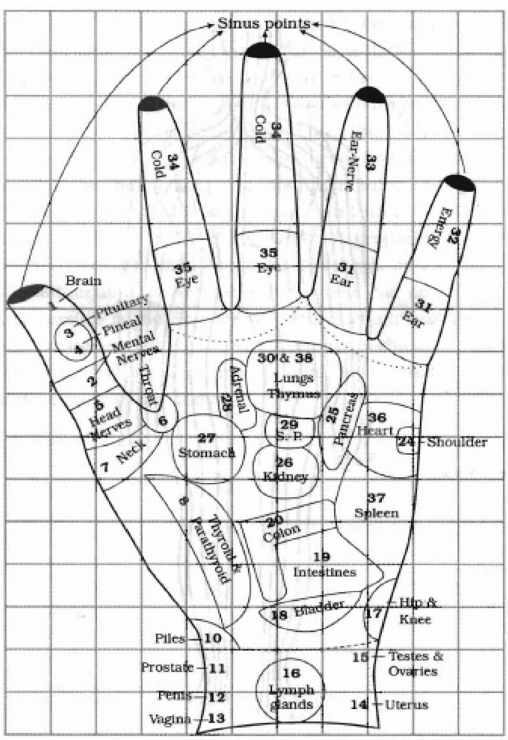

Figure 3. Risk monitoring points for prediction

These body sensors (biosensors) will predict the risks and abnormal behaviour in the particular organ. In order to identify these risks, proper risk prediction system for all ages is considered in the next section.

Wearable gloves can be designed with RFID tags, which contain correct sensor and necessary facilities to monitor the risk area indicated in Figure 3. They are linked with high speed wireless technology, so monitored data and patient's information are analyzed quickly. In order to finalize the results, efficient sensors must be used.

Figure 3 provides specific numbers, which are called risk indicating area. If body sensor is used in number 25, the basic history of the diabetic patient can be identified. It depends on the body sensor and abnormal pulses created from that specific number. If body sensor is slightly moved, correct signal would not be recorded therefore, correct decision may not be possible.

IV. WIRELESS NETWORKS

Wireless networks, such as WLAN, WiFi, WiMax, etc., are considered in the E-health implementations. The 2.4 GHz ISM band is allocated in many wireless network and technologies (examples: Wi-Fi, Bluetooth, ZigBee/802.15.4, DECT, etc.) in hospitals and homes. In ten years, wireless network will be everywhere because RFID sensors and wireless sensors network (WSN) have been applied most of the applications in profit and nonprofit organisations.

In E-health, WSNs have been deployed in where individual E-health application is monitored. In this paper, RFID sensors are incorporated with WSN which consists of a group of RFID tags integrated with RFID sensor. These RFID sensors are supplied by low energy batteries and having very limited sensing, signal processing, and wireless communication capabilities. All RFID sensors transmit data to the same collector node, known as base station (BS). Such networks have been deployed in a wide range of monitoring in E-health applications.

Wireless sensors networks in E-health applications are increased with significant traffic loads during the busy period. In order to simplify this problem, MAC protocols based on deterministic scheduling algorithms can be used [8]. In this research, optimized version of this algorithm will be consensually considered. In order to control the delay and save the power, TDMA-based MAC protocols can be used, but it needs superframe time-slot to transmit data. The proposed algorithm for our research should help to improve this time-slot and reduce energy consumption in E-health applications.

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A. Discussion and recommendations

Communication is established through many ways, which increases the efficiency of e-health systems they are such as e-health via high speed satellite and mobile network communications. In order to increase the quality of service in the e-health system, the digital video broadcasting through satellite version 2 (DVB-S2) can be applied [10]. Through this version, variable rates can be applied to individual e-health application.

In order to improve the e-health systems' communication, maximum lifetime of WBSN and WBAN, minimum energy route and efficient way of using constraint are challenging issues.

The e-health systems and communications prefer to allocate bandwidth efficiently when integrating heterogeneous wireless networks is obviously a challenge. "Consistency medical QoS providing over integrated WiFi/WiMax wireless networks" is challengeable research. Efficient radio resource management, scheduling and connection admission control, are still open issues in WiMax networks they are also crucial in integrated WiFi/Wimax wireless networks for E-Healths services.

Some risks may be unbelievable, but they need to be monitored at least 24 hours continuously. Some risks may be monitored more than 24 hours, but not continuously. Some cases are different it means that monitoring should be done over a fixed period of time in daily or monthly basis. In order to monitor such a risk prediction data, programmable e-health system will be recommended.

According to [12], traffic-awareness is most helpful when traffic demands are concentrated at a small number of heavily-loaded access points located close to each other.

V. CONCLUSIONS

Body sensors are very useful in patients' health monitoring and risk prediction systems. When they are used with RFID tags, e-health systems and communications are processed easily, accurately and quickly. Body sensors are implantable for long term diseases such as cancer, diabetic etc. without major surgery.

In the theoretical model of prediction system, channel selections and priorities are very important. Existing dynamic channel allocation algorithms are investigated and compared with modified algorithm, which should be less complex than the existing one. Quick responding and complexities are traded off; therefore, channel selection algorithms must be considered carefully.

RFID and wireless based e-health system are investigated with body sensors. Although there are few disadvantages when they are used individually, multiple actions and solutions can be performed simultaneously.

Communication for e-health system should be efficient reliable and secure for multiple e-health applications. In order to improve such an e-health systems and communication, ADCA technique should be modified to multiple rate e-health applications with latest high speed network and communication technology.

Diabetic patient may have a lot of other symptoms because it will easily damage most of the human organs very quickly. Risk prediction system will help to find all risks in a daily basis without pricking pain. In order to improve the risk prediction methodology in the e-health system, risk prediction and patient monitoring should be integrated with WBSN or RFID technology. In the future e-health system, immediate resolutions techniques are also added. It means that efficient ADCA technique should be used to implement the priority channel for a particular patient.

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