ARTICLE

AN INHERITED APPROACH OF IOT BASED SMART APPLICATION FOR THE INTERACTIVE HEALTHCARE MONITORING SYSTEM

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ABSTRACT

The proposed idea deals with the inherited features of socio-technical approaches in healthcare domain for continuous online Patient-Physician monitoring by using the IoT (Internet of Things) based Multi-Agent systems. It comprises the integrated environment such as IoT health body sensors, Internet and NFC (Near field Communication) enabled mobile system with the specific Android based GUI application from the patient and physician side communication, secular multi agent data transfer communication mechanism. Particularly this system is focused for reducing the lacking and difficulties of patient and physician interaction during the emergency period. Through this IoT based approach, the patient can easily interact with the physician and also the physician can suggest the prescription by visual interaction and measuring the basic ontological tests. This method also well adapted, while the patient or physician in roaming. The system also has a backup of the related information about the patient in the encrypted format and the same will be notified and retrieved automatically from the physician server. So the patient and physician will be in continuous monitoring for 24 X 7 using this integrated approach.

KEY WORDS

IoT (Internet of Things), Multi Agent Systems, Body sensor, Ontological tests, Encryption

INTRODUCTION

The integration of IoT in health care is an important path to solve the medical health problems and also leads to enhance the quality of life and health service level. This is very much essential in nowadays, to reduce the difficulties of immediate contact with the physician for the emergency problem. In this internet era, with the maturation of technology and promotion of application demand , many people have been attracted towards the IoT in health care sectors. All the existing IoT based health care system are concentrated on making the design of human body sensor and collection of human psychological data rather than providing the health care service for user mobility. In order to overcome these difficulties, We designed the IoT based health care system as 'human-centred', because it uses to analyse the data starting from the human body IoT health care sensor to the physician office with the integration of secure multi agent communication system. This is an entirely different approach in terms of providing human centric health care services through IoT. The proposed system is making the users to obtain the service and convenience brought by mobile medical treatment while the users are under highly mobile conditions in the physical world. So we believe that, this system makes an inevitable trend for development of IoT based health care system.

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LITERATURE SURVEY

In recent years, a lot researches is going in the field of machine to machine learning (M2M), Internet of things for the effective utilization in various sectors like health care, transportation, tourism and smart environments. It also witnessed that a lot of challenges and synchronization problem occurs in the communication between the devices, sensors and distributed network environments [1,2,3,4]. In case of the health care system, still many IoT technologies are used for designing the IoT based body sensors and the collection of human related psychological data. There is a lacking found in integrating the information about patient, analysis of the behavioural information and symptoms related to the various diseases. Meanwhile, there is a security issue arises between the communication and storage of patient privacy information. The autonomous nature of IoT aggravates these privacy threats [5].

According to the survey, most of the health system is severely overburdened. Because it is constantly challenged by the need to make difficult decisions about competing priorities. For adapting to this current scenario, many barriers have been raised to mHealth implementation globally. The highest is conflicting health system priorities (52%) and the lowest is underdeveloped infrastructure (26%). All identified barriers, however, should be reviewed when considering the many factors that can slow down mHealth adoption. Since mHealth currently lacks a strong evidence base to verify its impact on health outcomes and health systems [6]. Meanwhile, many researchers are doing their research to meet the challenges of bringing the revolution is required for providing end-to-end processing and connectivity solutions for IoT-driven healthcare solutions, working toward establishing standards for these solutions and accelerating innovation for organizations eager to realize the benefits of the IoT in healthcare[7]. Integrating IoT is the one way to promote the active participation of elderly in the design and implementation of their healthcare would be to learn from the field of design and adapt models, concepts and methods relevant to participation for use in a healthcare setting. [8]

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PROPOSED PATIENT-PHYSICIAN MONITORING SYSTEM ARCHITECTURE

In our proposed architecture, the physician would monitor a patient 24x7 and look for deep symptoms and anomalous in nature. We made it possible with the integration of emerging technologies of IoT. This system establishes a secure communication between the patient and physician to stay connected at all necessary times; even it also adapted in the of roaming. The proposed architecture, mainly comprises of three major modules such as Patient System(PaS), Physician System(PhS), Physician Office Server(PoS), Secular Communication System.

Patient system

Patient System (PaS) is nothing but an internet and NFC enabled mobile phone with GUI interaction. It is serving as a PDA device. It acts as mediator between the devices connected to the body sensor and the physician system communication.The primary function of the Patient System will receive the statics reading of Blood pressure, Glucose levels, pulse, hormone levels, temperature and any abnormal symptoms in the patient's body and communicate the data to the Physician System(PhS) via Physician office Server(PoS). We specifically designed the special Android based GUI Application for the interaction purpose of the patient and the physician through the IoT technologies. The Android based GUI Application as shown in the [Fig.1] includes the facilities like hospital location, initial precaution steps for Asthma, Diabetes diseases, body sensor interaction, etc. The list of IoT based health sensor interaction with this GUI application is shown in the [Fig.2]. It would make the patient and physician to have a clear study about the problem occurs in the patient's body.

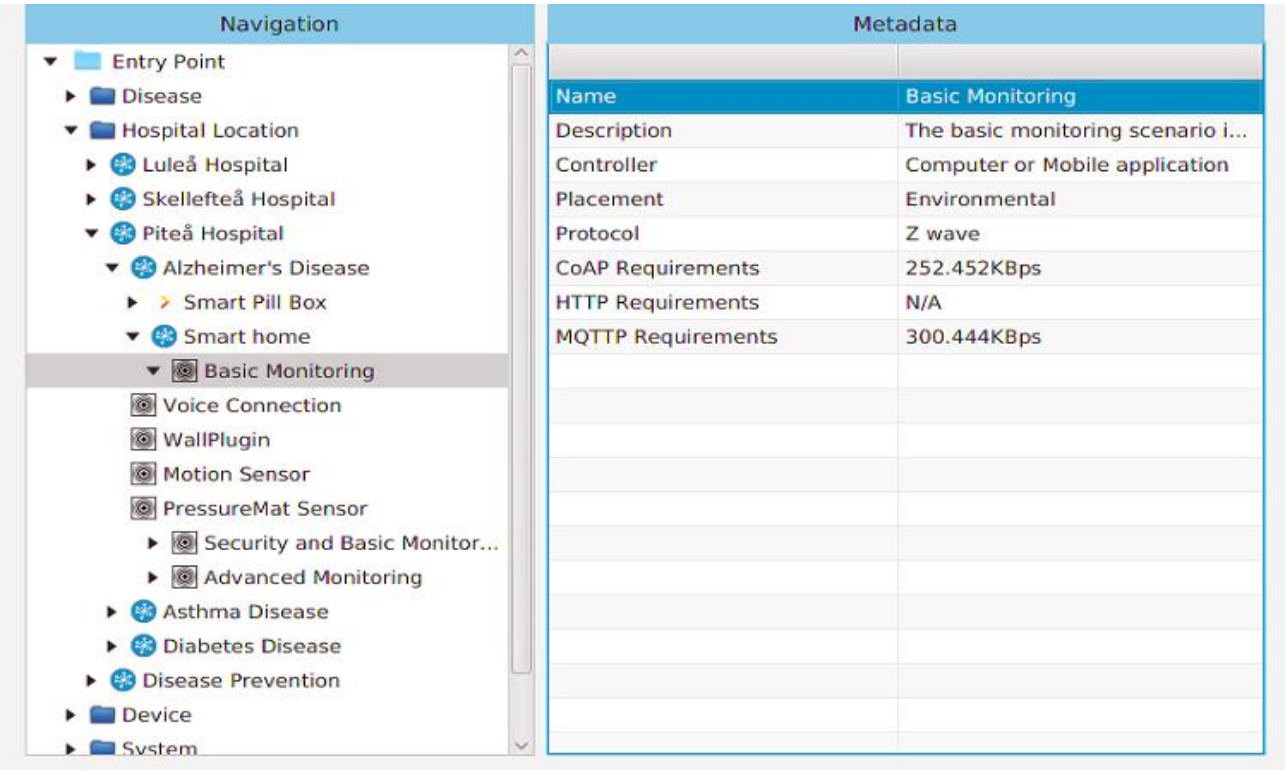

Fig.1: Patient System(PaS) user interface application

This it based GUI application enables the patient to communicate with the physician by doing the following steps

1. Turn on internet enabled PDA to receive an incoming stream of data from the attached IoT health sensors from the patient's body.
2. Comparing the data with the predefined threshold value for low blood pressure, High blood pressure, Glucose level, body temperature and make a decision of abnormality of the system. The proposed patient –Physician Monitoring algorithm shown below to enable the GUI application to monitor continuously about the status of the body and keep communicating to the Physician System(PhS).
3. It establishes the authenticated secure communication to the user prescribed physician by using the password management system authentication. This connection is also adaptable either the patient and the physician in roaming or travelling.
4. Finally, turn off incoming servicing requests from the Patient System(PaS) if it is not required.

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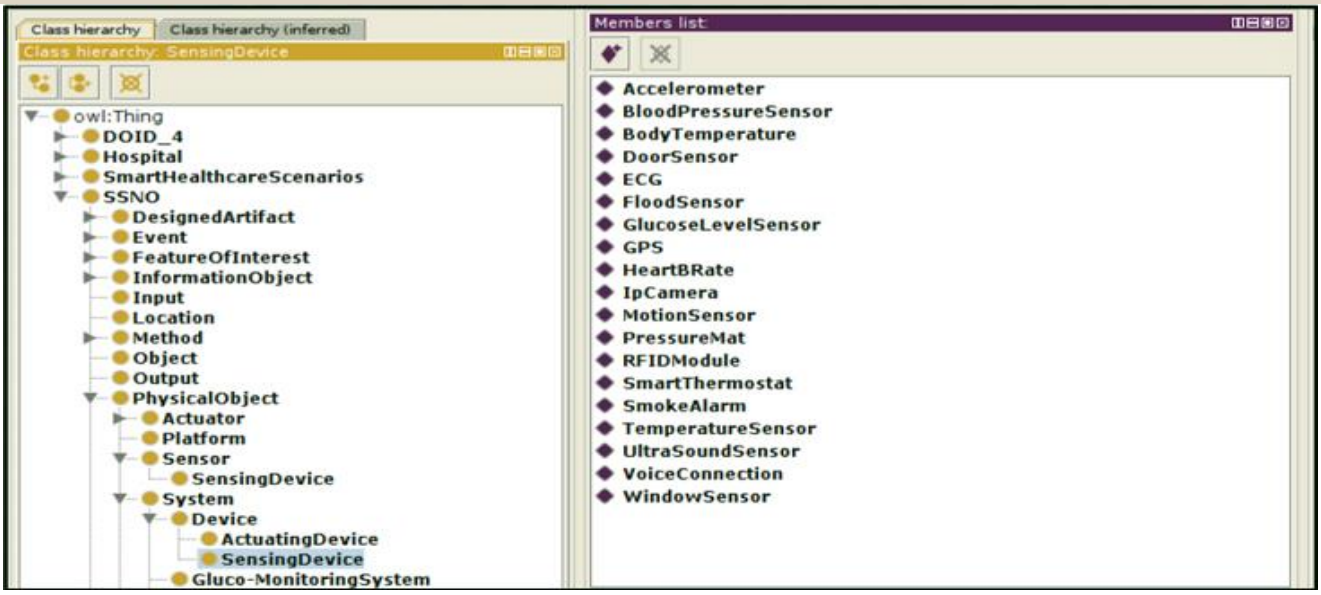

Fig.2: List of IoT based healthcare sensors

Algorithm for patient -physician monitoring

The proposed healthcare system ideally engages its patient on an integrated platform. Basically, the patient server would continuously carry out the following loop

declare
k:int (frequency of reading)
status(a_i) =0 (every variable initialize value)
status(a_j) =0 (every variable initialize value)
do : compute predicate values $Pa_i(t)$ & $Pa_j(t)$ where t is the time instance
{
compare predicate values $Pa_i(t) \geq threshold(\beta)$ where $i \leq 1 \leq n$
compare predicate values $(Pa_j(t) \geq threshold(\gamma)$ where $i \leq 1 \leq n$
do: if
{
true → send (physician, status (Pa_i), status(Pa_j), corr(Pa_i,Pa_j));
receive (physician, push(Pa_i,Pa_j) → store (physician, list($\sum Pa_i$,Pa_j)
search (patient, list(a_i,a_j) : k)
receive(physician, instruction /prescription) to follow
}
else
false →skip the physician

According to this integrated algorithm, the patient PDA device collects the information periodically through the IoT health sensors which have been attached to the patient's body. The above algorithm explaining the computation of the Blood Pressure test. It computes and compares the predicate values $P(a_i,a_j)$ of the Blood Pressure like High BP & Low BP for the predefined threshold values like $Pa_i(t) \geq threshold(\beta)$ & $Pa_j(t) \geq threshold(\gamma)$ for the physician observation. In addition to that, the proposed GUI application would attempt to discover the several past predicate values of the patient for better diagnostics. The proposed system has been designed to store the relevant status of the patient by using the secure storage management system in the Physician office Server(PoS) for future reference and diagnostics. The relevant information of the patient would be stored in the encrypted form as a Patient Entity profile which has been shown in [Fig.3]

IIOAB JOURNAL
ISSN: 0976-3104

Patient Linkage Profile

Name: Edwin

SSN: XXX-XX-XXXX //encrypted

Primary Physician: (encrypted string) Dr. P. Ruffana //encrypted

Primary Physician's Record Pointer: yy-yy-yy-yy-yy-yy //encrypted

Nearest Outpatient Clinic:

Nearest Hospital: File handler XYZ //encrypted

Allergic to: List() // encrypted

Current Medication: List() //encrypted

Major observations: List() //encrypted

Patient's Lawyer: Name, Phone, File pointer

Relative/friend in case of emergency: Name, Number

Fig.3: Patient entity profile

Physician System (PhS) and Physician Office Server (PoS)

Physician System (pHs) is an internet and NFC enabled mobile phone device which is integrated the IoT based Android GUI Application from the physician end. This Physician system(PhS) communicates the Patient System(PaS) through Physician Office Server(PoS), which would offer the continuous monitoring and observation to the patient. Normally, the Physician office Server located in the physician office would offer the data security and relevant statics details of the concerned patient. It used to store all the patient related information in the secure storage system as an encrypted format by keeping away from the malicious attacker. Sometimes, the Physician System (PhS) would suggest specific specialist such as cardiologists, endocrinologists, neurosurgeon, allergists to resolve the further anamolies of the patient. The functionalities of the Physician System(PhS) and Physician Office Server(PoS) is shown in the [Fig.4]

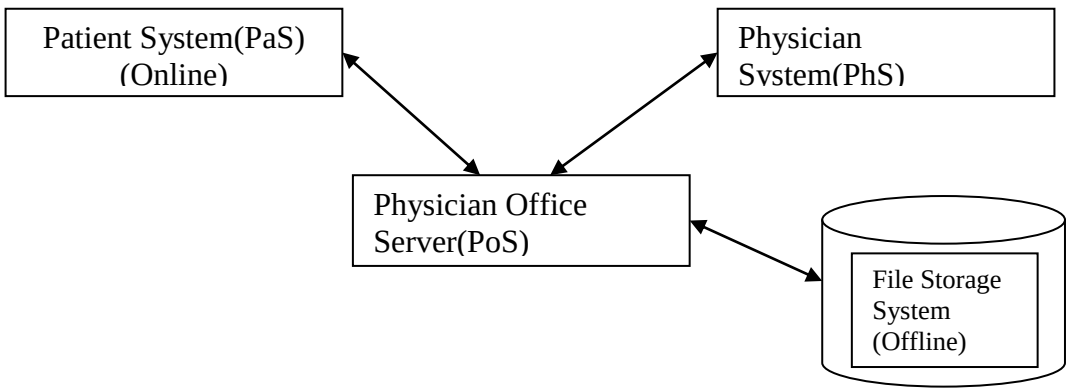

Fig.4: Functionalities of physician system and physician office server

The Patient System(PhS) also designed such a way to share the metadata to the patient in relations to the symptoms and relationship across the various human diseases. Each disease and its related information are comprised with metadata along with Disease ID (DOID) and the same to be maintained in the Physician Office Server(PoS). The metadata format of the various diseases is shown in [Fig.5]. This would help the patient to get more awareness and exposure about the seriousness of the particular disease. It will help in all the way to protect them and lead them away from from the serious infections & conditions.

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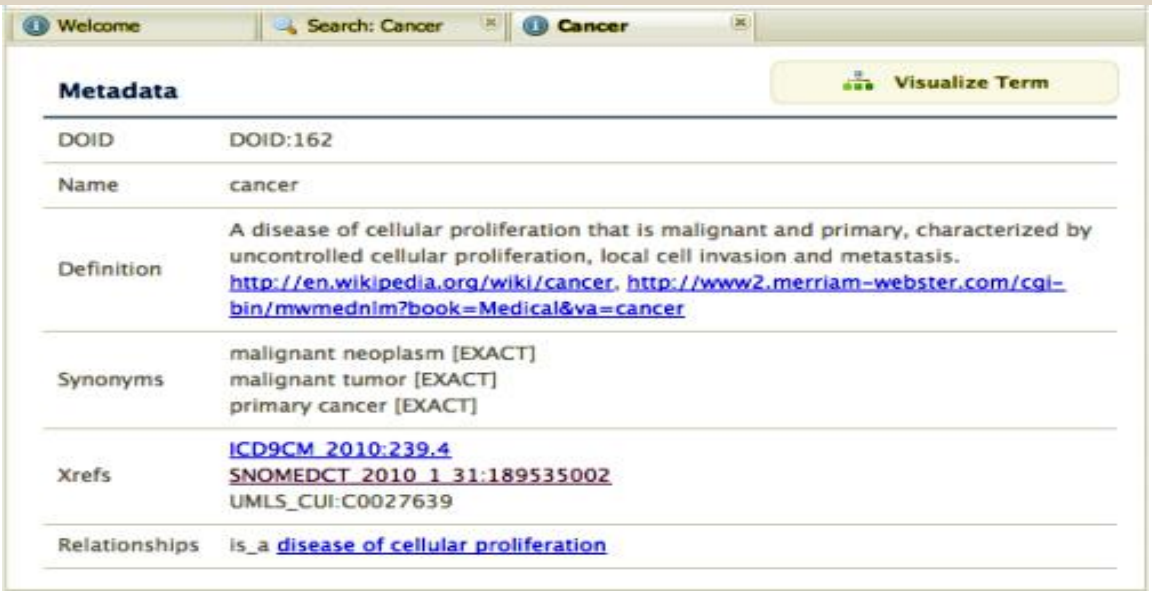

Fig.5: Typical disease metadata

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Secure multi agent communication system

The proposed architecture is integrated with the secure Multi Agent Communication System for the purpose of establishing a secure communication between the Patient and Physician System. We are using the Multi agent system for the purpose of continuous interaction and making the decision in contact with another agent system that is located in widely spread geographical regions. This would help the patient and physician interaction during the time of travelling or roaming in somewhere else. But the challenging part, we faced is the managing and engaging of all the systems in terms of coordination, cooperation and negotiation of communication. In this proposed system, it provides the password management system to the service agent and the secure agent for the purpose of encryption and decryption. The burden of the user device is reduced because of this encryption and decryption process done by the multi agent system. The service agent of the communication system serves as an applicant agent for acting as an interface between the Android platform GUI Application and networks. The secure agent played the role like crypto agent, to encrypt and decrypt data and send it back to the service agent. The secure agent uses the AES algorithm for generating a new key every time with the key size of 124Kbytes for the purpose of encryption and decryption process. There is an inbuilt provision assigned to the secure agent for keeping the generated key in the secure storage place. This will helps the patient-physician monitoring and interaction goes in the secured manner. The framework of the secure multi agent communication system is shown in the [Fig.6]

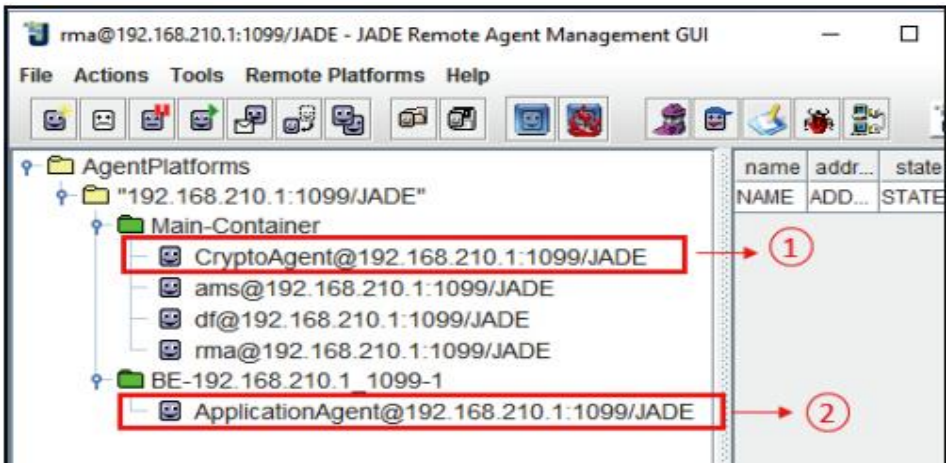

Fig.6: Secured multi agent communication management system

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Each agent system would use the data forwarding techniques while the patient or physician is roaming. In this data forwarding technique, each agent has given autonomy in terms of processing capability and communicates to the nearest or neighbouring Access Point Nodes for forwarding the data closer to the Physician office Server(PoS). This type of secure multi agent communication system will lead to use existing resources effectively in terms of flexible distributed computing architecture. It leads to easier

IIOAB JOURNAL
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coordination, asynchronous computing and reduced communication costs for the patient-physician interaction by giving autonomy of each involving agent for making the process.

CONCLUSION

The proposed IoT based integrated architecture has been designed to provide the multi agent based communication starting from the body sensors of the patient to the physician's office. It enables both the patient and the physician see the presence of each other in a synchronous channel for various activities like online monitoring, assigning medication dosages, observing the current status of the patient. Meanwhile, it ensures the data security and patient privacy through the secure communication and data forwarding techniques. In addition to that, this system is very much adaptable for the continuous patient-physician interaction in roaming. In the future, we would like to extend the application with the context of overcoming interoperability problems among the agents and the integration of big data analytics for handling huge volume of medical data.

CONFLICT OF INTEREST
None

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