Journal of Theoretical and Applied Information Technology
10th January 2014. Vol. 59 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

DEVELOPING ARCHITECTURE FOR MONITORING OF PATIENTS USING INTELLIGENT AGENT-BASED SYSTEM IN WIRELESS SENSOR NETWORK

[1]R.RAJAVIGNESH, [2] DR.G.THOLKAPPIA ARASU

[1]Assistant Professor Department of Computer Science and Engineering,
Arasu Engineering College, Kumbakonam, Tamilnadu, India.
[2]Principal, A.V.S.Engineering College, Salem, Tamilnadu, India.
E-mail: rajavignesh1182@gmail.com

ABSTRACT

Monitoring and diagnosis of patients without directly accessing them is very important in medical application of wireless sensor network. But, collecting, transferring and maintaining of data is challenging task. So, there is an immense need to handle all these information in a quickly and effectively way. In this paper, we utilize agents in different processes such as, data collection from the different sensors, transferring, storing to the appropriate servers, classifying the data and give the prescriptions to the patients. In this paper, we organize the proposed architecture in three layers, the first one is body area network layer which helps to store the medical information get from the body sensors of the patients, the second layer is conveyer layer which helps to transfer the medical information one layer to another layer and the final one is data analyze layer which helps to store, analyze medical data also it gives the exact prescriptions for the medical information of the patient. Finally the, remedy for the medical information is send through the conveyer layer. Finally the experimentation is made with the number of patient's rate of transferring the medical data and our implementation is done with the help of JADE and JNS.
E-mail: *Architecture, Patients, Agent System, Wireless Sensor Network*

1. INTRODUCTION WITH CHALLENGES

A Wireless Sensor Network (WSN) is a spatially distributed set of sensor platforms usually with a range of sensory modalities e.g. temperature or light intensity. Along with limited power resources, the individual platforms are typified by low processing and memory capabilities. They are usually operated by sampling their senses and constructing a packet containing these sampled values. If one is in radio range or indirectly through transitional nodes, this packet is then routed to a base station either directly. The base station can process this information and send suitable commands back down to a given node requesting it to boost its sampling frequency [1]. The node should be put to sleep to the degree that possible, so as to maximize its life-span. In sleep mode no radio activity can occur, which is the single major drain on the power of a node. This means we cannot receive sensory data from a node that is asleep regrettably. For power conservation, the opportunistic activation of the nodes could primarily be achieved by performing the interpolation at the base-station of the WSN, which is where each node could periodically communicate its sensed data. There are several reasons why this approach is unsuitable. Primary is the delay between the time the values are sensed and the time the base station receives them. Secondly, to reach their target the commands issued from the base station to outlying nodes could potentially take an unacceptable amount of time. A third problem is when relaying the sensed values back to the base station for processing the power consumption of the multiple hops. From this, it is evident that WSNs could benefit a great deal from the distributed, intelligent decision making process offered by agents [1].

A sensor network with intelligent behavior is a system that can get used to the situation, present information that is relevant for the moment and a system that has reasoning parts that are designed to function with low-level rules and work together to achieve a high-level goal [4]. For policy makers, healthcare providers, hospitals, insurance companies and patients, the cost of healthcare services has increased and this has been posing severe challenges. A major problem to be tackled is taking care of the health care services of a large number of patients within easy reach under the

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

circumstances. By deploying an appropriate patient monitoring system in hospitals, this challenge can be met to a certain degree. Using short-range communications it is observed that there has been some progress related to patient monitoring using wearable devices in this context. This type of network is more explicitly referred to as body area networks (BAN). There is a need for a comprehensive patient monitoring solution using wireless sensor networks (WSNs) and the quality and reliability of patient monitoring can be improved by using wireless sensor based mesh networks (WSMN), an increasing number of patients start wearing such communicating devices. The information on vital signs of a patient can then be transmitted to base stations by means of intelligent agents which would replicate the human nurses, and will be picked up by the appropriate healthcare professionals on their mobile device in this case [2][3][5].

In this paper, we develop architecture for monitoring of patients using intelligent agent-based system in wireless sensor network. The architecture of the proposed approach is prearranged in to three layers as body area network layer, conveyer layer, data analyst layer. The body area network consists of a set of body sensors and updation agent. To sense the significant parameters of the patient and it sends the sensed data to the updation agent for each particular time interval the body sensors are used. We plot the updation agent for each area, due to the limited power. From the body sensors, the updation agent, stores the received medical information of the patient. The next layer is the conveyer layer, this layer consists of two agents first one is collection agent and the second one is nurse agent both agents are primarily used for transmitting the medical information from one layer to another layer. From different upatation agent, the collection agent helps to collect the medical information from the every updation agent also merges the appropriate medical data and sent to the data analyst layer. The analyst layer consists of three parts first one is data repository, the second one is classifier and third one is physician. The use of data repository is store the medical information of every patient and the classifier helps to analyze the medical data of the patient and the physician gives prescription. At last the prescription is send to the patients through the nurse agent in the conveyer layer.

The rest of the paper is organized as follows: a brief review of some of the literature works in the relational data mining is presented in Section 2. The proposed architecture for monitoring of patients using intelligent agent-based system in wireless sensor network is given in Section 3. The experimental results and performance analysis discussion are provided in Section 4. Finally, the conclusions are summed up in Section 5.

2. REVIEW OF RELATED WORKS

For agent based health patient monitoring on Wireless sensor network, many Researchers have developed several approaches. A handful of noteworthy researches are presented in this section among them. Benjamin N.A. and Sankaranarayanan, S [7] have presented the act of WSMN used for patient health monitoring application, in terms of parameters like delay, MAC delay and throughput under varying number of patients and varying number of doctors in wards and also the malfunction performance when the mesh nodes fail, based on simulation study carried out with Opnet modeller 15.0.

Cristina Turcu, Tudor Cerlinca *et al.* [9] have proposed an RFID-based integrated system. This was aggregated health-related data across more hospitals as said by recognizable standards. In hospitals and public health officials, it was made available for emergency departments. When responding to a medical emergency situation, the solution was helped to save lives by giving hospitals and paramedics up-to- date information, on scene. Hence, in emergency medical situations, SIMOPAC offers EMS providers life-saving medical information via the CIP containing up-to-date medical information of vital importance to those entitled to make fast and precise patient care decisions. In order to attain real time information regarding the patients' biometric data, a low-cost intelligent embedded system was proposed, which might be used in different points of the healthcare system. To provide a complementary solution to hardware system, the research team proposed the use of agents, in order to integrate it in different healthcare systems.

Multi-agent systems (MAS) make straightforward human life with automated functioning. Fiaz Majeed *et al.* [8] have implemented multi-agent system for remote patient monitoring (RPM). To find weaknesses in existing technology and to add, to improve the system with mature functioning was the objective of the paper. They proposed the optimized nomadic devices based RPM framework, to accomplish a robust system. They have explored, different mobile based tele-health service system approaches that use

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Multiagent paradigm. They have proposed an optimized framework, based on their findings. In one framework, the proposed system provides state of the art RPM services. They have solved important problems in the existing MAS-based RPM infrastructure such as alternative solution for continuous GPRS connection was provided, a way to amplify battery life is proposed and data management in the network was resolved in their framework. Lastly, prototype system established its practical feasibility. In the MAS environment, the system work efficiently and securely.

Kevin Miller and Suresh Sankaranarayanan [5] have presented the information of the functioning of four main intelligent agents, i.e., the nurse agent, the sensor agent, the database agent, and the ward boy agent. This is for intimating the health information to the concerned doctor in the hospital, based on certain policies relevant to the hospital. Based on the temperature parameter monitored by the nurse agent, the policies worked. For policy based agent implementation, they proposed considers an example of the physiological parameter i.e., the body temperature monitoring. Using JADE-LEAP agent development kit, the implementation was carried out.

Mayuri Gund *et al.* [6] have proposed a multi-agent based mobile health monitoring system. This system was the combination of a wireless medical sensor module with data mining techniques. For improving communication among patients, physicians, and other health care workers, Mobile Health Care was the application of mobile computing technologies. They separated Association rule exploration into two data groups; they are real time sensory data collected from patient's body and historical data collected in past. As mentioned earlier, the system collected the diagnosis patterns, classifies them into normal and emergency terms and declares emergency by comparing the two data groups. As a result, it suggests methods to examine and model patterns of patient's normal and emergency status.

3. DEVELOPING ARCHITECTURE FOR MONITORING OF PATIENTS USING INTELLIGENT AGENT-BASED SYSTEM IN WIRELESS SENSOR NETWORK

Our proposed research related to the use of a wireless sensor network which consider in the form of a body sensor network monitoring patient's condition in a health application. In the light of this, we would like to briefly go through some of the familiar wireless sensor networks which could be considered as a body sensor network for our application. The architecture of the proposed system is given in below

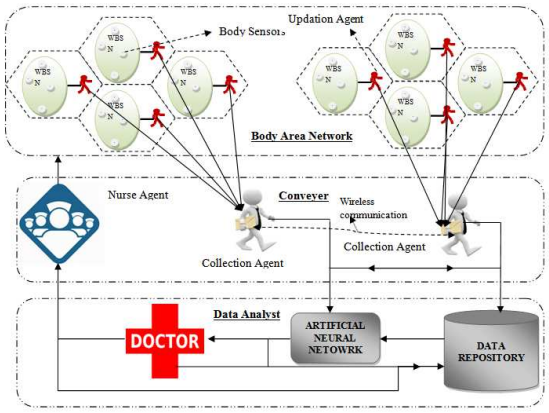

Figure: 1 Illustrates The Architecture Of The Proposed Approach

3.1 Body Area Network

In body area network layer, the sensors are attached to patient's body with the aim of obtain the bio-signals including blood pressure, body temperature, pulse and breathing. This body area network is mainly divided into two parts first one is Wearable Body Sensor Network and the next one is Updation agent. The main purpose of this BAN layer is to collects and updates the sensed data from the WBSN and sends those data to the conveyer layer.

3.1.1 Wearable Body Sensor Network

The WBSN is the sensors which are formed wearable or implantable in patient's body since the name is wearable body sensor network. From the patient's body, the bio-sensors accumulate the essential readings and send that to the Updation Agent.

A sensor can send their sensed data to at a particular distance because of limited power since we placed an Updation Agent for each particular distance. At each time interval T the WBSN sends their sensed data from the patient's body. Each WBSN sends medical information with its id $D=\{id, data\}$ to the Updation Agent. In order to send those data to Updation Agent, the WBSN sends request to nearest Updation Agent and the transmitting is starts when the responds received from the Updation Agent. At each time, the WBSN sends request to the Updation Agent since the patient is dynamic; the patient may go at anywhere, any place and the Updation agent become change based on the place of the WBSN. If the patient goes

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

to another place means then the WBSN sends request to nearest Updation Agent and the transmission is started after receiving response from the Updation Agent.

3.1.2 Updation Agent

The main purpose of the Updation Agent is to receive the medical information D from the set of WBSN and store the received medical information on the corresponding WBSN id. The Updation agent received the set of medical information $UD = \{D_1, D_2, \ldots D_n\}$ from many WBSN, where n is number of WBSN which are connected with Updation Agent.

The Updation Agent note down the id of the WBSN when it receives the request from the WBSN and the UA checks if the id of the WBSN is exist or not. If the id of the WBSN is already exist, then the UA updates the data of that WBSN else the UA makes the new place to store the data for new WBSN id.

3.2 Conveyer

The Updation Agent stores the information from various WBSN, the stored information of the Updation Agent would certainly goes to the Data Analyst layer. If we send the information of the WBSN of the patient through the Updation Agent some of the information become loss since the patient is dynamic. Each Updation Agent receives only some of the information of the single WBSN and the other may go any other Updation Agent based on the location of the patient.

The main purpose of the conveyer layer is to collect the medical information from one layer and transmitting that medical data from one layer to another layer. This conveyer layer is mainly divided into two parts; the first one is Collection Agent and the next one is Nurse Agent.

3.2.1 Collection Agent

The collection agent is used for collects the sensed data of the each patient from the Updation agent in the Body Area Network (BAN) layer and it transmit the collected data to the Artificial Neural Network (ANN) and Data Repository (DR) in the Data Analyst layer (DAL). We generate the Collection Agents for each N number of updation Agent. The collection agent collects the set of medical information UD (updated data) from the N number of Updation Agent. At each time interval T++, the collection agent collects the UD data from the each Updation Agent. Subsequently the collection agent merges the UD data which has same WBSN id. Each collection agent searches with all other collection Agents whether their WBSN id matches with others. If any WBSN id matches then the collection agents get the matched WBSN id and the corresponding UD data.

The process of searching and merging the UD data of the collection Agent is done with the help of the wireless communication among the collection agents. After the merging process, the merged updated data MUD is transmit from the CA in the CL to the ANN and DR in the Data Analyst Layer (DAL).

3.2.2 Nurse Agent

The Nurse Agent helps to trasmit the medical information from the physician (Doctor) in the DAL to corresponds WBSN in the BAN. The nurse agent transfer the medical information to the corresponding patients when it recieves the data from the physician in the data analyst layer.

3.3 Data Analyst Layer

The data analyst layer helps to analyze the medical information of the patient and also used for store the medical information. The collection agent send the MUD data to DAL for two purposes, the first purpose is to store the MUD data and the second one is to analyze the MUD. The medial information is stored in the data repository and the artificial neural network helps to analyze the MUD. The result of the ANN is send to physician. The physician analyzes the received information from the ANN and also analyzes the earlier medical history of the patient from the data repository. By analyzing the above both data, the physician gives the prescription to the nurse agent and the data repository. The nurse agent sends the doctor's prescription to the corresponding patients and the data repository stores those prescriptions of the patient.

3.3.1 Data Repository

The data repository helps to store the medical information of the patients. The data repository consists of patient id, medical data, result of the ANN, prescriptions of the physician. The data repository updates the patient's information in the following steps

- Whenever the MUD data received from collection agent
- Whenever the ANN's results given to the physician
- Whenever the physician gives prescriptions to nurse agent

Journal of Theoretical and Applied Information Technology
10th January 2014. Vol. 59 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

With the help of the data repository, the physician can evaluate the past medical history of the patient. By considering those past medical histories of the patient, the physician gives the prescriptions.

3.3.2 Artificial neural network

ANN is an artificial intelligence technique that is used for generating training data set and testing the applied input data [22]. A feed forward type NN is used for the proposed method. Normally, a feed-forward neural network has an input layer, an output layer, with one or more hidden layers in between the input and output layer. The input layer consists of five inputs i.e. $A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9, A_{10}, A_{11}, A_{12}, A_{13}, A_{14}$. The ANN functions as follows: each node H_i in the input layer has a signal A_i as network's input, multiplied by a weight value between the input layer and the hidden layer.

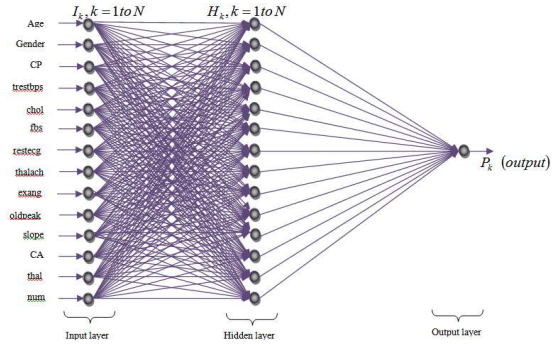

Figure: 2 Architecture Of The Artificial Neural Network

The training phase is classified into following three major steps. The training steps involved in neural network are as follows,

Step 1:

❖ Initialize the input, output and weight of each neuron. Here, $A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9, A_{10}, A_{11}, A_{12}, A_{13}, A_{14}$ are technical indicators, i.e. input of the network and $(P_k)output$ is the predict value, i.e. output of the network.

Step 2:

❖ Each node I_k the hidden layer receives the value $\ln(I_k)$ according to:

$$\ln(I_k) = \sum_{i,k=1}^{N} A_i I_k \quad (1)$$

❖ Then passed through the bipolar function:

$$f(A) = \frac{2}{(1+\exp(-A_i))} - 1 \quad (2)$$

❖ The output of the activation function $f(\ln(I_k))$ is then broadcast all of the neurons to the output layer:

$$(P_k)output = \sum_{k,n=1}^{N} H_k \, P_k(n) \quad (3)$$

Step 3:

❖ The inputs of training dataset are $A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9, A_{10}, A_{11}, A_{12}, A_{13}, A_{14}$ to classifier and determine the error function as follows.

$$E_v = (P_k)t\arg et - (P_k)output \quad (4)$$

In equation (4) $(P_k)t\arg et$ -is the target output and $(P_k)output$ -is the network output

Step 4:

❖ Adjust the weights of all neurons as $w = w + \Delta w$,where, $\Delta w$is the change in weight which can be determined as follows,

$$\Delta w = \beta . P_k \, . E_v \quad (5)$$

In Eq. (5), β is the learning rate, usually it ranges from 0 to 1.

Step 5:

❖ Repeat the process from step 2, until error gets minimized to a least value i.e

$$E_v < 0.1 \quad (6)$$

The neural network analyzes the medical information of the each WBSN and the result is given to the physician and data repository. The data repository stores the ANN's result of the patient and the physician gives the prescription to the nurse agent and data repository according on the basis of the ANN's result of the patient.

3.3.3 Physician

The physician helps to gives the prescriptions by analyze the result of the ANN and the past medical histories of the patient which helps to the patient to protect from the risk of the disease.

4. EXPERIMENTAL RESULTS

In this section, we described the experimental result of the proposed architecture for monitoring of patients using intelligent agent-based system in wireless sensor network.

Journal of Theoretical and Applied Information Technology
10th January 2014. Vol. 59 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

4.1 Experimental Environment

The proposed approach for monitoring of patients using intelligent agent-based system in wireless sensor network is programmed using Java (jdk 1.6), JNS and JADE. The experimentation has been carried out by the number of patient's medical data transferring through packets with core 2 duo processor PC machine with 2 GB main memory running a 32-bit version of Windows 7.

4.2 Evaluation Of The Proposed System Based On The Number Of Packets

In this paper, we implemented our proposed algorithm in java network simulation. Transmission of the every medical data through number of packet. Some of number of packets are discarded due to the traffic of the network since we evaluate our proposed system by vary number of packets and traffic of the networks. The following figures 3,4,5 represent the result of the proposed system.

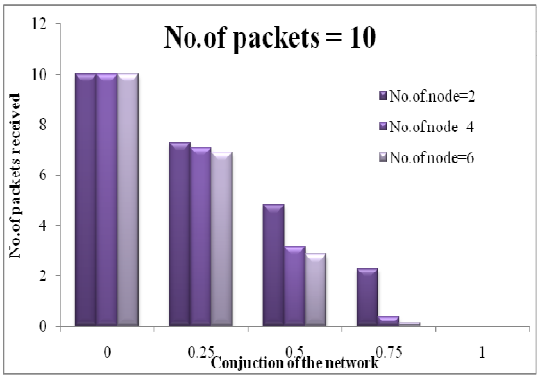

Figure: 3 Illustrates The Number Of Packets Received Based On The Conjuction

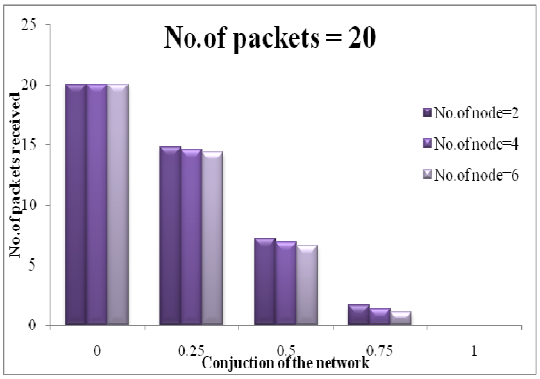

Figure: 4 Illustrates The Number Of Packets Received Based On The Conjuction

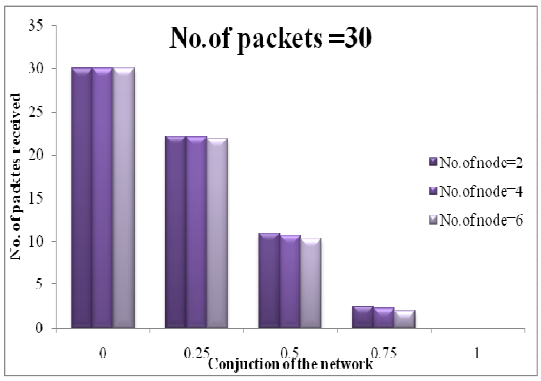

Figure: 5 Illustrates The Number Of Packets Received Based On The Conjuction

By analyzing the above figures 3,4,5 we conclude the thing the number of packets received is decreased when the conjuction of the network is increase. Since the some of the data become loss due to the traffic of the network.

5. CONCLUSION

We developed architecture for monitoring of patients using intelligent agent-based system in wireless sensor network. With the help of body sensors, the updation agent received and stored the medical information of the patient and the stored information in the each upadation agent is collected and sent the merged the appropriate data to the data analyst layer is done by the collection agent. The artificial neural network is used to classify the received medical information and the physician gives appropriate information to the correspond patient through the nurse agent. The proposed architecture helps the patient to keep safe from the critical situation of the disease without need of going to hospitals. This proposed architecture is evaluated by implement in java network simulator and JADE and we also proved the efficiency of the proposed system based on the traffic of the network.

REFERENCES

[1] Richard Tynan, David Marsh, Donal O'Kane and G.M.P. O'Hare, "Intelligent Agents for Wireless Sensor Networks, " *Proceedings of the fourth international joint conference on Autonomous agents and 32 bit multiagent systems*, Pages 1179-1180, 2005.

[2] Suresh S.," Policy based Agent Architecture for Sensor based Mesh Networks - Health Care Monitoring " *Proceedings of the International Conference on High Performance Computing,*

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Networking and Communication Systems (HPCNCS-08), pp.75-81, 2008.

[3] Suresh S & Subra Ganesan, "A layered architecture for agent based wireless sensor based mesh networks applications in health sector," *Intl. Journal of Embedded Systems and Computer Engineering, Serial Publications*,Vol.1,no.1, pp.51-61, 2009.

[4] Karlsson, B Bäckström, OKulesza, Wlodek Axelsson, L"Intelligent Sensor Networks - an Agent-Oriented Approach," *Workshop on Real-World Wireless Sensor Networks, Realwsn* '05, 2005.

[5] Kevin Miller, Suresh Sankaranarayanan, "Applications of Policy Based Agents in Wireless Body Sensor Mesh Networks for Patient Health Monitoring," *International Journal of E-Health and Medical Communications*, 2(2), 24-45, April-June 2011.

[6] Mayuri Gund, Snehal Andhalkar, Prof. Dipti Patil, Dr. V.M.Wadhai "An Intelligent Architecture for Multi-Agent Based m-Health Care System," *International Journal of Computer Trends and Technology-March to* April 2011.

[7] Benjamin, N.A. Sankaranarayanan, S. "Failure Performance Study of Hierarchical Agent Based Patient Health Monitoring in Wireless Body Sensor Mesh Network, *"International Conference on Advances in Computing, Control, & Telecommunication Technologies*, pp.85-87, 2009.

[8] Fiaz Majeed, Aslam Muhammad, Rizwan Saleem and Martinez-Enriquez A. M"Towards Maturity in Multi-agent Based Remote Patient Monitoring," *International Journal Of Multidisciplinary Sciences And Engineering*, Vol. 2, No. 1, March 2011.

[9] Cristina Turcu, Tudor Cerlinca, Cornel Turcu, Marius Cerlinca, Remus Prodan, Ioan Ungureanu, "Improving Efficiency in Patient Identification and Monitoring Using RFID and Multi-agent Technologies," *Proceedings of the 2nd WSEAS International Conference on Biomedical Electronics and Biomedical Informatics*, pp.259-266,2009.