Journal of Theoretical and Applied Information Technology
15 June 2012. Vol. 40 No.1

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

# AUTOMATIC PATIENT MONITORING SYSTEM USING SCATTERNET FOR CRITICAL CARE

**[1]SIVARANJANI A, [2]VIGNESH KUMAR K, [3]SATHYA S, [4]SANTHI B**

[1]M.Tech II year, SOC, SASTRA UNIVERSITY, THANJAVUR

[2] M.Tech II year, SOC, SASTRA UNIVERSITY, THANJAVUR

[3] M.Tech II year, SOC, SASTRA UNIVERSITY, THANJAVUR

[4] Professor, SOC, SASTRA UNIVERSITY, THANJAVUR

E-mail: [1]siv.ranjani2000@gmail.com, [2]k_vignesh_kumar@yahoo.co.in, [3]sathyas630@yahoo.com, [4]shanthi@cse.sastra.edu,

**ABSTRACT**

Wireless sensor network provides a useful method to acquire and monitor the physiological signals of a patient. Bluetooth has a wide variety of applications in the medical field. Previously in a patient monitoring system, the physiological signals of a patient are transferred by using piconet. And it has some drawbacks such as limited number of nodes and limited communication range. To overcome these drawbacks, we proposed a system using Bluetooth scatternet. In this proposed model three piconets are interconnected to form Scatternet Sensor Network. The first and second piconet consists of one master node (local nurse) and five slaves nodes (patients). The third piconet consists of one master node (Chief nurse) and three slave nodes (Chief Doctors). Chief nurse act as a bridge node, which interconnect three piconets. The patients are at 24×7 critical care. If anything critical occurs, the Chief Doctor receives the data and sends acknowledge to the concerned patient. Furthermore, with the help of this system, medical personnel can take care of a few patients simultaneously, and thus, the personnel expenses can be reduced.

**Keywords:** *Bluetooth, Scatternet Network, Piconet, Physiological Signals.*

## 1. INTRODUCTION

In recent years the great innovations brings advanced technologies in Medicinal ground. Most of the Health Care – Hospitals are trying to make available and uphold the effective enduring treatment with more alert and preventions. Such an effective treatment requires a professional Patient Monitoring System [8]. The Patient Monitoring System is a greatly developed technology for controlling and monitoring the situation of various Human-health parameters. Some of our Human-health parameters include temperature, heartbeat, blood pleasure, pulse, etc. needs a continuous monitoring.

Consequently Wireless Sensor Technology makes the Patient Monitoring System (PMS) matter of uncomplicated in addition to valuable. Among the various wireless communications Bluetooth communication the low cost and intended to communicate with diverse devices flawlessly. The basic idea of the Bluetooth is to connect the various portable or fixed devices without wires and cables. The functionality of Bluetooth requires a host; it can be several number of permit devices. It has two types of network topology namely Piconet and Scatternet.

## 2. BACKGROUND AND RELATED WORK

PMS using Wireless Sensor Technology have been discussed in so many research papers. Currently the Health Care has made immense advances in patients care. Now a days the major focal point is to encompass the effective long-term treatment with professional Monitoring System. There are several numbers of monitoring methods were implemented using wireless communications and improving the health care more specialized. The implementation of Telemedicine system for patient monitoring using mobile telephony is discussed in [1] used a RS-232 interface for patient

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

monitoring. In [2] the technology mainly focused on health of older adults and discussed about the various wireless tracking technologies. The advanced Information and Communication Technology (ICT) is used in developing the efficient monitoring system which could enhance the health care's quality by lady health workers [3]. A Wireless PDA-Based Physiological Monitoring system for Patient Transport in [3] is the integration of Personal Technology (PDA) and WLAN Technology. [4] Discussed about the performance of an IEEE802.15.4/Zigbee MAC based WBAN operating in diverse patient monitoring situation. The monitoring system developed using the PIC18F2550 and the XBEE communications Processor in [5] provides the low- power consumptions, Low cost, and real- time multi-patient monitoring without using telephones, web-based, and GPS. An important parameter is viewed remotely and adjusted to meet demand by a prototype based on wireless communication channel i.e. Wireless Lan (IEEE802.11) and WMTS which is presented in [6]. The Sensors, Web Servers and Back-end Databases is a three-tier architecture named WANDA is a monitoring system for CHF patients [7]. Hence the Wireless Sensor Technology has its imperative part in patient monitoring in variety of aspects.

Based on the function state slave and master would be any Bluetooth device. Both slaves and master will synchronize at the same level of sequences. And one or two Bluetooth devices will launch a connection by synchronization and it will form a type of personal area network called piconet. Every Piconet is able to hold up to eight different Bluetooth devices. Inside each piconet, single device serves as the master, whereas the other seven devices function as slaves.

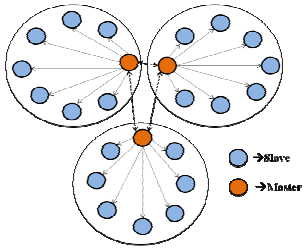

*Figure.1 Scatternet*

To connect more than eight devices simultaneously, we encompass to form multiple piconets, and subsequently connect the master devices from each piconet together. Hence connecting two or more piconet is named as Scatternet, refer Fig.1. In Scatternet the slave of one piconet would be master of other piconet. For creating Scatternet the bridge node is must, because it will communicate with all piconet and act as Global master node.

## 3. PATIENT MONITORING USING SCATTERNET

### 3.1 Existing System

The existing system [9] has the structural design of piconet topology. It moreover specified the approach intended for integration of physiological sensor nodes and information from various sources. The main weakness of this system is the use of piconet, as a result of that we can exploit only 8 nodes or else less than that. So that only one node will act as master. Because of very less number of nodes in the network the range of communication is very inadequate. However in hospital they wish for monitoring more number of patients, in such case it won't be helpful.

### 3.2 Proposed System

We have proposed a system to overcome the existing, by adopting scatternet. Interconnecting more number of piconets we can form a large network called scatternet .We can connect up to 273 nodes in a scattenet. By using that we can monitor more number of patients. Here each piconet will have local master nodes and the local master nodes will be interconnected via one global master node known as a bridge node. By adding number of nodes we can increase the range of communication in the network.

## 4. OVERALL SYSTEM ARCHITECTURE

Here in our proposed system, we have considered only three piconets. Among three, two piconets are considered as patients' sensor network and another one is considered as Medical management. The piconet1 and piconet2 has 6 slaves and each having one local master node. And the Piconet3 has 3 slaves and one master node. For connecting all piconet a global node in piconet3 which is act as a bridge node. The 5 slave in piconet1 and piconet2 are considered as *patients* and local master node is considering as *Local Nurse*. And the node which act as bridge node for all piconet is considered as *Chief Nurse*. The 3 slaves in piconet3 are considered as *Doctors*. The bridge node will play a role as *slave* for piconet1 and piconet2 further as *master node* for piconet3.

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

The *Local Nurse* (local master) of piconet1 and piconet2 only can interact with *Chief Nurse* (bridge node).

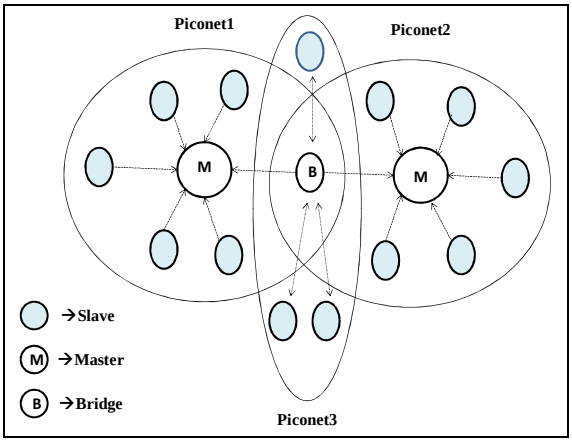


*Figure. 2 Overall System Architecture of Automatic Patient Monitoring System Using Scatternet Sensor Network*

**4.1 Scatternet monitoring System**

The patients are at 24×7 critical care. Several therapeutic sensors will be set to every patient node. The therapeutic sensors are to measure and to sense the various health parameters. Here we are going to consider only three parameters, they are heart activity, blood pressure, temperature. Depending on the diagnostic stress of a patient's syndrome the sensors are configured for monitoring the relevant physiological indication. The data from each patient are transmitted to the local nurse. Based on patient's physiological status, the local nurse can either gives treatment or forwards the status to the chief nurse. Chief Nurse does the same and forwards the status to either chief doctor or assistant doctor depending upon their availability. Finally the doctor takes the further steps to treat the patient. The overall system architecture is given in the figure 2.

So as previously mentioned, in this proposed model three piconets are connected to from Scatternet.

**i. Piconet1 and Piconet2 has 7 nodes**

*7 nodes = 5 Patients (slaves) + 1 Chief nurse (slave) + 1 Local nurse (master)*

**ii. Piconet3 has 3 nodes**

*4 nodes = 3 Doctors (slaves) + 1 Chief nurse (master)*

**iii. Role of Chief Nurse**

- *Slave of Piconet 1 and Piconet2*
- *Master of piconet3*
- *Bridge node*

**iv. Three cases**

In our system we have taken into account of three cases

**Case 1:** If the patient's status is normal stage.
**Case 2:** If Patient is in a critical stage.
**Case 3:** If "n" number of Patients in a critical stage

| | |
|---|---|
| **Case1** | physiological data ↓ local nurse (Local master P1 or P3) |
| **Case2** | Physical data ↓ Local nurse(Local node) ↓ Chief nurse(Bridge, Master P3, SlaveP1 & P2) ↓ Doctor(Slave P3) |
| **Case3** **(n<4)** | 1st 3 steps of Case2 will occur , In 4th step the Chief nurse will transfer data to "n" no. of Doctors(slave P3) |

*Table.1 Three cases discussed in our proposed system*

In this proposed model we have made use of three medical sensors for patient's nodes:
(i) An ECG sensor which can be used to bring together the physiological signals for monitoring heart activity
(ii) A blood pressure sensor for monitoring blood pressure, and
(iii) A temperature sensor for monitoring the body temperature.

Our proposed routing protocol requires location information of the nodes and constructs the route between any source and destination and reduces the number of hops. Rigorous simulation works are done to evaluate the performance of our protocol in terms of mobility speed and number of mobile nodes and to compare our results with similar Bluetooth routing protocols.

This proposed algorithm involves the efficient transmission of data from each patient to the chief doctor or the associate doctor passed through local nurse and chief nurse.

Journal of Theoretical and Applied Information Technology
15 June 2012. Vol. 40 No.1

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

### 4.2 Physiological Routing Algorithm

Here the various parameters like Body Temperature, heart rate and blood pressure are denoted as x, y, z respectively. And normal values for the various physiological signals of patients are X= 85 - 95, y= 70 – 75, z= 75 – 80.

**Step 1:** Read the values for x, y and z

**Step 2:** If the following conditions (85>x>95, 70>y>75 and75>z>80) are true, then set patient's status as normal. Otherwise set as critical.

**Step 3:** Forward the values of x, y and z from the corresponding patient node to either master1 or master2 (local nurse).

**Step 4:** If the patient's condition is critical, go to step 5, else stop.

**Step 5:** The data received by the bridge is then forwarded to either Assistant Doctor1 or Assistant Doctor2.The selection of one among the two assistant doctors is based upon their availability. Then stop.

## 5. SIMULATION AND RESULTS

The tasks involving Scatternet formation, device discovery and efficient routing of data has been evaluated by means of network simulator (NS2). In order to implement the operations for device discovery and scatternet formation, we have enriched the network by giving to each node the role of master or the role of slave. Our simulator strictly follows all the specifications of the BT protocol stack Scatternet.

In this simulation, 3 Piconets involving a sum of 16 nodes formed a Scatternet are used. Two of the piconets have 5 slaves each and 1 master each. Third piconet has 3 slaves and 1 master. One of the slaves acts as the bridge between all the three piconets. The Scatternet network formed is shown below.

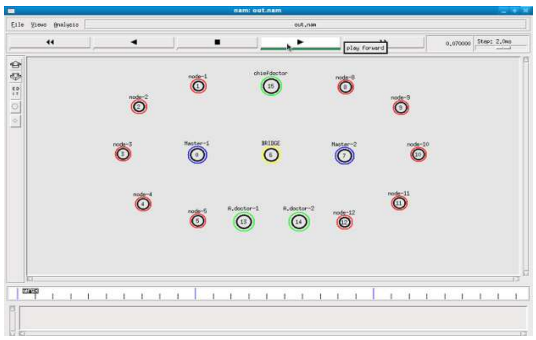

*Figure.3 Scatternet network using NS2*

- Red Node – Patients (Slave P1 & P2 )
- Blue Node – Local Nurse (Master of P1 & P2 )
- Yellow Node –Chief nurse(Bridge, Master P3, SlaveP1 & P2)
- Green Color – Doctors (Slave P3)

The condition of the patients is calculated and the message is passed to the higher authorities depending upon the condition of the patient. The direction of data flow depends on three cases as mentioned above.

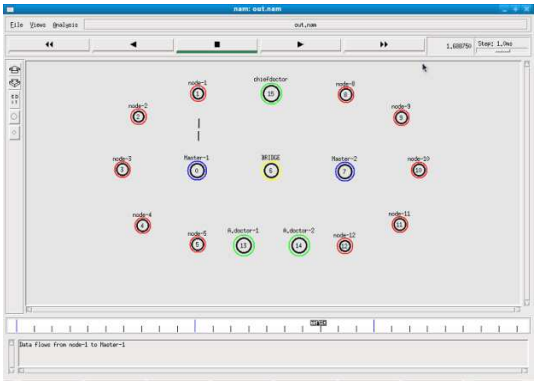

*Figure.4 Data flows from node-1 to master1*

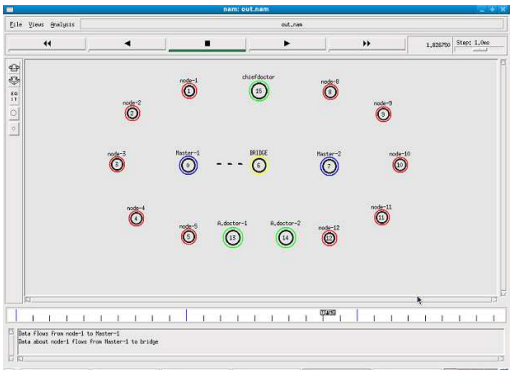

*Figure.5 Data flows from master1 to bridge*

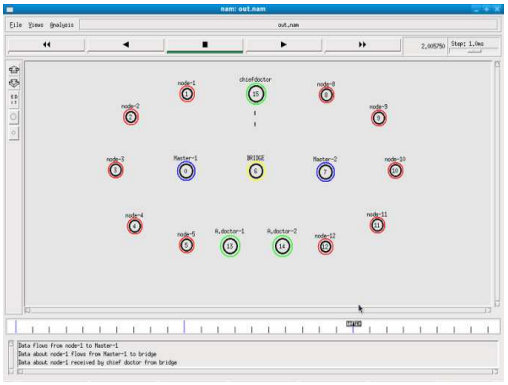

*Figure.6 Data flows from bridge to doctor*

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

## 6. CONCLUSION

A Bluetooth-based wireless sensor network has been developed for continuously monitoring the physiological signals of a patient. This new technology has potential for offering a wide range of benefits to patients, medical personnel, and society through continuous monitoring feature, early detection of abnormalities with high reliability and security, and potential knowledge discovery through data mining of all collected medical data. In the previous paper, patient monitoring system using piconet was discussed and implemented where the major drawback was the usage of less number of nodes and the limited communication range.

In our proposed model, we proposed a model to improve the coverage range of the network. To overcome these shortcomings, the scatternet sensor network is formed. This network is cost effective and it not only increases the coverage range but also increase the number of nodes in the network. First, medical personnel can get the patients' physiological information in time, and then, give real-time diagnostic advices that are important to patients' recovery. Furthermore, with the help of this system, medical personnel can take care of a few patients simultaneously, and thus, the personnel expenses can be reduced. As a result of this system, patients can be benefited by high-quality medical care, thus avoiding the distress and disruption caused by a lengthy impatient stay in hospital.

## REFRENCES:

[1] M. V. M. Figueredo, J. S. Dias, "Mobile Telemedicine System for Home Care and Patient Monitoring", Proceedings of the 26th Annual International Conference of the IEEE EMBS .

[2] An Initiative of The SCAN Foundation and Public Health Institute "Center for Technology and Aging, Technologies for Remote Patient Monitoring in Older Adults Digital", Position Paper Discussion Draft December, www.techandaging.org .

[3] Dr. Muddassar Farooq Associate Professor ( Project Director), "Remote Patient Monitoring System With Focus on Antenatal Care for Rural Population" , Next Generation Intelligent Networks Research Center, National University of Computer and Emerging Sciences.

[4] Jamil Y. Khan, Mehmet R. Yuce, and Farbood Karami, "Performance Evaluation of a Wireless Body Area Sensor Network for Remote Patient Monitoring ".

[5] Ahmed N. Abdalla, Muhammad Nubli, Tan Chien Siong, Fauzan Khairi and A. Noraziah "Enhancement of real-time multi-patient monitoring system based on wireless sensor networks", International Journal of Physical Sciences Vol. 6(4), pp. 664-670, 18 February, 2011 Available online at http://www.academicjournals.org/IJPS ISSN 1992 - 1950 ©2011 Academic Journals.

[6] Hung-Chieh Yu , Shu-Ming Tseng " A Wireless Based Sensor for Patient Monitoring System with Remote Diagnostic".

[7] Myung-kyung Suh & Chien-An Chen & Jonathan Woodbridge & Michael Kai Tu & Jung In Kim & Ani Nahapetian & Lorraine S. Evangelista & Majid Sarrafzadeh, "A Remote Patient Monitoring System for Congestive Heart Failure", Received: 17 January 2011 / Accepted: 3 May 2011 # Springer Science+Business Media, LLC 2011.

[8] http://www.deeparticles.com/Article/The-Importance-of-Patient-Monitoring-Accessories-in-the-Healthcare-Industry/50788.

[9] Ying Zhang and Hannan Xiao " Bluetooth-Based Sensor Networks for Remotely Monitoring the Physiological Signals of a Patient " IEEE transactions on information technology in biomedicine, vol. 13, no. 6, November 2009.