

# MONITORING CARDIO RESPIRATORY AND GESTURE RECOGNITION SYSTEM USING SENSOR PILLOW SYSTEM

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**Abstract** - In this paper, I have developed a system to diagnose sleep disorders for paralysed people by monitoring cardio respiratory and Gesture Recognition during sleep condition based on Polysomnography, then intimate doctor through Zigbee or GSM. Polysomnography will record the brain waves, oxygen level in the blood, heart rate in the human. Gesture movements can be measured using Sensor Pillow which contains an arrangement of FSR sensors. When the force applied on the active surface of FSR sensor, which producing an analog signal. The entire arrangement of FSR sensor, Respiratory sensor, Zigbee or GSM with Visual Basic (VB) software in our system is useful for monitoring the disorder of sleep, Heart rate, Blood Pressure. For small distances, we use Zigbee otherwise using GSM.

**Key Words:** Polysomnography, FSR, Cardio-respiratory and Gesture recognition

## 1. INTRODUCTION

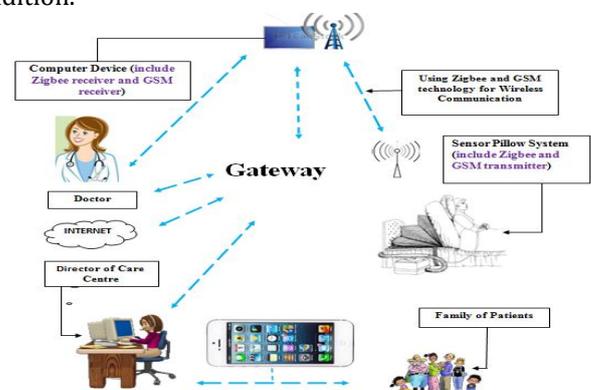
Sleep is one of the important part of our life and we spend one third of lives in bed. Various diseases can occur due to improper sleep. The respiration rate and heart beat can indicate the sleep disorder [5]. So it is very important to monitor the sleep quality. The quality of sleep can be measured by using our sensor pillow system. Furthermore, at the time of a gesture, the heart, lungs, blood vessels and blood stream are operating together as the vital source of the force delegated together on the head and body is called cardio-respiratory system [1].

Sensor Pillow is also used for monitoring the physiological parameters during sleep. Physiological parameters indicate whether the patient is in good or in bad health condition. These collected data's can give to the doctor to analysing the condition of a patient's health. The proper arrangement of head, neck and shoulder in a pillow is a necessity for restful sleep [2]. The movements of their

body in sensor pillow can be recorded to issue the obligatory movement reinforcement [3]. Many monitoring devices are applied nowadays. But the main drawback of previous monitoring devices is using many electrodes which can be attached to the patient's body to monitor the patient's health condition [4].

But in the sensor pillow system surrogate of Ballistocardiographic (BCG) system, FSR sensor, Respiratory sensor and heart beat sensor are used to monitor gesture and physiological parameters from the patient. The sensor pillow system can be used for Real time monitoring [5]. The fundamental necessity of sleep monitoring stages is an algorithm which can differentiate the sleep stages and wakefulness. The gestured output could grant useful information for doctors to provide appropriate medicine to patients [6].

In Proposed system, we design a sensor pillow system which contains an array of FSR sensor, Wireless sensor network and Visual Basic (VB) for monitoring the conditions of the patient. Wireless Network uses both Zigbee and GSM to transfer the data from patient to relative's or doctors. If both the patient and doctor are in hospital, Zigbee is enough to show the patient's health condition.



**Fig-1: Architecture**

Suppose the patient is in large distance, that time GSM is used to intimate the patient's health condition to doctors via wireless. Zigbee is a wireless technology which depends on IEEE 802.15.4 standard and it can be operated at ultra low power consumption. By using Zigbee we can connect a large number of pillows simultaneously

## 2. GESTURAL SYSTEM

The fig-1 shows the architecture of sensor pillow system.

This system contains three primary devices such as

1. FSR sensor for input
2. Wireless network depends on Zigbee or GSM to intimate the patient's health condition to the doctor.
3. Visual Basic (VB) software for analysing or monitoring the physiological parameters and Cardio respiratory.

### 2.1 FSR Sensor

The Fig-2 shows the array of FSR sensors integrated on the pillow for monitoring the gesture movements.



Fig-2: Array of FSR sensor on pillow.

FSR (Force Sensitive Resistor) is a sensor which produces the analog signal whenever the force applied on the active surface. FSR produces a differential analog signal which varying with amplitudes that depends on the patient gesture movements in bed and pillow. When a person does not lay a body part in a bed and change his/her gesture movements the amplitude of an analog signal produced by FSR sensor should also be varied. When a person does not lay a body in proper arrangement in bed/pillow, the amplitude of analog signal produced by FSR is reduced to zero value.

### 2.2 Wireless Network Devices

We use Zigbee for wireless communication which is used to transfer data from patient to doctor through wireless. It covers a range up to 400 feet (40 to 120 meters). They are many wireless devices used for health monitoring. But Zigbee is used in our system because it has the ability to reroute and adopt the network architecture, if the patient changes the place for doing other activities. Also Zigbee is

low cost and ultra low power consumption. So Zigbee is used in our system.

Zigbee depends on standard IEEE 802.15.4 and it contains two layers Physical layer and MAC (Medium Access control) layer for PAN (Personal Area Network). They are three frequencies in Zigbee physical layer 1. 2.4GHZ ISM Band (World Wide) 2. 915MHZ ISM Band (America) 3.868MHZ Band (Europe). In our system, using a Zigbee modem from Maxstream, which support up to 16 Personal Area Network ID (PAN ID) and using the frequency of 2.4GHZ.

Features of Maxstream Zigbee contain 1. It contains two sleep functions. They are on sleep and cyclic sleep 2. It can be operated on both AT Command and API Command 3. The power consumed by Zigbee is 2mW when it is in running mode and less than 1microwatt when it is in the sleep mode.

Zigbee can be modeled as three Networks such as Star Network, Tree Network and Mesh Network. In our system Zigbee could be designed as a Mesh network because of the following reasons. 1. Mesh network support dynamic network relocation. 2. Mesh network provides communication using pliable patterns. 3. It provides reliability.

#### 2.2.1 Transmitter Section

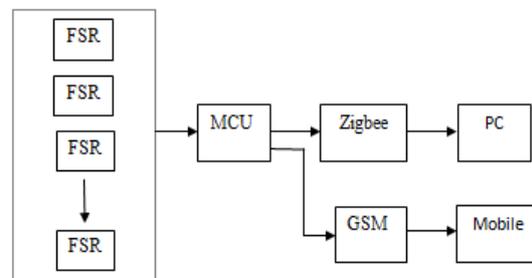


Fig-3: Block Diagram of Transmitter Section

The Fig-3 shows the block diagram of transmitter section. It contains an array of FSR sensor connected to the MCU (Microcontroller Unit), Power supply circuit, Respiratory sensor, Zigbee module and GSM module.

MCU provides a feature of nanowatt technologies for processing the signal from sensor which is needed for monitoring. The MCU contain inbuilt ADC for converting the analog to digital signal because the PC does not accept the analog signal. Now ADC is producing the digital data in parallel form, but PC accepting only the serial signal.

Therefore digital signal can be converted into serial form by using UART. After that serial data can be transferred to the receiver section by using Zigbee module. The power of sensor node could be managed by the MCU. Depending on the power consumption each sensor sends the data based on battery voltage indicator. For example, suppose the battery voltage indicator indicates more than 80% the sensor node send the data every 5 seconds. If the battery indicates 30% or less than 30% sensor node sends the data every 10 seconds. So every node reads the data from sensor and store it in internal memory and afterwards it send the data to the base node based on the condition of power.

Zigbee can be used only for small distances. So GSM is used whenever the patient is in large distance. GSM is a wireless modem that works with a GSM wireless network. For data applications Matrix Sim300 TTL is a Fixed Cellular Terminal (FCT) is used. It is a flexible and convenient terminal which satisfies various data communication demand over GSM. By using RS232C standard serial port 'GSM is connected to a personal computer. SimadoGDT11 proffers features like Short Message Services (SMS), Data Services, Fax services and Web Browsing. GSM also supported Remote login and data file transfer.

Computer need AT Commands to control modems. The standard AT Commands are also specified in the GSM standards. The Extended AT Commands in GSM various things can be done. They are reading, writing and deleting SMS messages, transmitting SMS messages. checking the signal strength, monitoring the charge status and charge level of the battery and reading, writing and searching phone book entries.

### 2.2.2 Receiver Section

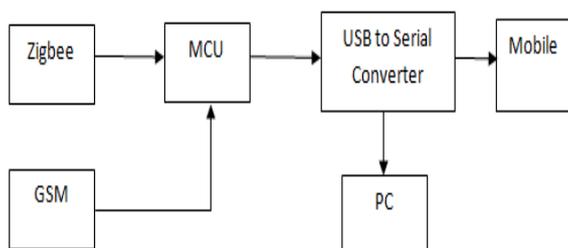


Fig-4: Block diagram of receiver

Fig-4 shows the block diagram of the receiver section. In that, MCU receives the data from Zigbee or GSM and processing it by using ADC and UART. Suppose many nodes are connected in a network, the data received by every node and stored it in an internal memory of MCU and afterwards transfer the data to a personal computer through UART using USB to Serial converter for every 200milliseconds. Suppose new node wants to add in a wireless network, it sends a request to the router and wait for a response.

### 2.2.3 Software

In this paper, we designed asleep, gesture recognition software using VB programming language. This software demonstrates the various physiological parameters during sleep, which has many sensors. Each and every sensor denotes the position of the patient. By using the sensor output, the doctor can easily analyze the health condition without direct communication of patient

## 3. RESULT AND DISCUSSION

The mass of the head and pressure generate the FSR sensors attached in the pillow. This system is not only suited for invigilating the gesture activity and also determining the physiological parameters of the heart, respiration rate and tremor motion for both young and elder peoples. They are two steps for recording the sleep, gesture realization. The first step is to detect the different gesture movements from an array of FSR sensors which are equipped with a pillow. The second step is to investigate the cardio respiratory signal contingent on the gesture signal from the first step. Fig.5 shows the different sleep posture of the patient. The different sleep postures are supine, left lateral and right lateral. The sensor analyze the patient through the postures when they are sleeping, the result should be displayed in visual basic software.

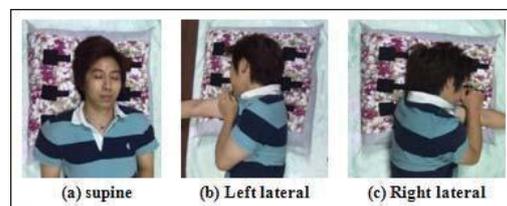


Fig-5: Sleep Postures

Fig-5 shows the different sleep posture of the patient. The different sleep postures are supine, left lateral and right lateral. The sensor analyze the patient through the postures when they are sleeping, the result should be displayed in visual basic software

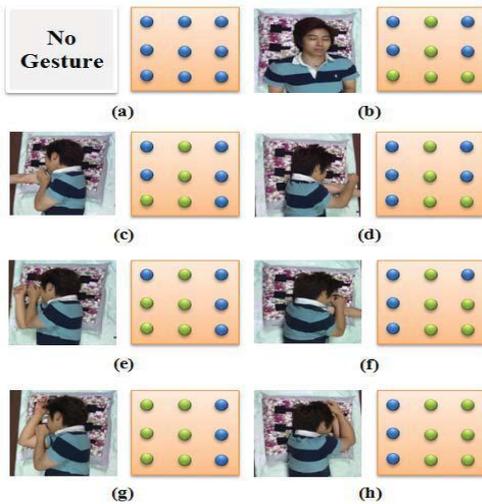


Fig-5: Different sleep posture

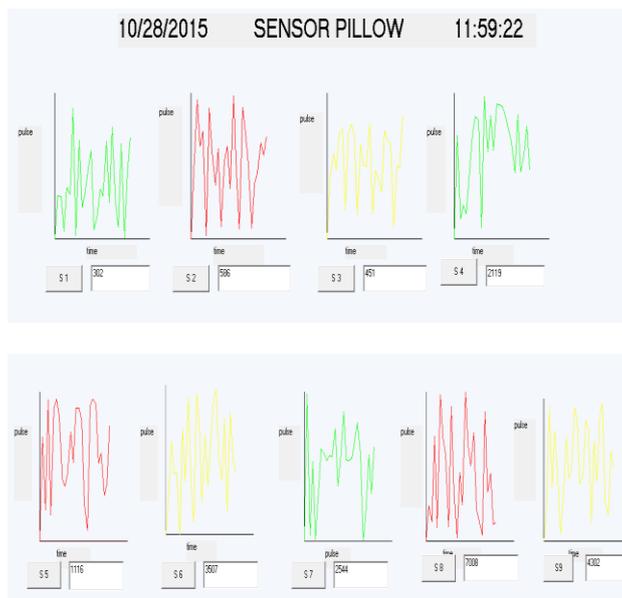


Fig-6: Screenshot of the analysis software for sleep gesture recognition

The Fig-6 shows the different sleep posture and the Fig-7 displays the screenshot of the different gesture positions. When comparing both figures during supine posture S9, S8, S5, S7 and S2 sensors are activated. During left lateral S8, S7, S5, S2 sensors are activated and patient in right lateral S9, S8, S5, S2 sensors are activated. The pillow detects the patient movements by using FSR sensor based on the proper arrangement of the patient's head, neck and shoulder in the pillow. According to the position of the patient is varied, the signal's generated from the sensors are also varied.

#### 4. CONCLUSION AND FUTUREWORK

We have designed a sleep monitoring and gesture realization for patients depends on Polysomnography. Polysomnography is communicating with patient and doctors or concierge of the patient. This work shows that FSR is very useful for sensing the gesture movements and cardio respiratory. Several patients can be monitored at the same time by using the sensor pillow system. Apart from this technology, this system is applicable to every person who is eager to pick up the health condition. In future, the entire software work should be explored in hardware components and also used in Real Time Monitoring applications.

#### 5. ACKNOWLEDGMENT

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#### 6. REFERENCES

- [1] M.Folke, L.Cerberud, M.Ekstrom, and B.Holk, "Critical review of non-invasive respiratory monitoring in medical care", Med Bio Engin comp, vol.41, pp, 337-383, 2003.
- [2] R.Wolk, A.S. Gami, A.Garcia-Touchard and V.K. Somers, "Sleep and cardiovascular disease," Curr. Probl.Cardiol, vol.30 pp. 625-662, 2005.
- [3] K.H. Park, Z.Bien, J.J.Lee, B.K. Kim. J.T. Tim, J.O. Kim, H. Lee, D.H. Stefanov, D.J.kim and J.W. Jung, et al., "Robot Smart house to assist people with movement disabilitie," Auton Robot. Vol. 22, pp. 183-198, 2007.
- [4] J. Alihanka, K. Vaabmranta. And I. Saarikivi, "A New Long-term Monitoring of Ballistocardiogram, Heart Beat, and Respiration," AM.J.Physiol., vol. 240, pp. 384-392, 1981.
- [5] X. Zhu, W. Chen, T. Nemoto, Y. Kanemitsu, K. Kitamura, K.Yamakoshi, and D. Wei, "Real-time monitoring of respiration rhythm and pulse rate during sleep," IEEE Trans Biomed Eng, vol. 53 pp. 2553-2563, 2006.
- [6] T. Watanabe and K. Watanabe, "Noncontact Method for Sleep Stage Estimation," IEEE Transactions on Biomedical Engineering, vol. 51, no 10, Oct., 2004.
- [7] J. Alametsä, E. Rauhala, E. Huupponen, A. Saastamoinen, A. Värrri, A.Joutsen, J. Hasan, and S. Himanen, "Automatic detection of spiking events in EMFi sheet during sleep," Medical Engineering & Physics, vol. 28, pp. 267-275, 2006.

## BIOGRAPHIES



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