Secured Wearable Bio-Sensor System Using ZigBee for Monitoring Sick Patients

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Abstract – The Proposed paper is the design of wearable bio sensor system using zigbee. This system tries to build that analysis of health parameters like heart rate, respiration rate and temperature. As these parameters are basic for any measurements and common for all type of treatments. By analyzing these parameters, the doctor may come to a decision. This wireless system is rapidly developing one. So, this system never affect the patients to stay in hospital to look over the health condition. This system is not only a patient monitoring system also normal human being also may use this. By regularly look over the health parameters, and according to the condition they may change their food habits and exercises. This avoid future problems like any kind of diseases. This system also immense to old people to monitor them. Now a day's sports person also using these systems to monitor them, according to the result, they change their diet and exercise. In future, this kind of system is going to exist in all home and there is no need to spend a long time in the clinic.

Index terms – Patient Monitoring.

1. INTRODUCTION

This system deals with monitoring unit and data acquisition unit. The sensors which fix on the garment of the patient picks the signal from the patient's body. The Heart Beat sensor provides a simple way to study the heart's function. The function of temperature sensor is to measure the body temperature of patient. Respiration sensor is sensitive to stretch. When strapped around a chest or abdomen, it will convert the expansion and contraction of the rib cage or abdominal area, to a rise and fall of the signal. The signal conditioning unit accepts input signals from the analog sensors and gives a conditioned output of 0-5V DC corresponding to the entire range of each parameter. And it makes this signal to suitable for microcontroller. Signal from temperature sensor is analog signal so it is given to the microcontroller through Analog to digital converter. Microcontroller receives all signals from sensors and analyses the values. Using the display the medical instructions and other necessary information are displayed to the patients. Then this signal is given to the ZigBee transceiver and transmitted. The signals are received through ZigBee transceiver in the doctor's cabin and the values are analysed by the microcontroller. Through RS-232 interface, controller is interfaced with computer. Finally doctor analyse the values of each sensors, by the signals received doctor instructs the patients and give prescriptions' too.

The monitoring unit comprises of Biosensors (Heartbeat sensor, Temperature sensor and Respiration sensor), Microcontroller, ADC, SCU, ZigBee Transceiver-Transmitter side, Display. The Data acquisition unit is on doctor's cabin which comprises of ZigBee Transceiver-Receiver side, Microcontroller, RS-232 Interface and Computer.

2. SYSTEM ANALYSIS

2.1 Existing System:

The patient remains to be in hospital till their health status is analyzed. You are in control of your health. While it might seem easier to simply wait for your next doctor's appointment to find out whether you are healthy, you can often go for years without seeing a doctor. In any case, you can be the one to check up on your health when you use a health monitoring system. Also if any patient go to hospital the health status of them is analyzed at that time only, continuous monitoring is not possible.

Demerits of the existing system:

1. Should wait for Doctor's appointment.
2. Patient should be admit in bed, routine work is affected.
3. For aged people, it is not so convenient one.

2.2 Proposed System

Unobtrusive, wearable sensors will allow vast amounts of data to be collected and mined for next-generation clinical trials .Data will be collected and reported automatically, reducing the cost and inconvenience of regular visits to the

physician. Smart wearable devices are used for this purpose. "Wearable Bio-sensor system using ZigBee" is the system used here for monitoring the health status of the patients. The sensors are fixed in the patients dress from there, the various health parameters are analyzed.Real-time data acquisition and analysis: The rate of collection of data is higher in this type of network than in many environmental studies. Efficient communication and processing will be essential . Event ordering, time-stamping, synchronization, and quick response in emergency situations will all be required.Reliability and robustness: Sensors and other devices must operate with enough reliability to yield high-confidence data suitable for medical diagnosis and treatment. Since the network will not be maintained in a controlled environment, devices must be robust

Advantages of wearable sensors:

1. No need to admit in hospital, patient can check the health status from where they are.
2. Apart from patients, this system is also used for sports players for check their stamina.
3. Very comfort for patients as the sensors are fixed in their dress itself.
4. Right Treatment at the right time at the right cost.
5. Easy to wear and takeoff.
6. Reducing the health care cost.
7. Integration with existing medical practices and technology.
8. Real-time, long-term, remote monitoring.
9. Miniature, wearable sensors, and assistance to the elderly and chronic patients.

3. DESCRIPTION

This paper consists of heart beat sensor, respiration sensor, temperature sensor, signal-conditioning unit, ADC, microcontroller, transmitter, receiver and computer. The different type of sensors which are fixed in the cloth has its functions. Different parameters like heart beat, respiration rate, temperature are taken into account.

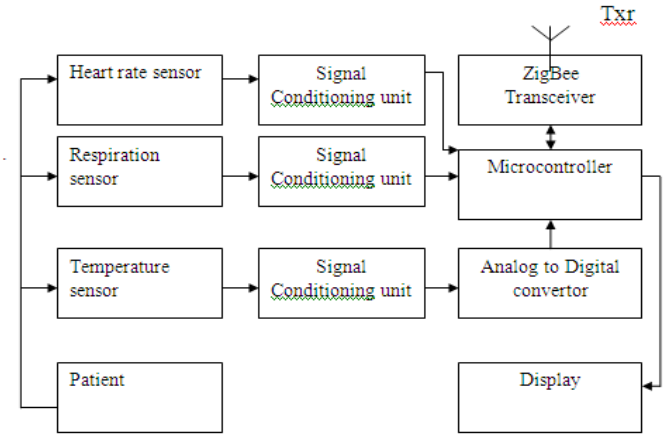

Fig 1 Monitoring Unit

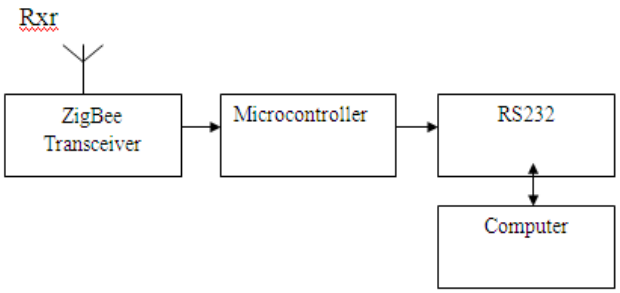

Fig 2 Data acquisition Unit

3.1 Respiration Sensor:

The respiration sensor is sensitive to stretch. When strapped around a chest or abdomen, it will convert the expansion and contraction of the rib cage or abdominal area, to a rise and fall of the signal. The respiration signal is a relative measure of chest or abdominal expansion[8]. If two respiration sensors are used, it is possible to compute the difference in amplitude from expansion between the thorax and abdomen. The sensor consists mainly of a long strap that is stretched around the client's chest or abdomen. The sensor should be placed during a full expiration and quickly fastened with just a small amount of tension at the time. The sensor should not be loose when breathing out completely. The sensor can be placed on top of clothing, if not too bulky.

The signals are then given to SCU and then to microcontroller for further processing. And through ZigBee module it is transmitted to receiver section (Doctor's cabin).

3.2 Temperature Sensors:

The temperature sensor is called thermistor. Body temperature rate is measured here [8]. This device converts changes in temperature to changes in an electrical current. Temperature changes as a function of the amount of blood per fusing the tissue. The temperature sensor can be attached to the dorsal or pal mar side of any finger or toe. If the thermistor is to be used on various parts of the body or among various people.

Finally the signal is given to SCU and given to ADC as the signals are analog signals and converted here. ADC0809 is used here.Then the signal is processed by microcontroller then transmitted to the doctor's system present in receiver section.

3.3 Heart Beat Sensor:

Photoelectric sensors are used as heartbeat sensors. The heart beat sensors are used for the following [8],

1. Measurements of the heart rate of different individuals.
2. Measurements of the heart rate before and after exercises.
3. Measurements of the recovery rate: how fast a person's heart returns to normal after exercises.

The Heart Beat Sensor provides a simple way to study the heart's function. This sensor monitors the flow of blood through ear lobe. As the heart forces blood through the blood vessels in the ear lobe, the amount of blood in the ear changes with time. The clip can also be used on a fingertip or on the web of skin between the thumb and finger. The signal is amplified, inverted and filtered, in the box. By graphing this signal, the heart rate can be determined. Then the signal is given to SCU and processed in microcontroller and transmitted.

3.4 Signal Conditioning Unit:

The signal conditioning unit accepts input signals from the analog sensors and gives a conditioned output of 0-5V DC corresponding to the entire range of each parameter.

3.5 Microcontroller:

The microcontroller 89S52 is manufactured by Atmel. This is 8051 based Full Static CMOS controller with Three-Level Program Memory Lock, 32 I/O lines, 3 Timers/Counters, 8-Interrupts Sources, DPTRs, 8K Flash Memory, 256 Bytes On-chip RAM.

Here 8-bit microcontroller is used for low cost and easy implementation. Microcontroller which is featured with buffer circuit, driven circuit and relays. RS232 is used to interface the microcontroller with pc.

3.6 Analog To Digital Converter (ADC)

ADC 0809 analog to digital converter is a successive approximation type analog to digital converter. The successive approximation technique uses a very efficient code search strategy to complete n-bit conversion in just n-clock periods. The circuit uses a successive approximation register to find the required value by trial and error.

The ADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register.

3.7 Serial Interface-RS232:

Serial data is any data that is sent one bit at a time using a single electrical signal. In contrast, parallel data is sent 8, 16, 32, or even 64 bits at a time using a signal line for each bit. Data that is sent without the use of a master clock is said to be asynchronous serial data. Several communications standards exist for the transfer of asynchronous serial data.

Common PC's transfer data using the EIA RS-232C (also known as V.28 or V.24). Updated versions of this standard include RS-232D and EIA/TIA-232E, but most literature still refers to the RS-232C or RS-232 standard. Through this interface, microcontroller is interfaced with computer and the parameter values as heartbeat rate, respiration level, temperature range are displayed through computer.

3.8 Zigbee Transceiver:

The ZigBee 2.4GHz transceiver is used here. ZigBee offers unique advantages for wireless applications includes low power consumption and it can be extended through adding Zigbee modules. As it is a transceiver, so this device is fixed on transmitter as well as in receiver side, i.e. in Monitoring unit and Data acquisition unit.

The transmitter unit in monitoring side transmits the collected signal and the receiver in acquisition unit collects and processes.

3.9 Hardware Implementation:

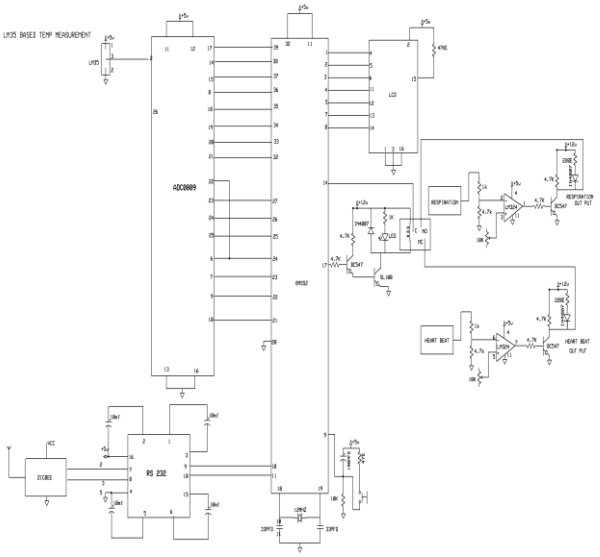

Fig 3. Circuit diagram of – Acquisition unit

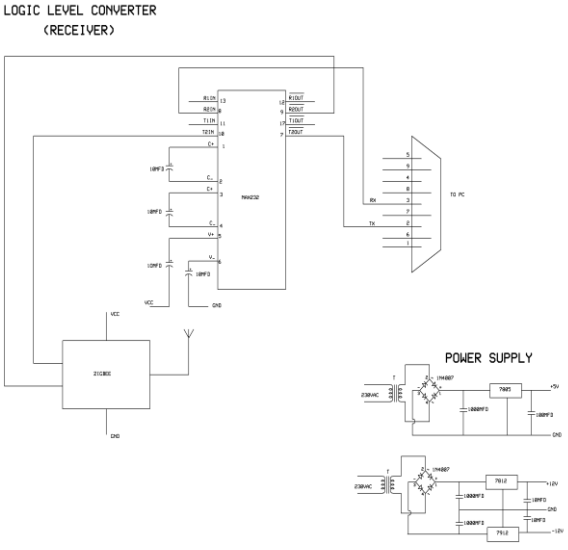

Fig 4. Circuit diagram of – Monitoring unit

3.10 Heart Beat Sensor:

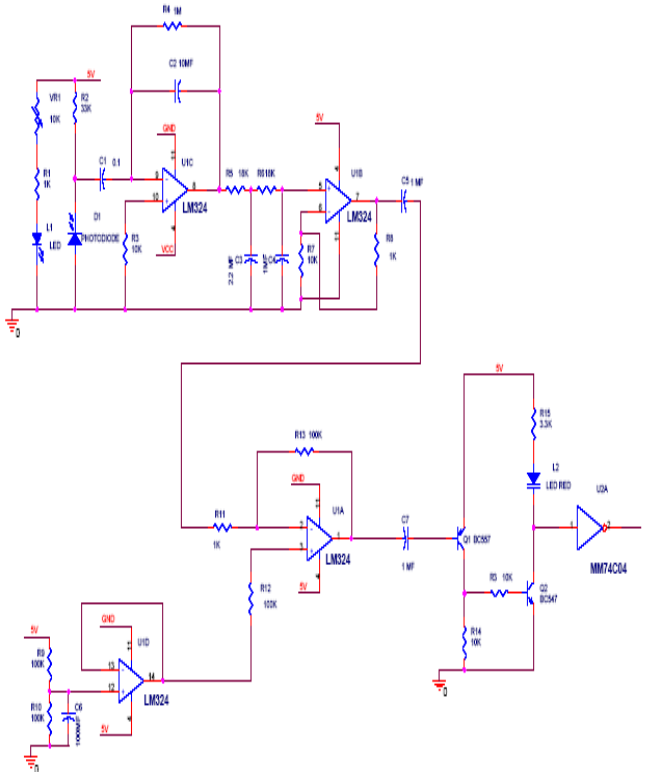

Fig 5. Circuit Diagram for Heart Beat Sensor

3.11 Circuit Working Description:

This circuit is designed to measure the heart rate. IR transmitter and receiver measure the heart rate. Infrared transmitter is one type of LED, which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other. The IR transmitter and receiver are placed in the pulse rate sensor. When you want measure the pulse rate, the pulse rate sensor has to be clipped in the finger. The IR receiver is connected to the Vcc through the resistor which acts as potential divider. The potential divider output is connected to amplifier section.

When supply is ON the IR transmitter passes the rays to the receiver. Depending on the blood flow, the IR rays are interrupted. Due to that IR receiver conduction is interrupted so variable pulse signals are generated in the potential divider point which is given to A1 amplifier through the capacitor C1. The coupling capacitor C1 is used to block the DC component because the capacitor reactance is depends on the frequency. For DC component the frequency is zero so the reactance is infinity now capacitor acts as open circuit for DC component.

The LM 324 quad operational amplifier constructs the amplifier section. It consists of four independent, high gains and internally frequency compensated operational amplifiers named as A1, A2, A3 and A4 amplifiers. The A1 amplifier amplifies the varying pulse from the potential divider. In this amplifier the capacitor C2 is connected in parallel with feedback resistor to filter the any DC component in the amplified signal. If any spikes in the amplified signals, they are further filtered by the C3 and C4 capacitors. After filtration the A2 amplifier again amplifies the signal. Then amplified signal is given to inverting input terminal of comparator.

The comparator is constructed by the A4 amplifier in which the reference voltage is given to non inverting input terminal. The A3 amplifier generates the reference voltage. Then the comparator compares the two signals and delivered the +12v to -12v square wave pulse at its output. Then the square wave signal is given to base of the BC 557 and BC547 switching transistors in order to convert the TTL voltage 0 to 5v level. Finally the TTL output is given to MM 74C04 inverter to invert the square pulse. Then the final square wave signal is given to microcontroller or other interfacing circuit in order to monitor the heart rate.

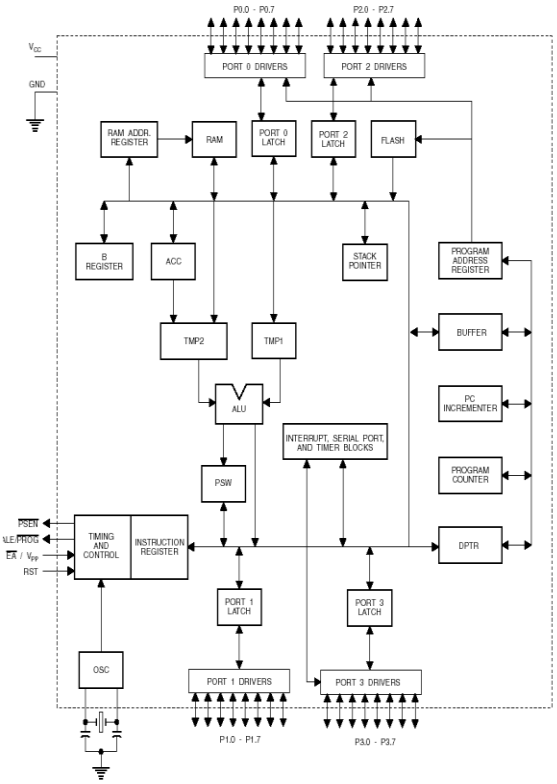

Fig 6. Block diagram of AT89S51

4. ZIGBEE TRANSCEIVER

ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power, wireless sensor networks. The standard takes full advantage of the IEEE 802.15.4[2][9] physical radio specification and

operates in unlicensed bands worldwide at the following frequencies: 2.400–2.484 GHz, 902-928 MHz and 868.0–868.6 MHz.

The specification is a packet-based radio protocol that meets the needs of low-cost, battery-operated devices. The protocol allows devices to intercommunicate and be powered by batteries that last years instead of hours.

ZigBee protocol features:

1. Low duty cycle - Provides long battery life
2. Low latency
3. Support for multiple network topologies: Static, dynamic, star and mesh
4. Direct Sequence Spread Spectrum (DSSS)
5. Up to 65,000 nodes on a network
6. 128-bit AES encryption – Provides secure connections between devices
7. Collision avoidance
8. Link quality indication
9. Clear channel assessment
10. Retries and acknowledgements

5. SECURE CONNECTIONS

The ZigBee specification provides a security toolbox approach to ensuring reliable and secure networks. Access control lists, packet freshness timers and 128-bit encryption based on the NIST Certified Advanced Encryption Standard (AES) help protect transmitted data.

As one of its defining features, ZigBee provides facilities for carrying out secure communications, protecting establishment and transport of cryptographic keys, cyphering frames and controlling devices. It builds on the basic security framework defined in IEEE 802.15.4. This part of the architecture relies on the correct management of symmetric keys and the correct implementation of methods and security policies.

Basic Security Model:

The basic mechanism to ensure confidentiality is the adequate protection of all keying material. Trust must be assumed in the initial installation of the keys, as well as in the processing of security information. In order for an implementation to globally work, its general correctness (e.g., conformance to specified behaviors) is assumed. Keys are the cornerstone of the security architecture; as such their protection is of paramount importance, and keys are never supposed to be transported through an insecure channel. There is a momentary exception to this rule, which occurs during the initial phase of the addition to the network of a previously unconfigured device.

6. SOFTWARE MODELING

6.1. Front Panel :

In the front panel the controllers or indicator levels are there. In the real time according to the signals sensed by the sensors the values of the indicators get changed. As of it is real time the value get changed rapidly. According to the signals detected the numerical value of the respective parameters are displayed.

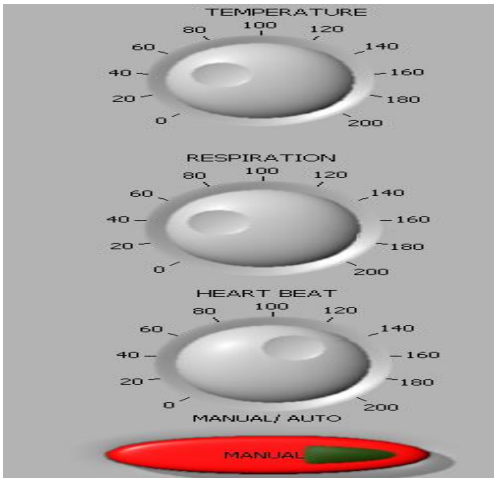

Fig 7. Front panel - LabView

6.2 Back Panel:

In the back end the indicator connections are there. According to the connection with the VI structures, it functions. As for the real time condition the value given to the VI structures get varied.

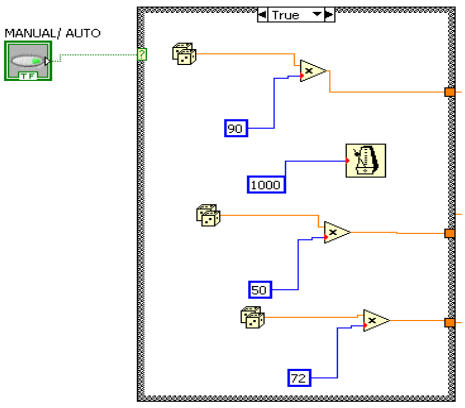

Fig 8. Back panel -LabView

The user selection in manual condition is varied according to the real time situation. The body temperature, breathing rate and heart rate may vary for individuals. According to that the conditions or code are given in back panel. As for the given connections, in the front panel we get the display.

7. RESULT ANALYSIS

Health Parameters	Normal Value	Unit
Heart Rate	60-72	Bpm (Beat per minute)
Respiration Rate	12-24	Bpm(Breath Per minute)
Body Temperature	37	Deg°C

Table 1. Parametric Values

Health Parameters	Obtained Value	Unit
Heart Rate	110	Bpm (Beat per minute)
Respiration Rate	40 (11 Sec – Breath holding time)	Bpm(Breath Per minute)
Body Temperature	41	Deg°C

Table 2. Parametric Values for Abnormal Person

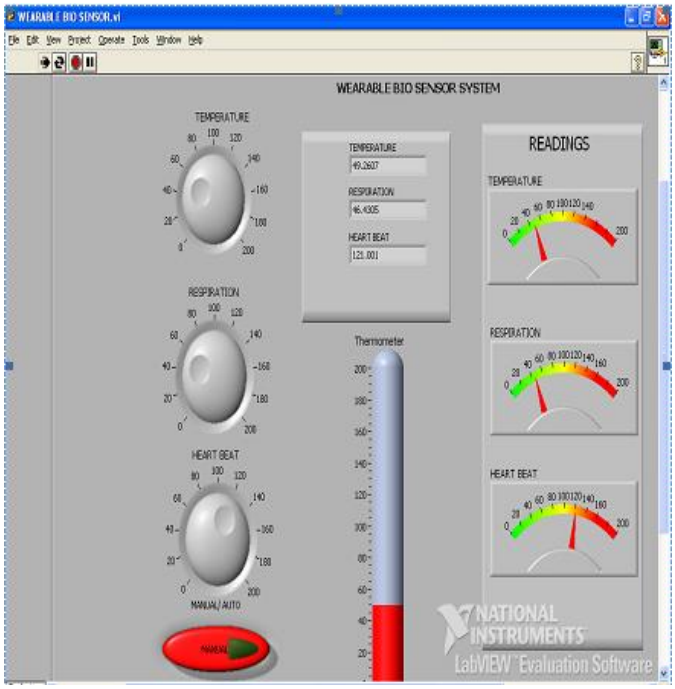

Fig 7. Results for Analysis of Parametric Values

8. CONCLUSION

This system never affect the patients to stay in hospital to look over the health condition. This system is not only a patient monitoring system also normal human being also may use this. By regularly look over the health parameters, and according to the condition they may change their food habits and exercises. This avoid future problems like any kind of diseases. This system also immense to old people to monitor them

REFERENCES

[1] P.Sukumar And R.K.Gnanamurthy ,"Segmentation And Abnormality Detection Of Cervical Cancer Cells Using Fast Elm With Particle Swarm Optimization" , The Serbian Genetic Society publishes Journal, Genetika, Vol. 47, No.3, 863-876, 2015.

[2] P.Sukumar And R.K.Gnanamurthy ,"Computer Aided Detection of Cervical Cancer Using Pap Smear Images Based on Adaptive Neuro Fuzzy Inference System Classifier", Journal of Medical Imaging and Health Informatics, American Scientific Publishers, Vol. 6, 1–8, 2016

[3] P.Sukumar And R.K.Gnanamurthy ,"Computer Aided Detection of Cervical Cancer Using Pap Smear Images Based on Hybrid Classifier", International Journal of Applied Engineering Research ,Research India Publications,Volume 10, Number 8 (2015) pp. 21021-21032

[4] P.Sukumar And R.K.Gnanamurthy ,"Computer Aided Screening of Cervical Cancer Using Random Forest Classifier", Research Journal of Pharmaceutical, Biological and Chemical Sciences, Volume 7, Issue 1, January – February 2016, pp.1521 – 1529

[5] T.Maheswari And P.Sukumar, "Error Detection and Correction in SRAM Cell Using DecimalMatrix Code", IOSR Journal of VLSI and Signal Processing (IOSR-JVSP), Volume 5, Issue 1, Ver. II (Jan - Feb. 2015), PP 09-14

[6] K.Sabeha And P.Sukumar, "Highly Secured Indoor Outdoor Localization forE- Hostel Management", Journal of Network Communications and Emerging Technologies (JNCET), Volume 5, Issue 1, November (2015), pp 30-34

[7] S.Tamilselvi And P.Sukumar, "Power Reduction for Sequential Circuit using Merge Flip-Flop Technique", International Journal of Emerging Technology and Advanced Engineering(IJETAE), Volume 4, Issue 2, February 2014, pp 926 – 932.

[8] P.Uma Devi And P.Sukumar, "Low Energy Asynchronous CAM Based On Reordered Overlapped Search Mechanism", The International Journal Of Science & Technoledge, Volume 3, Issue 3, March 2015, pp 74 – 80

[9] C.Rubin And P.Sukumar, "Performance Analysis Of Artifact Reduction In Astro Images", International Journal of Innovative Research and Development, Volume 2, Issue 4, April 2013, pp 348 – 358

[10] V.Yammuna Rani And P.Sukumar, "A Novel approach for severity classification of Retinal lesions using ANN classifier", Unique Journal of Engineering and Advanced Sciences, Volume 2, Issue 2, June 2014 pp 79 – 84

[11] M.Kangavalli And P.Sukumar, "Asynchronous Transfer Mode Implementation Using Z-T CAM", International Journal of Engineering Research-Online, Volume 3, Issue 2, March 2015, pp 155 – 162

[12] S.Tamilselvi And P.Sukumar, "Clock Power Reduction using Multi-Bit Flip-Flop Technique", IRACST – Engineering Science and Technology: An International Journal, Volume 4, Issue 2, April 2014, pp 46 – 51

[13] C.Meganathan And P.Sukumar, "Retinal Lesion Detection By Using Points Of Interest And Visual Dictionaries", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Volume 2, Issue 2, February 2013, pp 175 – 181

[14] S.Prabhakher And P.Sukumar, "Performance Analysis of Rotation Invariant parts Based Object Detection in High-Resolution Images", International Journal of Engineering Science Invention, Volume 4 Issue 5,May 2015, pp.01-06

[15] K.Sabeha, And P.Sukumar, "Highly Secured System to Find the Improper Impression of Fingerprints in Hostel", IJSRD - International Journal for Scientific Research & Development, Volume 3, Issue 11, 2016, pp.545-549

[16] Ravi. S, Kumarakrishnan.V,Rohini, R, And Sukumar.P, "MATLAB/SIMULINK Based Intelligent Power Quality Conditioner Using Fuzzy Logic Controller", Middle-East Journal of Scientific Research(MEJSR), 24 (Special Issue on Innovations in Information, Embedded and Communication Systems), 2016,pp.26-31

[17] S. Ravi, Vitaliy Mezhuyev , K. Iyswarya Annapoorani , P.Sukumar, "Design and Implementation of a Microcontroller Based Buck Boost Converter as a Smooth Starter for Permanent Magnet Motor", Indonesian Journal of Electrical Engineering and Computer Science, Volume 1, Issue 03, March 2016,pp.566-574

[18] P.Sukumar And Dr.S.Ravi, "Weed Detection Using Image Processing By Clustering Analysis", International Journal of Emerging Technologies in Engineering Research(IJETER), Volume 4, Issue 5, May 2016,pp.14-18.
[19] P.Sukumar And Dr.S.Ravi, "IOT Based Efficient Vehicle Location Help Line System Using NFC", International Journal of Emerging Technologies in Engineering Research(IJETER), Volume 4, Issue 5, May 2016,pp.10-13.
[20] P.Sukumar And Dr.S.Ravi, "Cropping OF Weeds in the Farm Field by Image Acquisition and Processing Methods", International Journal of Emerging Technologies in Engineering Research(IJETER), Volume 4, Issue 5, May 2016,pp.5-9.
[21] P.Sukumar And Dr.S.Ravi, " Crime Recognition in Skin Images Using Vein Patterns", International Journal of Emerging Technologies in Engineering Research(IJETER), Volume 4, Issue 5, May 2016,pp.1-4.
[22] Juan A. Fraile, Javier Bajo, Juan M. Corchado, Ajith Abraham (2010), 'Applying Wearable solutions in Dependable Environment' IEEE Transactions on Information Technology in Biomedicine.
[23] Axel Sikora, Voicu F.Groza, (May 2005) 'Coexistence of IEEE802.15.4 with other Systems in the 2.4 GHz-ISM-Band' IMTC Technology Conference.
[24] Benny P.L., Surapa Thiemjarus, Rachel King (2004), 'Body Sensor Network-A wireless sensor platform for pervasive health care,' Department of Computing, Imperial College London.
[25] Benny P. L. and Guang-Zhongv (2006), 'Key Technical Changes and Current Implementations of Body Sensor Networks', Department of Computing, Imperial College London.
[26] Chao Chen, Carlos Pomalaza-Ráez,(2009), 'Monitoring Human movements in Home using Wearable Bio-sensor,' Indiana University - Purdue University, Fort Wayne, Indiana USA.
[27] Chris R. Baker, Kenneth Armijo (2007), 'Wireless Sensor Networks for Home health care', Advanced Information Networking and Applications Workshops (AINAW'07).
[28] Dittmar. A, Taccini. N (2003), 'Knitted Bioclothes for Health monitoring', Journal.
[29] Fabrice Axisa, Pierre Michael Schmitt, Claudine Gehin (September 2005), 'Flexible Technologies and Smart Clothing for Citizen Medicine, Home health care and Disease prevention', IEEE Transactions On Information Technology In Biomedicine, Vol. 9, No. 3.
[30] Jin-Shyan Lee, Yu-Wei Su, and Chung-Chou Shen(2007), 'A Comparitive Study of Wireless Protocols:Bluetooth, Wifi and ZigBee', Annual Conference of the IEEE Industrial Electronics Society (IECON).
[31] Mark A. Hanson, Harry C. Powell (Jan 2009), 'Body Area Sensor Networks: Challenges and Opportunities', IEEE Computer Society.
[32] Nabil Hamza, Farid Touati and Lazhar Khriji (Feb 2009), 'Wearable Biomedical System Design based on ZigBee Technology for Autonomous Healthcare', International Conference on Computer, Communication and Power.
[33] Nicholas F. Timmons, William G. Scanlon (Mar 2003) 'Analysis of the Performance of IEEE 808.15.4 for Medical Sensor Body Area Network'.
[34] Pandian.P. S, K. P. Safeer, Pragati Gupta. D. T, Shakunthala.B (May 2008), 'Wireless Sensor Network for wearable Physiological Monitoring', Journal Of Networks, Vol. 3, No. 5.
[35] Robert G. Lupu, Andrei Stan, Florina Ungureanu (Jul-2008), 'Wireless Device for Patient Monitoring', Proceedings of the World Congress on Engineering.
[36] Xiao-Fei Teng, Yuan-Ting (2008), "Wearable Medical Systems for P-Health," IEEE Reviews In Biomedical Engineering, Vol. 1.

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