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Development of Medical Diagnosis Device for Major Abnormalities for Arm Forces by Virtual Instrumentation and Vision System

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Abstract: *The research paper presents the development of the device and system for remote surveillance of health of Army people working in remote places. The developed System is based on Virtual Instrumentation and image processing which can monitor and detect health problems like (Heart problems, Central Nervous System abnormalities, Stress, Strain, Start/ Growth of cancer, tumour etc.) of remotely working person. The prototype system using wearable sensors, Virtual instrumentation and image processing for remote patient monitoring and virtual consultation which will be fully automatic.It detects/forecast the major abnormalities happening with the person staying in remote Places/working in border. So it will be quite useful for Arm people specially working in hilly/ dissert/ other remote areas.The device is a wireless health monitoring device which will be very useful for arm forces to diagnose physiology status (from initial stage).*

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I. Introduction

Virtual Instrumentation and internet of things (IoT) is transforming healthcare and the role of IT in healthcare. The applications of IoT are nowhere essential in transforming lives of people than in healthcare. IoT refers to physical devices, such as a weight scale, thermometer and patients' vital monitoring devices (glucose, blood pressure, heart rate & activity monitoring, etc), connect to the internet and transforms information from the physical world in to the digital world.

According to Gartner, there will be nearly 26 billion devices on the Internet of Things by 2020. These devices seamlessly gather and share information directly with each other and the cloud, making it possible to collect record and analyze data. This information provides insight in to the health and supplements actions to improve the health, without the hindrance of the daily routine. The sensors help to transform the physical world data (e.g: temperature, pressure, humidity, etc) including human health data (heart rate, oxygen saturation, blood pressure, blood glucose, etc) to the digital world and the actuators transforms the digital data to physical actions (e.g: Infusion pumps, dialysis system, etc).

The IoT devices have sensors for receiving signals from the environment for analysis, or actuators for controlling the environment based on the inputs, or both sensors and actuators. These devices connect with one station to another station in defense use through wireless

Alessandro Dionisi et al (1) developed wearable sensor to monitor the health. Life shirt was developed with Lycra fabric and that was able to measure ECG, frequency of leg movement, temperature, blood oxygen, saturation, blood pressure, and respiration activity, data are recorded in a cellular device and sent to VI based data centre. T. F. Andrade et al (2) demonstrated a Virtual Instrument that permits more effective assessment of body fat, automatic data processing, recording results and storage in a database. Nimal J. Kumar e al (3) had presented the design and development of a novel mannequin-based ophthalmic anesthetic training system with two cameras integrated into it to provide a real-time visual feedback to the trainee. The system include a virtual instrument, which has been developed to acquire the images, process, and automatically capture the required information from the images from the cameras.

In [4], three separate methods are separately implemented to segment the tumor affected region of the brain MRI.The [4-5] follows the real ant colony behavior. A hybrid of Ant colony optimization and Fuzzy logic produces a segmented Brain MRI. From Markov Random Field method, labels are created and Posterior energy function are calculated for every image pixels. Minimum Posterior energy function is searched in algorithm while in Fuzzy algorithm is used to find the optimum label for segmentation.

Author in [6] has provided a comparison among the three segmentation methods namely –K mean clustering with watershed algorithm, optimized K-means with Genetic algorithm and optimizes C-means with Genetic algorithm.In [7], it has segmented tumor in MRI using a two stage segmentation. Stage one includes the

Gabor filtering and stage two subjects the filtered images to iterative contour detection. Gabor filter has advantage of suppressing high frequencies therefore, removes noise and highlights the tissue. Input image is filtered using Gabor Filter for different frequencies and angles. The average of all the filtered image is obtained which is input to the second stage of the said method of segmentation. Boundaries are detected by the second stage, segmenting thus the tumor in MRI images. Paper [5] helps to find if tumor is benign or malignant. If tissue has a regular or proper shape, it is benign. irregular shape corresponds to Malignant tumor. In [8], the probability of finding the actual location of the tumor is more and the computational time is also less. This paper has conducted the tumor detection using the self-merging method following the conventional K-means clustering..Stokking et al. [9] developed a fully automatic segmentation from region growing method and morphological operations. The paper has improvised [15] which was automatic but required human intervention time to time. [7] has automated the user intervention. Region is grown in layers iteratively. Initially from histogram first peak is taken as background and next peak is taken as threshold. This threshold defines the seed volume. After a layer is grown, two erosions are applied. Heuristic approach for seed point selection is applied. This paper has two parts that iterate. First finds the lower threshold and second part, upper. Once range of threshold is determined thresholding, erosion, region growth and peak detection is carried.In [10], the evaluations of two segmentation methods have been conducted, the narrow band level set method and a classification method. The purpose of the work done in paper is to find the applicability of the automatic segmentation methods on the manually-segmented brain structures. The Dice Similarity Index is used as a measure of closeness between computer segmented tissue volumes and their corresponding published hand drawn results. The narrow band level set achieves better results with the Dice Similarity Index above 70% which is acceptable.

Anderson in [11] presents novel algorithm which combines statistically-based segmentation techniques with partial differential equation-based methods using neuro-mechanical models to provide an efficient algorithm for automated brain MRI segmentation. The level of accuracy required for 3D printing applications is being provided here. It has combined gamma filtering, k-means clustering, and active contour modeling to get robust segmented brain MRI images. Non linearity of gamma filter improves the performance of the contour algorithm. It aids the convergence of the contour method. Clustering helps to find the threshold for binarization of image. Huo et al. [12-15] has combined segmentation techniques results using confidence map averaging (CMA) to make segmentation robust and sharp.

II. Methods and System

It can monitor and detect the initial stage/start stage of major diseases like(Heart problem, Central Nervous System abnormalities, Stress, Strain, Start/ Growth of cancer, tumour etc.). It includes the following major steps

1. Development of solar wearable sensors which can send the bio signal to the main processing unit
2. Development of algorithm for Tissue slice enhancement and bio texture enhancement
3. Development of program for filtration/Denoising 2D & 3D medical images using wavelet
4. Development of Virtual Instrument based system (Hardware- acquisition, processing, display and validate the patient image) in which the high filtration and multiresolution functionality can be achieved

This involves the development of tools for medical image enhancement and analysis. The development of Device by using wavelet analysis and 3D image processing for phantom images, MR and CT images .The technique can reduce noise contents in signals and images enhancing the gradient at most edges. The techniques will give the better and low cost diagnosis of diseases than existing technologies. The noise filtration technique by Symlet Wavelet will be quite robust. There will be many possible extensions of the technique. Its applications in spatially dependent noise filtration, edge detection and enhancement, image restoration, and motion artefact removal**.**.The system uses wearable sensors, Virtual instrumentation and image processing. The data used is available in a routine clinical environment.It consists of a mechanical solution capable of bidirectional wireless communication with a software application running in a personal computer, integrating a database. The main purpose for this work is to briefly describe the development of a virtual instrument for more effective assessment of body abnormalities, automatic data processing, recording results and storage in a database, with novel features. Presenting the better mechanical characteristics in the market, offers a friendly user interface and a good transmission rate for the wireless communication between device and software with high potential to conduct new studies in the development of new models based in the time response of disorder tissues.

Wearable Sensors

The proposed system will use wearable sensors or sensors integrated in clothes. It will be based on solar power as shown in figure 1. The power management system is shown in figure 2. The architecture of wearable system is shown in figure 3. Signal conditioning for cardiac measurement is shown in figure 4.

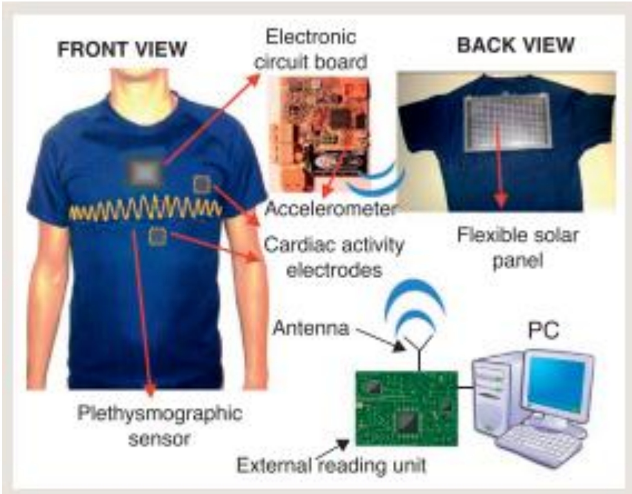
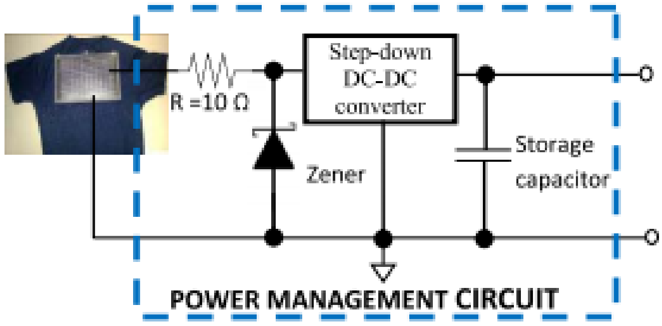


Figure1 Wearable sensor and protocol



!. Block diagram of proposed solar energy-harvesting module.

Figure2- The power management system

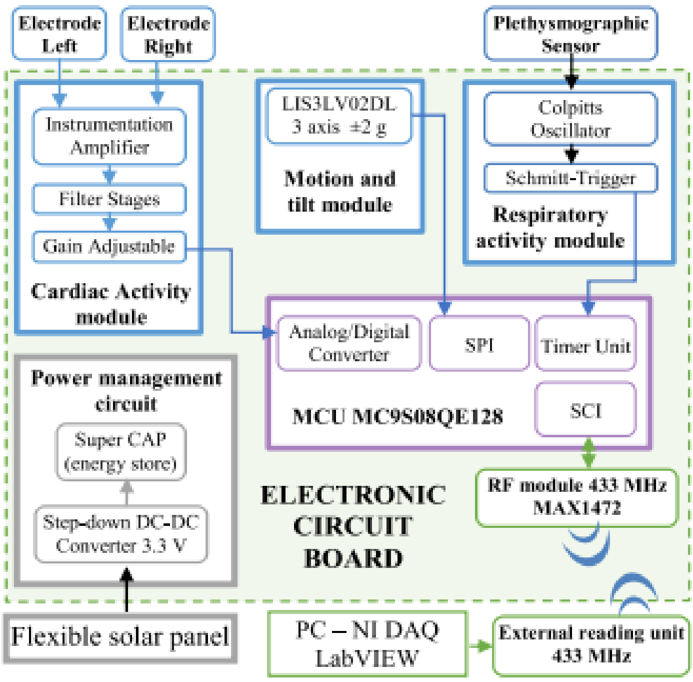


Figure3 Architecture of wearable system

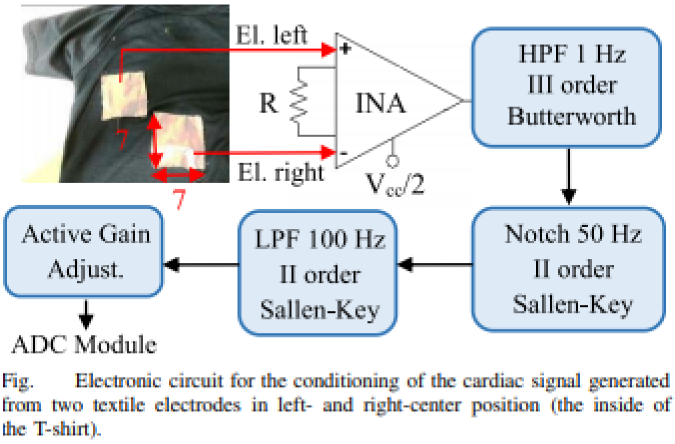


Figure 4 Cardiac signal generation

Workstation and hardware

1. PCI-8252 with NI Vision Acquisition Software
2. The 12-bit PCI-MIO-16E-4 from National Instruments (NI) DAQ board
3. SCXI-100 chassis houses
4. SCXI-1100 32-channel differential input multiplexer Module
5. Bio Sensors
6. CCD Cameras

The VIs will acquire the nerve signals, process it by the program made in Labview.
After processing it will be send to display and further analysis.

The software trigger acts as a conditional retrieval in that the incoming signal is not altered, enabling pre-trigger scans to be read. The electroneurology VIs can accept an arbitrary number of inputs; however, there are some calculations that are applied only to a single nerve recording electrode. For example, in the calculation of the fundamental relationships for the nerve as in the strength/duration curve or the restitution curve, the data involved in the measurement are only concerned with a single electrode. When conduction velocities are calculated, however, they are determined for every successive pair of electrodes, since conduction velocity can change as a function of distance along a nerve.

Square-pulse will be considered for current stimuli of variable amplitude (strength) and duration. In fact, several specific combinations will be made for acquisition and analysis of a conducted action potential. The strength/ duration curve represents a locus of critical points, which are values of strength and duration that result in the generation of an action potential. This curve separates the normal and abnormal state, As shown in figure 5 and 6.Figure 7 is basic virtual instruments module, figure 8 is sample patient monitoring and wound /injury evaluation system.

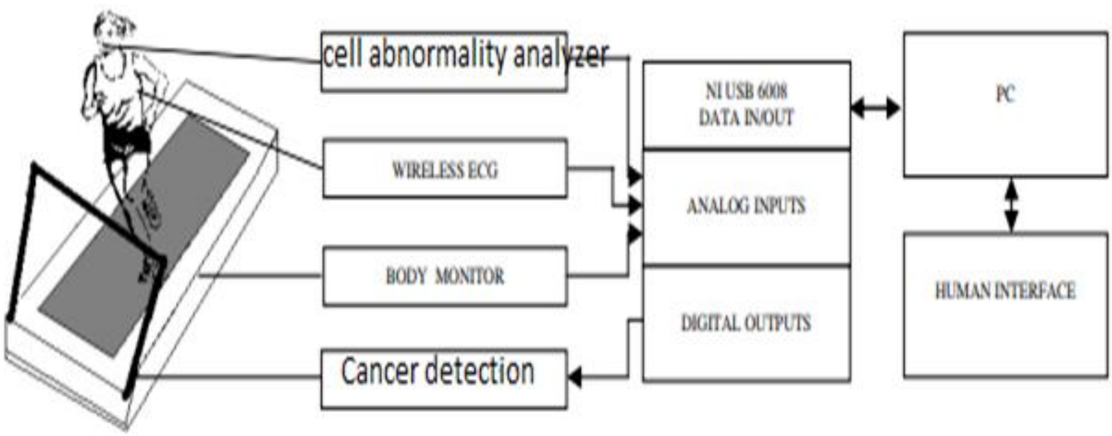


Figure 5 Basic blocks of Virtual instrumentation for diagnosis

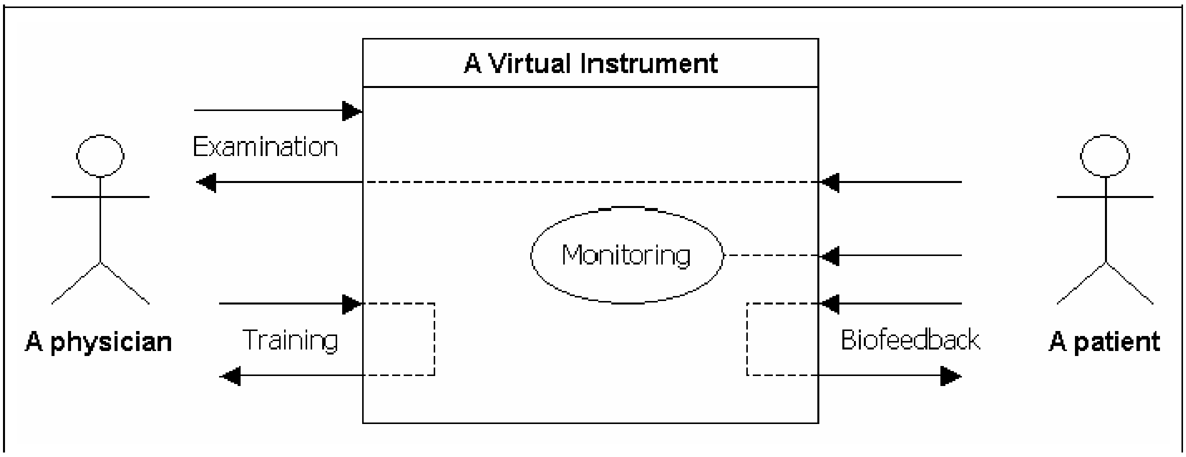


Figure 6. Biomedical instrumentation and VI

Image processing based on Wavelet transform is included with virtual instrumentation. It is described in the following section.

III. Image Processing and Filtering used for detecting tumourprestage

The various methods of segmentation have been observed. There are different kinds of artefacts like point spread function, partial volume effect etc which lead to the poor diagnosis. Removal of an artefact will be treated in the pre-processing. In this paper the noise removal and tumor detection by Meyer wavelet transform is presented. This method is a promising alternative to currently used methods and overcomes some of their limitations.

Wavelets are mathematical functions that cut up data into different frequency components, and then study each component with a resolution matched to its scale . Different wavelets Such as Morlet, Mexican hat, Meyer, Haar, Daubechies, Symlets, Coiflets, Splines biorthogonal investigated by different persons having different applications. The texture of tissue can be described by periodic functions, while a defect can be described by a high frequency event in one direction and low-frequency event in other. The usefulness of transformations is that they project a functions onto a new set of basis functions. If one or more basis functions represent a feature, and all the other basis functions are orthogonal to it, then one can quickly determine if a feature exists in a signal by projecting then signal function onto the new basis.

We have used Meyer Wavelet. It is quite effective in boundaries of image in texture. The wavelet decomposition function decomposes the image into different level of intensities, which makes able to detect abnormalities.

The Meyer wavelet is an orthogonal wavelet that is indefinitely differentiable with infinite support.
The Meyer scale function and wavelet are defined in the frequency domain in terms of function *v* by means of well-known equations.

$$\Phi_{mey}(w) = \begin{cases} \frac{1}{\sqrt{2\pi}} & if\ w \le \frac{2\pi}{3} \\ \frac{1}{\sqrt{2\pi}} \cos\left(\frac{\pi}{2}\upsilon(\frac{3w}{2\pi}-1)\right) & if\ \frac{2\pi}{3} \le w \le \frac{4\pi}{3} \\ 0 & otherwise \end{cases}$$

where, for instance (other choice can be made),

$$\upsilon(x) = \begin{cases} 0 & if \quad x < 0 \\ x & if \quad 0 \le x \le 1 \\ 1 & if \quad x > 1 \end{cases}$$

and the wavelet spectrum is given by
The denoising steps by wavelet transform is given below in figure 7.

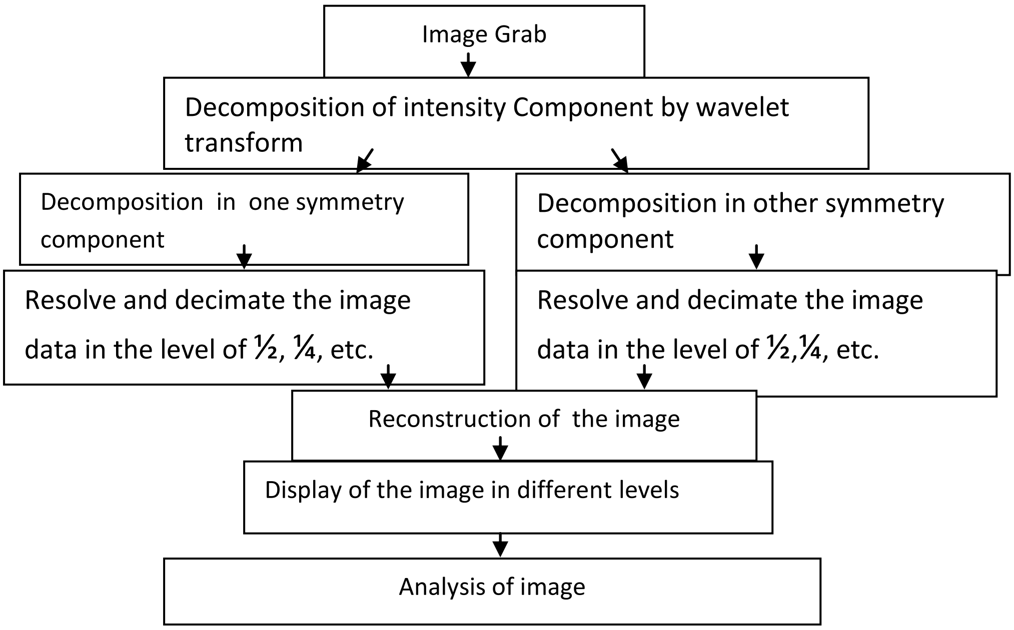


Fig7 Flow diagram of the analysis by Symlet Wavelet

The de-noising algorithms based upon the discrete wavelet transform (DWT) that can be applied successfully to enhance noisy multidimensional magnetic resonance (MR) data sets i.e two-dimensional (2-D) image slices and three-dimensional (3-D) image volumes. Noise removal or de-noising is an important task in image processing used to recover a signal that has been corrupted by noise. Random noise that is present in MR images is generated by electronic components in the instrumentation.

IV. Conclusion

The aim of research is to develop wireless health monitoring device which will be very useful for arm forces to diagnose physiology status (from initial stage).It givesremote surveillance of person working in remote area(Hilly, Deserted, etc.) for vital functions through the use of internally and externally located solar wearable sensor and virtual instrumentation device. As opposed to discrete interactions, the provision of healthcare will non contact. After non contact diagnosis a decision maker can make the decision whether the person will be retain at the work station or will be withdrawn / replaced.It can monitor and detect the initial stage/start stage of major diseases like(Heart problem, Central Nervous System abnormalities, Stress, Strain, Start/ Growth of cancer, tumour etc.). It will not be affected by light, vibration, and other noise parameters so that noises can not be read as diseases.

The embedded sensors and electronics circuits in cloths will acquire the data from major part of the body (like Heart, Brain, other),it will send the data through wireless system to central monitoring unit (via Virtual instrumentation monitoring device). The analysis unit analyse the abnormalities. After diagnosis of the state of army the authority can take the decision of treatment or replacement from that place. So it is quite useful for Armedfoces working in remote areas. However it is useful for normal persons and normal diagnosis.

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