Denoising Of EEG Gesture Using DWT

Jothimani.S, Suganya.A

Abstract*: EEG signal is very complex and arbitrary in trendy environment. The Electroencephalography (EEG) signal is infected by the various noise sources, because of its lower amplitude. Similarly Electromyography (EMG), Electrocardiogram (ECG) signals have been contaminated by power line, baseline noises. The filter system recovers the infected noises. Filtering endure as of the considerable defeat the noise is not eliminated in EEG signal. So the signal has to remove these noises before treating the bloody signal. To propose an efficient demonizing algorithm DWT (Discrete Wavelet Transform) to de noising the EEG signal. In this paper introduce the dissimilar methods of discrete wavelet to analysis between the different patients. The analysis made by the well and epileptic patient that demonstrate the efficiency of sound exclusion.

Index Terms*: Artifacts, Power line noise, Baseline noise, Discrete Wavelet Transform (DWT).

I. INTRODUCTION

Electroencephalography is exclusive tactical tools intended for monitor brains movement. It analysis the electrical prototype in a brain and examines the skull injuries, latent problem, epileptic, intellect cancer, headache, etc. The gadget is associated to human and connected with the EEG computer system. When the measurement is taken, it gets the noisy signal in a brain. Use of EEG signal has small SNR. To de noising use the wavelet transform. EEG present intellect signal information based mostly on recording information lead to non-invasive technique to research the intellect movement that's vital for therapeutic and analysis(i.e. neurobiology, science, psychology, linguist ics and psycho physiological research) uses. The graph signals are commonly impure by relic that always comes from muscle action, which can scale back its quality for scientific or analysis by heavy explanation of the signal [1].

There are various methods for measuring brain activity which afford precise meticulousness and decision of brain activity in spatial localization. EEG is a lower cost in a various ranges between 0.5 to 500 HZ and 20 to 40 HZ. In these waves ranges it has the different types such as delta, theta, alpha, beta and gamma waves in Fig.1. The discrete wavelet transform used to de noising the signal.

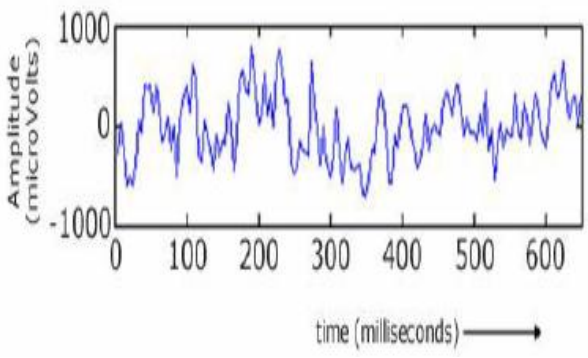

Fig.1 Normal EEG Waveform

A. Frequency band of EEG signal

The intellect effect recorded as small amplitude of approximately 100Mv. The occurrence of this intellect effect mixture initial range from 0.5 - 100 Hz with the distinctiveness are highly dependent on the brainy cortex [2]. Generally, the brain waves has classified as five group waves in Fig.2.

Delta (δ) -The Delta waves is high amplitude wave the frequency range from 0.5-4 HZ. They occur in bottomless snooze, in infancy, and in severe unrefined head infection and deep sleep stage. The NREM stage the delta waves arise.

Theta (θ) -The Theta waves are rhythm waves naturally REM sleep waves among 4 and 7 Hz. It occur mainly in childhood state and adults.

Alpha (α) -The Alpha impression are cadenced waves happening a reliability range among 8 - 13 Hz, it is conduit among aware and subliminal mind, which is interaction between beta and theta.

Beta (β) - The Beta waves are very small amplitude, and towering regularity range from 13 - 30 Hz. They are pretentious by rational movement. the human awake condition the beta waves originated.

Gamma (γ)- The Gamma effect have frequencies between 38-42 Hz. These are associated with bursts of insight and advanced in turn processing.

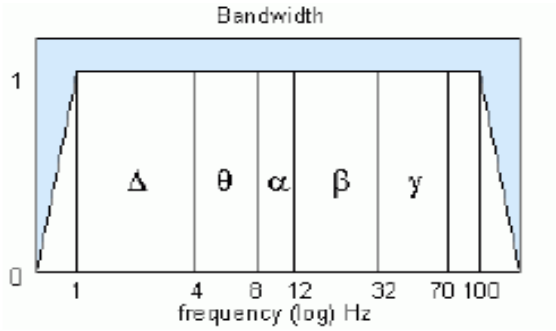

Fig.2 Frequency Bands of EEG signal

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Jothimani. S, Assistant Professor, Electronics and communication engineering, M. Kumarasamy College of Engineering, Karur, India. (E-Mail: jothimanis.ece@mkce.ac.in@gmail.com)

Suganya. A, Assistant Professor, Electronicsa and communication engineering, M. Kumarasamy College of Engineering, Karur, India. (E-Mail: suguanyaa.ece@mkce.ac.in@gmail.com)

B. Common Artifacts

The relic use is to implicit all flags that show up in EEG verification it does not originate as of the mind. The most part widely recognized curios in the EEG flag show up amid the securing because of various causes, as awful terminals area, not spotless shaggy calfskin, anodes impedance, and so forth. Additionally to find physiological relics, bio electrical gesture from dissimilar fraction of the body (sympathy and force action, ogle squint and eyeball development) that are act in the Electroencephalography.

C. Control stroke Noise

Natural proceedings, notably graph indicators, square measure ordinarily damaged through fifty or sixty Hertz row repetition hindrance as of ropes, light-weight fluorescents and elective cathode and securing hardware. Daylight begins in fluorescents a lot of usually than not causes pretend spikes within the chart. They're sent in several chart and m channels

D. Baseline Noise

Noise caused in EEG due to the some primary aspects. Signals picked from the electrodes from the skull due to the muscles and human lungs the various noises present. The base line noise by the mismatching of electrodes in human body and the swelling in between then electrodes can change the impedance of electrodes, which causes lower frequency relic. The base line noise occurs due to the temperature and amplifier changes in the gadget. Baseline noise should be removed for proper analysis of patient monitoring and proceed any further signal processing.

II. PROBLEM IDENTIFICATION

The signal is impure by the any of noises during the transmission and recording process, which is eliminated to introduce wavelet techniques to remove noises. The different relic's signals measured using the electrooculographic (EOG), the Electrocardiograph (ECG), the electromyographic (EMG), baseline noise, and power line noise. The recording of EEG signals at the frequency of 50HZ the power line noise rose. To introduce wavelet transform to demonizing the power line noise to record EEG signal and further any signal processing analysis of EEG signal.

III. OBJECTIVE OF THE WORK:

To design an efficient wavelet converter for removing the command line up and baseline noises which there in the electrooculographic signal. In our work chapter IV describes the related work of Electroencephalography Denoising, chapter V describes the existing system investigation, chapter VI describes the planned EEG Denoising technique, chapter VII describes the implementation results and chapter VIII describes the corresponding conclusion of the work.

IV. RELATED WORK

A. Denoising of Electroencephalography Indicate the Analysis of Brain Disorders

The de noising of EEG signals and concludes the use of discrete wavelet converter provides effective solution for Denoising non-stationary signals such as EEG The electroencephalography signal which have significant in sequence about different actions of intelligence. The analysis of EEG signal is deliberate to place the electrodes on head and take the signal with small amplitude. The signals usually were contaminated with unwanted artifacts that may hide some valuable information in the signal. The presence of line noise, eye blinks, eye movements, heartbeat inhalation and additional muscle activities the signals are more complicated to analyze. The proper judgment of sickness requires faultless analysis of the EEG signals. It is difficult to depose the Signal by the presence of various noises [3].

B. Artifact Removal from EEG Signals

Relic elimination from electroencephalogram signal the medical instrument of EEG recordings area unit usually infected with many relic [4]. Power line nosiness and baseline clamor is often gift within electroencephalogram reply of each patient. The variety of ways is accessible to traumatize the noise effectively each at the time of electroencephalogram record. Additionally the preprocessing is used to eliminate noise in EEG signal.

V. SYSTEM ANALYSIS FOR EEG DENOISING

A. System Analysis

Linear filters are the fast rising pasture in signal processing. When the recording of EEG signals the noises is arise. The filter techniques propose the noise. Conversely, numerous problems present in the facet of filter regulation and execution. The brain damages are not properly detected and diagnose too late. Consequently the consistent tool is needed with the intention of urgent situation to obtain a quick access in grievance. Seizure, the abnormal change in brain's electrical activity with long duration can disturb various organs' functions leading to brain injury. The EEG waves are delta the frequency range 1-4 Hz, theta wave frequency range from 4-8 Hz, alpha wave has frequency range from 8-12 Hz, and beta wave has frequency range from 12-30Hz and gamma wave range more than 30Hz. It represents convinced neural states of the intelligence.EEG system has 256 electrodes and the sampling frequency of 16KHZ [5].

B. EEG Processing

A little metal discs known as electrodes are located resting on the top of head in particular place. The position electrodes these positions of electrodes are recognized through the instrument that measures the heads 10/20 system. These measurements are full from the fixed points of the head. EEG monitoring system uses a differential amplifier for each channel to monitor the brain activity. In each channel the inputs of two signals voltage difference is measured by differential amplifier. The resultant signal is enlarged and demonstrates as a channel of EEG bustle. Likewise the pairs of electrodes placed in EEG instrument to process the signal.

The predictable analogue tools consist of an speaker, a galvanometer, and a script tool. A galvanometer is a coil of wire within a magnetic field. The output signal as of the amplifier passes to wire and oscillate. Galvanometer a pen accumulates up and down each time the coil moves.

The amplifier output monitored by filters will set the pane inside which the EEG movement is recorded. The various analog devices like AD8244, AD8422, and AD7177 analog to digital converter ICs used in EEG. The analog to digital converter ICs used to monitor the current sensing, parameter prediction, health measurement, respiration management, wealth and fitness of patient. [6].

C. Fractional Fourier Transform

The fractional Fourier transform was first introduced by Namias [7] in its incomplete form. The FFT can be expressed as,

$X_\alpha(t_\alpha) = \int_{-\infty}^{\infty} x(t) K_\alpha K\alpha(t_\alpha, t)\, dt$ **(1)**

Where $K_\alpha(t_\alpha, t) = K_\emptyset . \exp[j\pi(t_\alpha^2 cot\emptyset - 2t_\alpha tcsc\emptyset + t^2 cot\emptyset)]$ (2)

VI. PROPOSED METHODOLOGY

Electroencephalogram (EEG) is a bioelectrical mind movement utilized by doctors as an imperative instrument to examine the utilitarian condition of the cerebrum and to analyze certain neuron physiological conditions and clutters. It is likewise utilized as a non-obtrusive neuron physiological methodology. The nearness of physiological ancient rarities, for example, eye flickers, muscle development and cardiovascular heartbeats in cloud Records forms basic and makes investigation risky. Eye development delivers the EOG that is sufficiently able to be unmistakable obviously in the EEG. The EOG mirrors the potential distinction that changes amid eye development between the cornea and the retina. Another normal article is development of the eyelid, for example eye flickers additionally influencing the corneal-retinal intensity that changes amid development of the eyes. Another normal article is development of the eyelid, for example Eye squints impacting the corneal-retinal contrast in potential [7]. The blinding ancient rarity as a rule creates a more suddenly changing waveform than the eye development and along these lines contains all the more high-recurrence segments in the blinding antiquity.

Eye-blinks and eyeballs movement produce electrical signals are called Ocular Artifacts (OA). These artifacts measured through the EMG signal. These relics commonly occur at the stage of swallow, chew, speak, succeed and hiccup. This is known as Muscular Artifacts (MA). This is of the mill volt sort and contaminates the EEG signals of the microvolt sort. The frequency range of the EEG signal is between 0 and 64 Hz and the OA is between 0 and 16 Hz and the frequency range of MA between 50 and 500 Hz. When the correction algorithm is applied to the wavelet-based EOG and EMG signals for the whole length of the EEG signal, even in non-OA zones the presence of low and high frequency. The overlap of these artifacts with the desired signals, the valuable EEG background activity is significantly lost [8].

A. Wavelet Transform

The wavelet transform is used to de noising the EEG signal. The various transforms such as Fourier transform, fast Fourier transform, short time Fourier transform and wavelet transform. The use of Fourier transform the signal loss occurs in recording of signal. To overcome the losses wavelet is introduced [9].

The wavelet transform of a sigmoid x (t) is defined as,

$$\boldsymbol{WTX(T,a) = \left(\frac{1}{\sqrt{a}}\right)\int_{-\infty}^{+\infty} x(t)h(t-Ta)\, e^{-j2\pi ft}dt} \quad (3)$$

$$\boldsymbol{WTZ(T,a) = \left(1/\sqrt{a}\right)\int_{-\infty}^{+\infty} x(at)h(t-T/a)\, e^{-j2\pi ft}dt} \quad (4)$$

The wavelet transform has continuous wavelet transform (CWT) and discrete wavelet transforms (DWT). It has some special function parameters T and A is processed. The part of signal is chosen to introduce the transform technologies. It treated different for low and high frequencies. The small value of wavelet it taken as narrow function. For large vale of wavelet the signal is expanded.

B. Wavelets for analyzing EEG signals

A wavelet is a little waveform which has its vitality purposeful in event. This change is utilized to change over a sign into a progression of wavelets. The wavelet change is a vital device for investigation of EEG signals. One of the essential advantages of the wavelet change is that it is limited in both time and recurrence though other established strategy like the Fourier transformation are confined in recurrence as it were. Additionally, it offers great occasion assertion for low-recurrence segments and great recurrence goals for high-recurrence segments of the flag being broke down.

$$\boldsymbol{\varphi_{j.k} = 2^{j/2}\varphi(2^j - k)} \quad (5)$$

It conquers weaknesses of other comparative techniques, for example, the brief span Fourier change wherein time-recurrence restriction is consistent for all frequencies. The outcome is that change can be intended to recognize explicit flag advances confined in symmetrical sets. Constant wavelet change (CWT) is legitimate in peculiarity identification. a discrete and fast implementation of cwt for the most part with genuine esteemed premise is known as the standard dwt discrete wavelet transform(DWT) with standard dwt flag has a same data estimate in change space and in this way it is a non-repetitive transform [10].

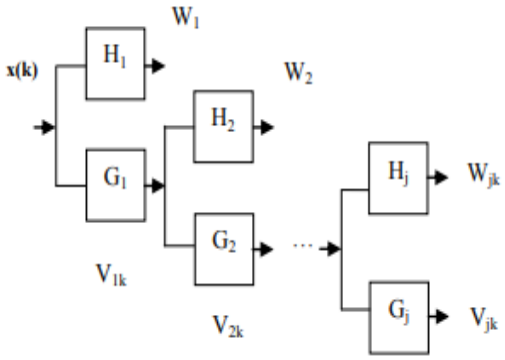

Fig.3. Architecture of DWT

Fig.3 demonstrates the calculation of the SWT of a flag x (k), where Wj,k and Vj,k are known as the detail and the estimate coefficients of the SWT. The channels Hj and Gj are the standard low pass and high pass wavelet channels, separately. In the initial step, the channels H1 and G1 are gotten by up testing the channels utilizing the past advance (for example Hj-1 and Gj-1).

The detail coefficients Wj,k are equivalent to the yield of the high pass channels and correspondingly the estimate coefficients Vj,k are equivalent to the yield of the low pass channels. As indicated by the time recurrence properties of the wavelet change Hj and Gj are a bank of perfect narrowband channels. The EEG accounts are sullied by EOG and EMG signals. The EOG and EMG signals are non-cortical exercises [11]. The eye, facial muscles and mind exercises have physiologically separate sources, so the recorded EEG is a superposition of the genuine EEG and some part of the EOG flag and EMG signals. It very well may be written to as,

$$\mathbf{EEG_{rec}(t) = EEGtrue(t) + s.EOG(k) + t.EMG(K)} \quad (6)$$

Where, EEG_{rec} (t) - Recorded EEG signal which is infected signal.
EEGtrue (t) - EEG cortical action (i.e., Brain activity),
s.EOG (k) - Propagated ocular artifact occur the eye blink and movements in recording location.
t.EMG (K) - Propagated muscular artifact due to eye blinks, jaw clench, swallows spit in the recording spot.
EEGtrue (t) - is calculated by removing s.EOG(k) and t.EMG(K) with continuous keeping of EEG activity.

VII. IMPLEMENTATION & RESULTS

A. EEG Denoising Process

The Proposed EEG Denoising method had been done in the Matlab environment. In implementation stage, we have to collect different EEG data. The following steps are held in EEG Denoising process.

Step 1: Apply discrete wavelet transform to the impure EEG signals and decay it.

Step 2: To recognize the point in the infected EEG at each level.

Step 3: To recognize the visual and brawny artifact zones using coefficient of variation.

Step 4: Apply de-noising technique.

Step 5: Apply inverse discrete wavelet transform to the access wavelet coefficients to obtain the de-noised EEG signal.

B. Implementation Results

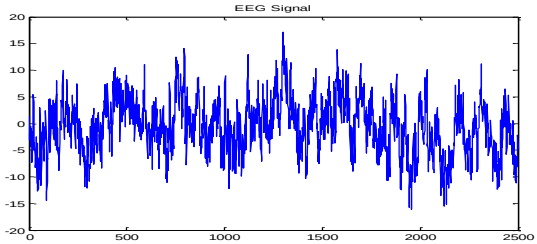

Fig.4. Representation EEG Signal

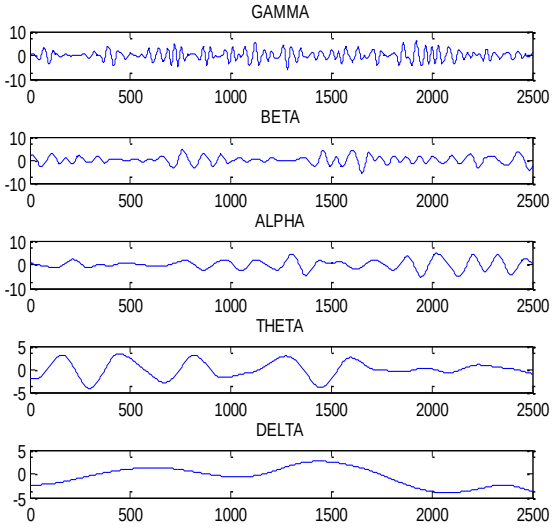

Fig.5. Representation of EEG Components (Gamma, Beta, Alpha, Theta and Delta signals)

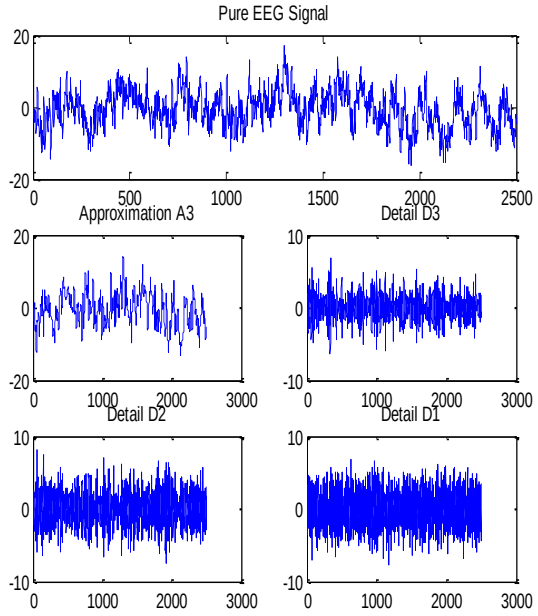

Fig.6. DWT Coefficients for Pure EEG Signal

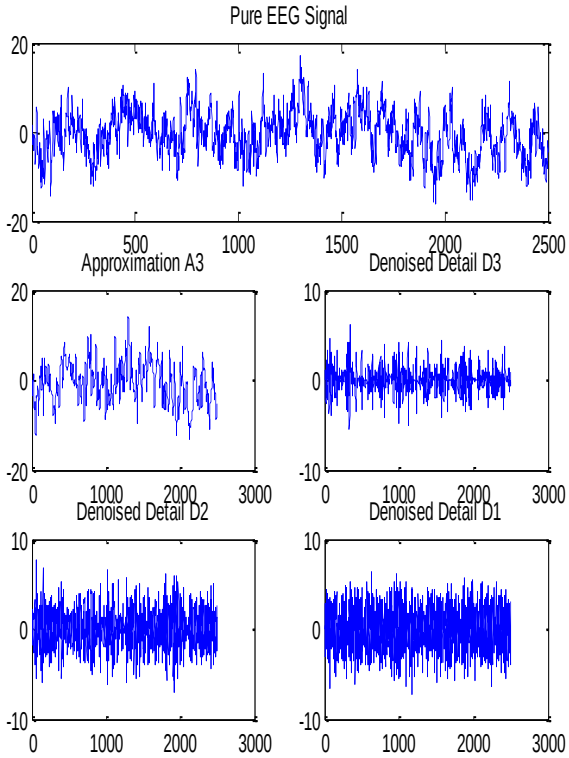

Fig.7. DWT Coefficients for Denoised EEG Signal

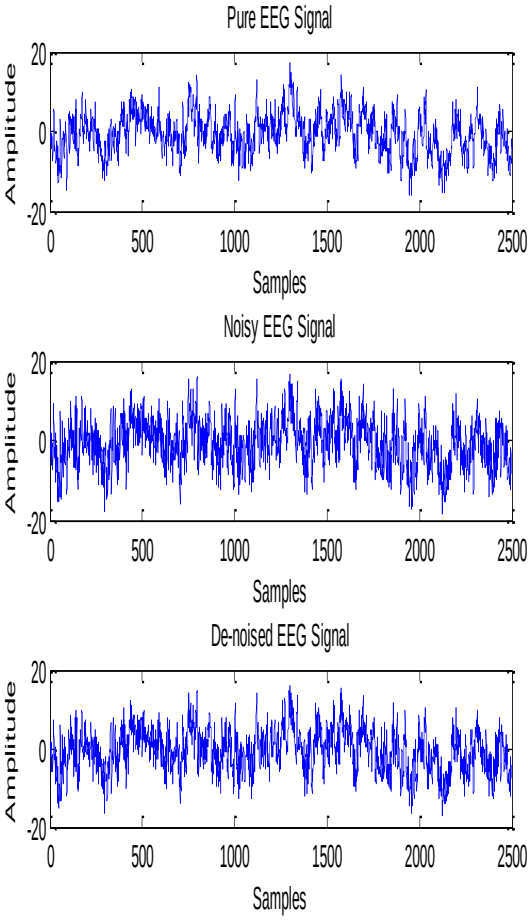

Fig.8. Denoising of EEG Signal by using DWT

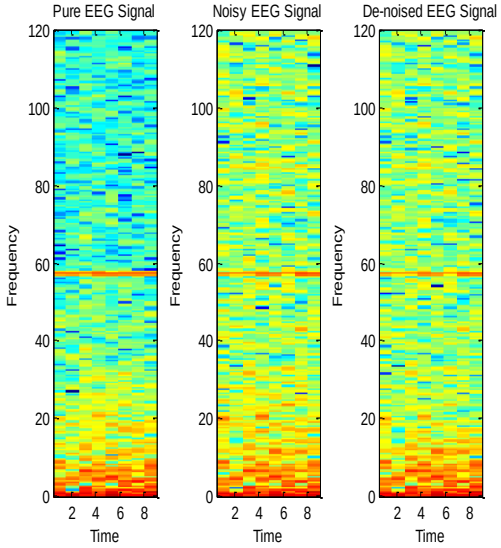

Fig.9. Spectrum representation of Pure EEG, Noise and denoised EEG signal

VIII. CONCLUSION

The signal based Denoising methods were studied for EEG signals. It is known to signals with higher PSNR and SNR at the a variety of estimate parameters like MSE, PSNR and SNR considered and it is concluded that wavelet method give the best Denoising result with its multi resolution capacities. The orthogonal based transform analyses the signals in both occurrence and incidence domain and also signals with low noise amplitudes can be removed from the signals by pick the best wavelet to decompose the signal. In wavelet transform we decompose only the low pass components of the signals. The DWT based EEG Denoising was implemented and it gives better noise cancellation. The DWT architecture is most suitable analytical tool for on stationary waves.

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AUTHORS PROFILE

Jothimani received the M.E. degree from M.Kumarasamy College of Engineering, Thalavapalayam, and Karur in 2014. She is currently working as an assistant professor in M.Kumarasamy College of Engineering, Karur.
Her research interest includes signal processing,, image processing and wireless networks.

Suganya received the M.E. degree from M.Kumarasamy College of Engineering, Thalavapalayam, and Karur in 2018. She is currently working as an assistant professor in M.Kumarasamy College of Engineering, Karur.
Her research interest includes biomedical applications, image processing, advanced microprocessors and microcontrollers.