iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XII **Month of publication:** December 2017

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 5 Issue XII December 2017- Available at www.ijraset.com

Determination of the severity of Amyotrophic Lateral Sclerosis using Wavelet Transform

H K Shreedhar[1], Anandthirtha B Gudi[2]
[1,2]*Department of Electronics and Communication, Global Academy of Technology*

Abstract: ***Neural discords result in degeneration of neurons in the human body. These kind of disorders lead to Parkinson's Disease, Huntington's disease , Amyotrophic Lateral Sclerosis etc. They result in loss of cognitive abilities and serious gait disability. The suffering of person is dependent on severity of the neurological disease. Among the above mentioned neural disorders, Amyotrophic Lateral Sclerosis (ALS) is observed in their age of early thirty's. In this work, a database of gait signals consisting of ten healthy control subjects and ten pathological subjects suffering from ALS is used. Two different wavelets are considered for analysis of severity level discrimination of the disease.***
Keywords: Amyotrophic Lateral Sclerosis, Gait analysis, Neurodegenerative diseases, Severity assessment, Wavelet analysis

I. INTRODUCTION

Most of the neurological disorders exhibit deformation of neurons resulting in abnormality of gait of a patient. In diagnosing certain types of diseases, methods in practice are blood test, Electromyogram (EMG) analysis, CT scan and many more methods [14]. These methods are time consuming and also they are costly. Sometimes the diagnosis may not be that accurate. Except CT scan all other methods are invasive. Therefore alternate method found is gait analysis which is helpful for early detection of ALS and to measure its severity level. This is a noninvasive, cost effective and less time consuming method.

The stride interval of human gait fluctuates in complex fashion. It reflects the rhythm of the locomotor system [6]. It has been found that gait of ALS patients is less steady and temporally disorganized when compared with normal control subjects [1]. Severe gait disability leads to falls in adults. Data acquisition and signal processing are two main areas that enable the study of gait variability [3].

II. METHODOLOGY

The gait database used in the present study was contributed by Hausdorff et al. [1], and it is downloaded via the web page of Physionet [12]. Each data set consists of 5 minutes of recording of gait signals consisting of 45,000 samples. Out of which, first six thousand and last three thousand samples are not taken into consideration for the analysis due to startup and concluding time of walking. The remaining 36,000 samples are normalized and considered for analysis. The data acquired consists of gait signals of both left leg and right leg. Analysis can be done by considering gait signals of both the legs. In this work, left leg gait signal is considered for analysis.

A. Continuous Wavelet Transform

Wavelet analysis is used to analyze the signal in both time and frequency domain. It is very much useful for the analysis of low frequency signals like biomedical signals. In this work, the aim is to determine start time of each step and number of start points in a sample set. To perform this analysis, point to point analysis of gait signals is very much essential. Therefore CWT is used in this study. Haar and Gauss wavelets are used for signal analysis.

B. Determination of Appropriate Scale

First Haar wavelet is considered. For every control subject, Entire signal frame consisting of 36000 samples is divided into blocks of 6000 samples each. CWT is applied for each block with scale factor of 10 and coefficients are determined. The coefficients which are below threshold value of 0.2 are not considered for analysis. Then starting from the beginning of the block, five consecutive points are considered. In this group, if first three points are zeros and remaining two points are non zeros, then first non zero point is considered as start point. If this condition is not satisfied, then the algorithm advances to next point and a new set of five consecutive points are considered. In this manner all the start points in a block are determined and is continued to determine start points for the entire frame of six blocks. The result of applying this procedure to one block with a scale of 10 is indicated in Fig.1.

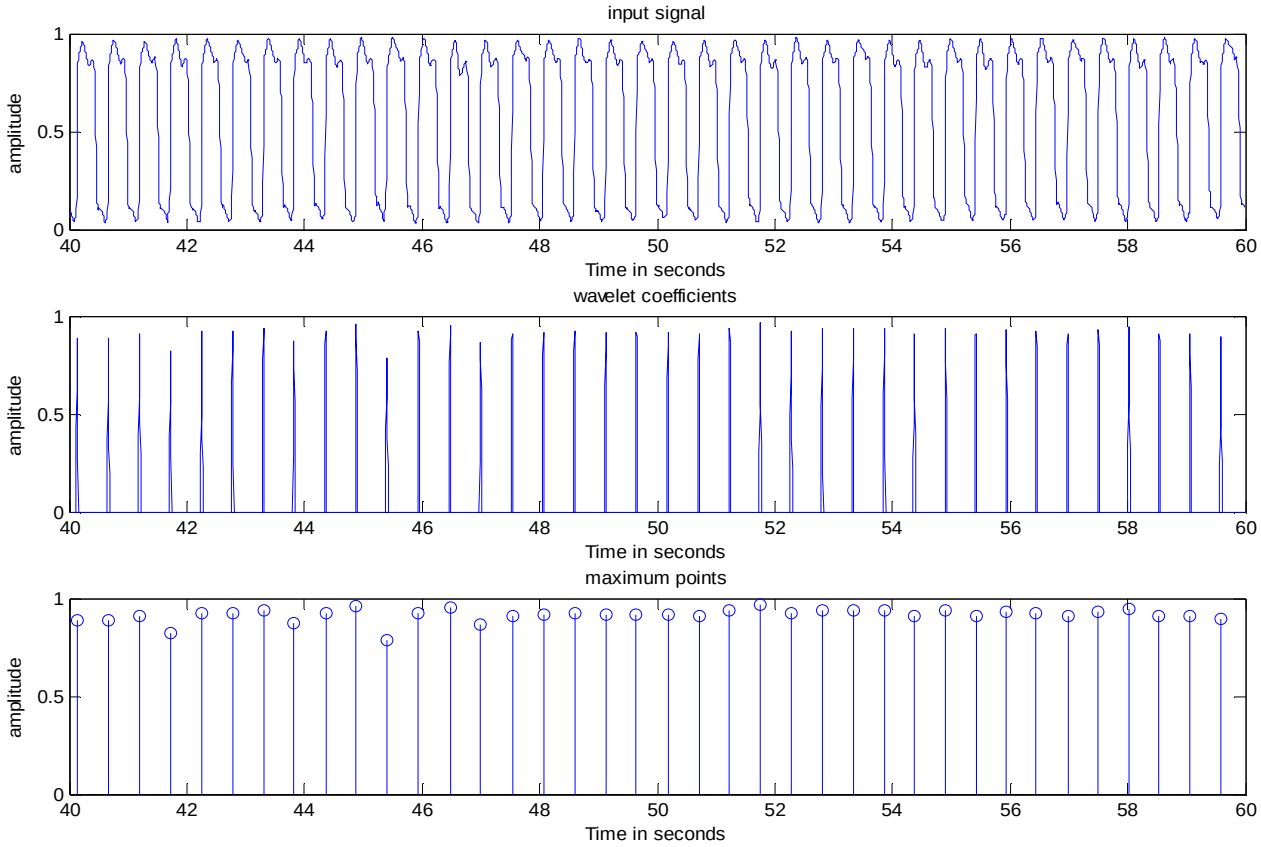


Fig.1Wavelet coefficients and determination of start pointsWavelet coefficients and determination of start points

This procedure of determination of start points is repeated for scale of 20, 30 and 40. Total number of start points is determined for each scale. From this, start time deviation is determined. The results are indicated in the Fig. 2.

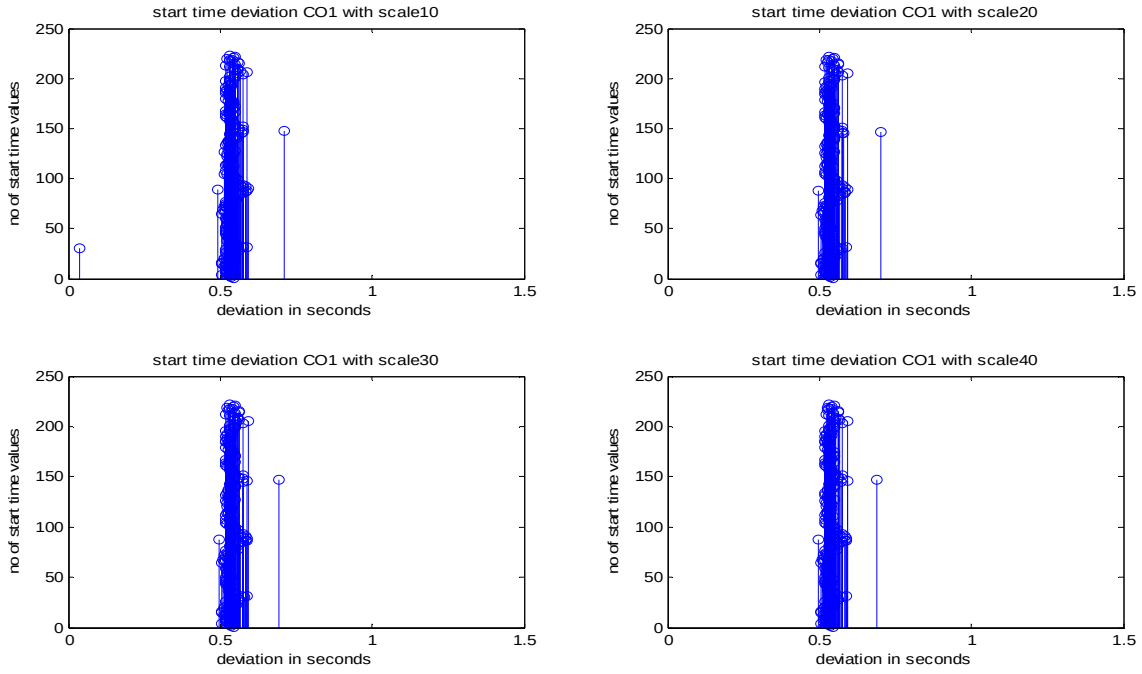


Fig.2 Start time deviation for the scale of 10, 20, 30 and 40

The process of determination of start points and deviation is continued for all the control subjects and in each case, number of start points is tabulated. Finally this result is compared with start point determination by average crossing method [11]. The scale for which minimum deviation observed is determined and is chosen for analysis. For Haar wavelet, scale of 10 is found to be best suited for analysis and for Gauss wavelet scale of 40 is found to be best suited for analysis.

C. Classification of Pathological subjects

Once scale factor has been determined, reference subject for the analysis needs to be found. For this, total number of start points for every control subject is determined and an array consisting all these values is formed. Mean value of this array is found. The control subject which has minimum difference from the average value is considered as reference subject. In this work, CO4 is chosen as reference subject. The reference subject has about 227 start points in the given frame of 36000 samples. Once the reference subject is found, signals of different pathological subjects are considered for classification. For each of the pathological subjects, start point deviation is calculated. Depending on number of start points, the subject is classified as mild, moderate and severe. In this work, five patients with mild level of disease, three moderate level severity and two severe level of disease are considered.

III.RESULTS

A. Result of analysis with Haar Wavelet

The results are indicated in the Fig. 3, 4,5,6,7 and 8.

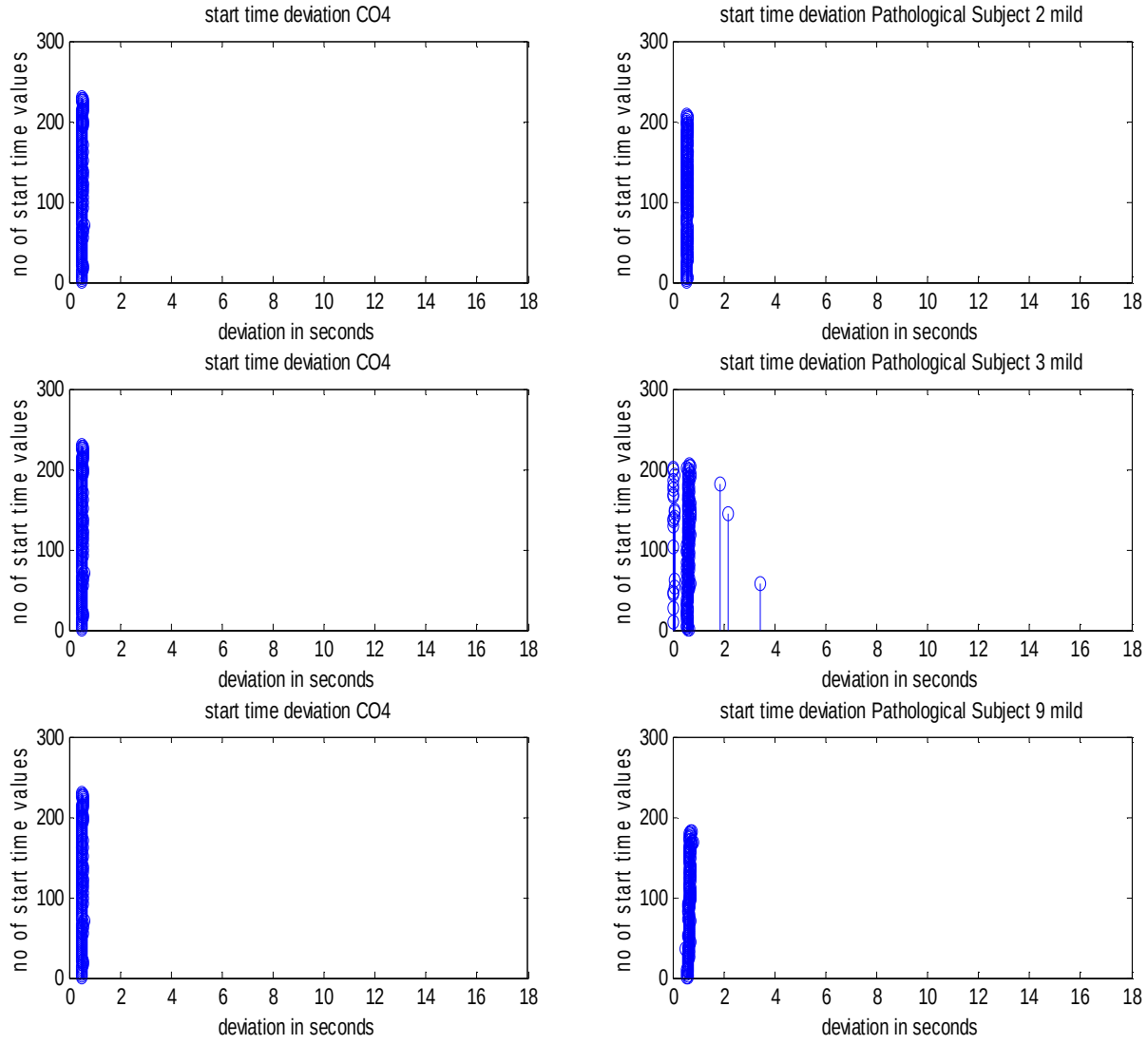


Fig.3 Start time deviation for the Reference subject and three mild patients

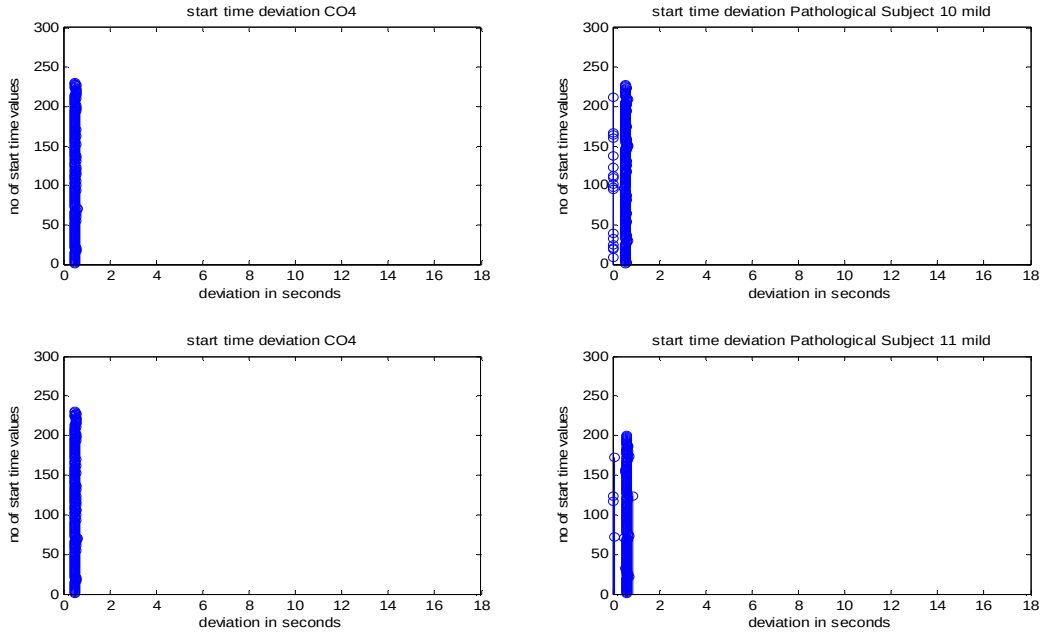


Fig.4 Start time deviation for the Reference subject and two mild patients

Fig.5 shows the comparison between start points of Reference and mild subjects. Blue colored bar indicates reference subject and red colored bars indicate mild pathological subjects drawn on the basis of analysis carried out for easy visibility of severity.

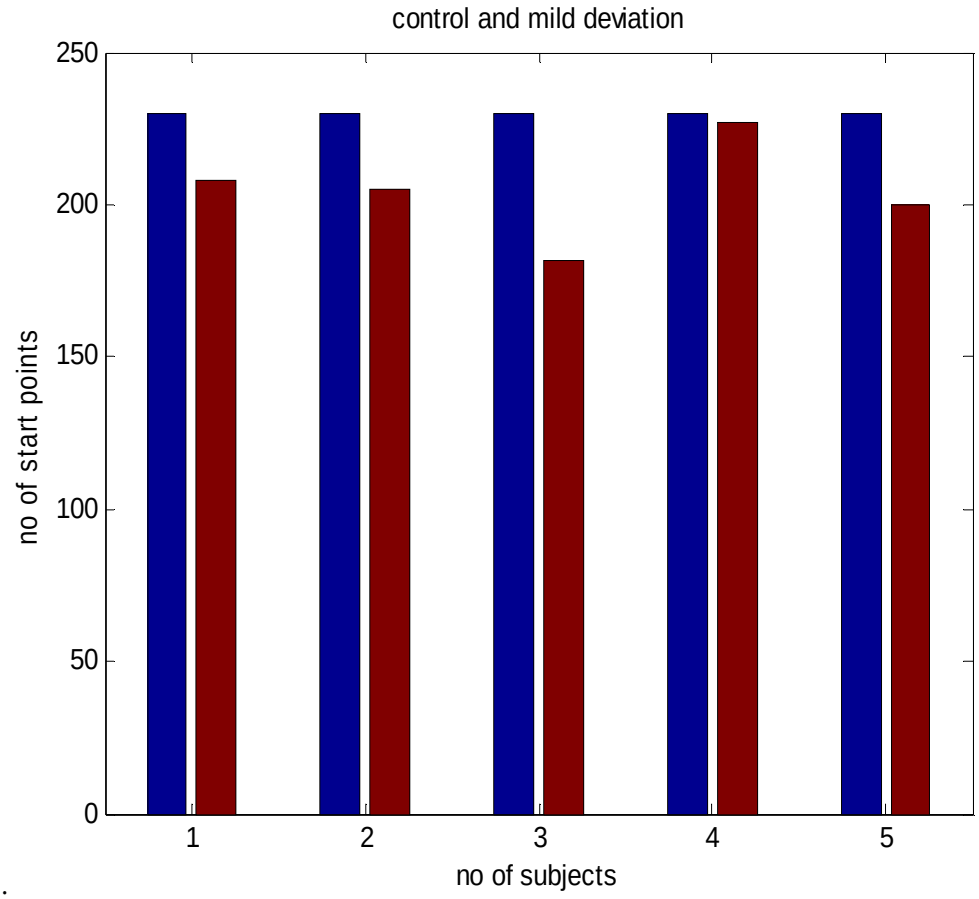


Fig.5 Comparison between start points of Reference and mild patients

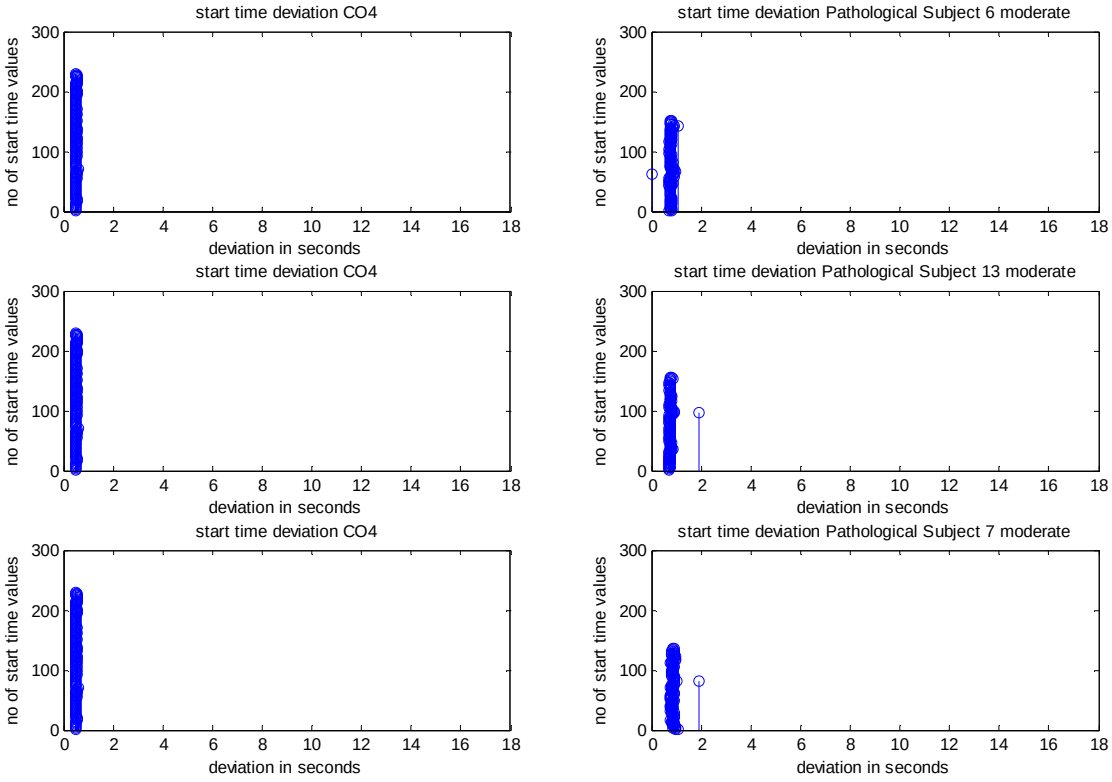


Fig.6 Start time deviation for the Reference subject and three moderate patients

Fig. 7 shows the comparison between start points of Reference and moderate subjects. Blue colored bar indicates reference subject and red colored bars indicate moderate pathological subjects, drawn on the basis of analysis carried out for easy visibility of severity.

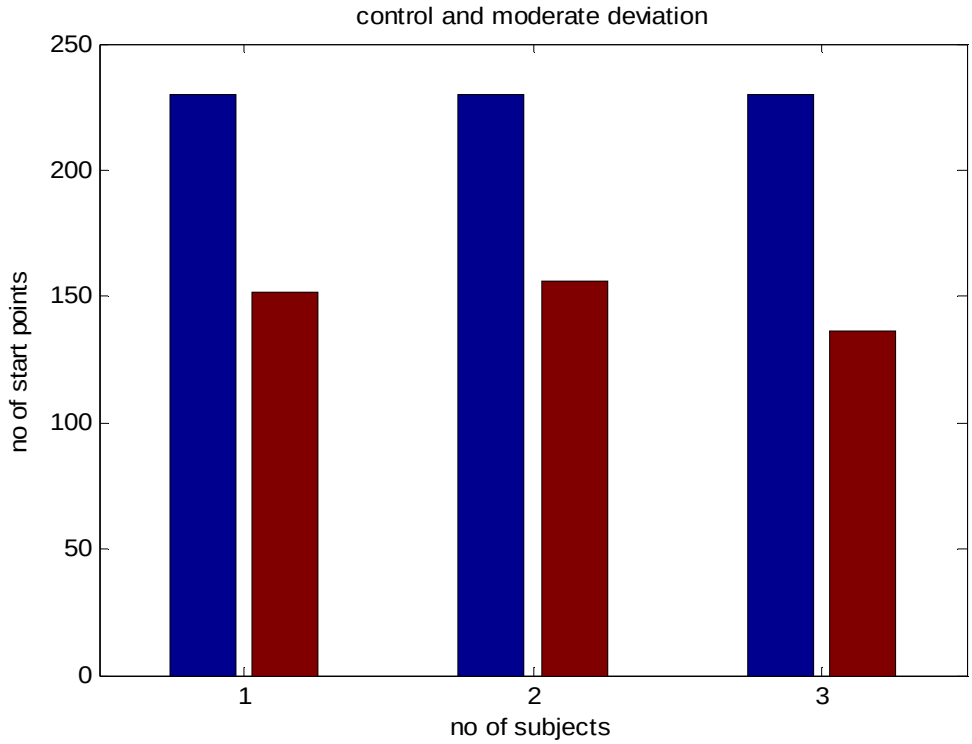


Fig.7 Comparison between start points of Reference and moderate patients

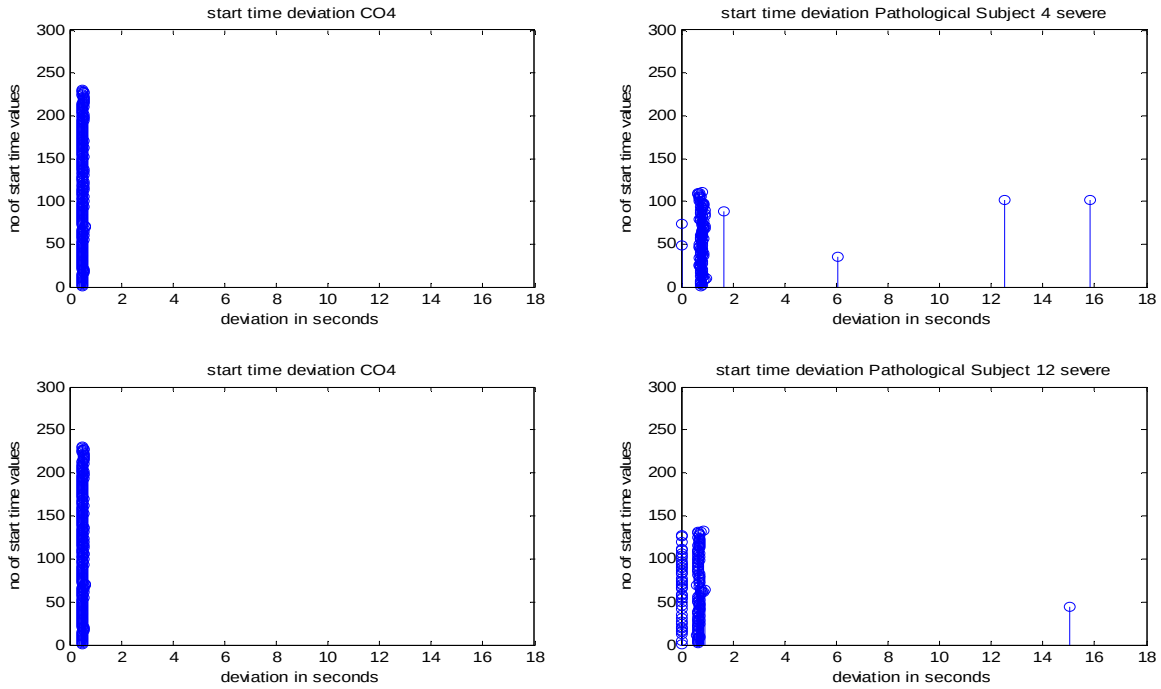


Fig.8 Start time deviation for the Reference subject and two severe patients

Fig. 9 shows the comparison between start points of Reference and severe subjects. Blue colored bar indicated reference subject and red colored bars indicate severe pathological subjects drawn on the basis of analysis carried out for easy visibility of severity.

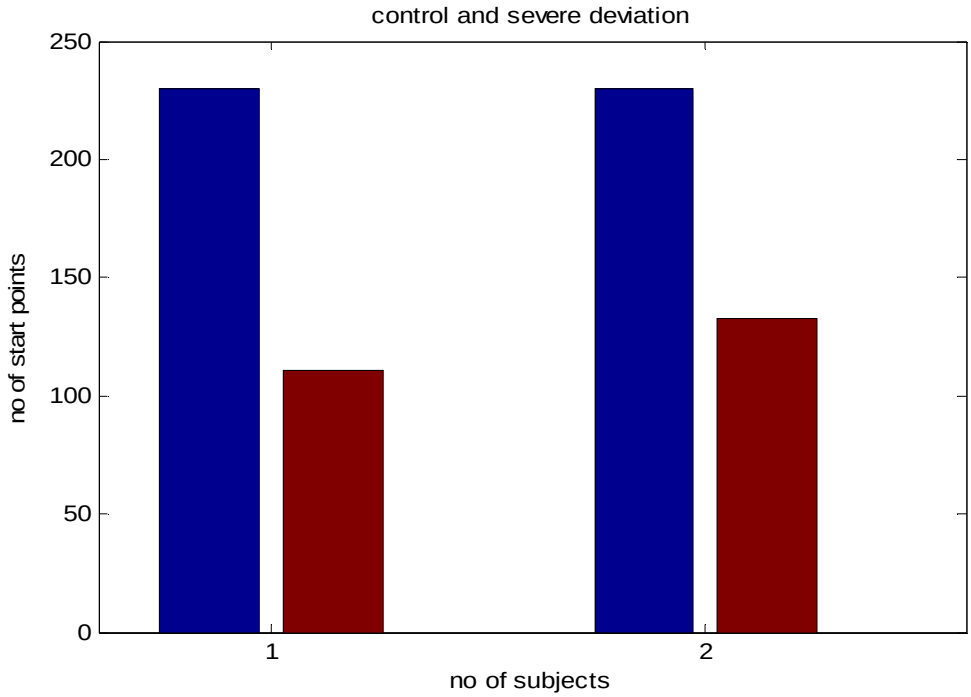


Fig.9 Comparison between start points of Reference and severe patients

B. Result of analysis with Gauss Wavelet

The analysis results of same control and pathological subjects with Gauss wavelet is indicated in Fig.10, 11 and 12. Table 1 indicates the parameters and their values used for determination of severity along with time consumed for analysis by different wavelet approach.

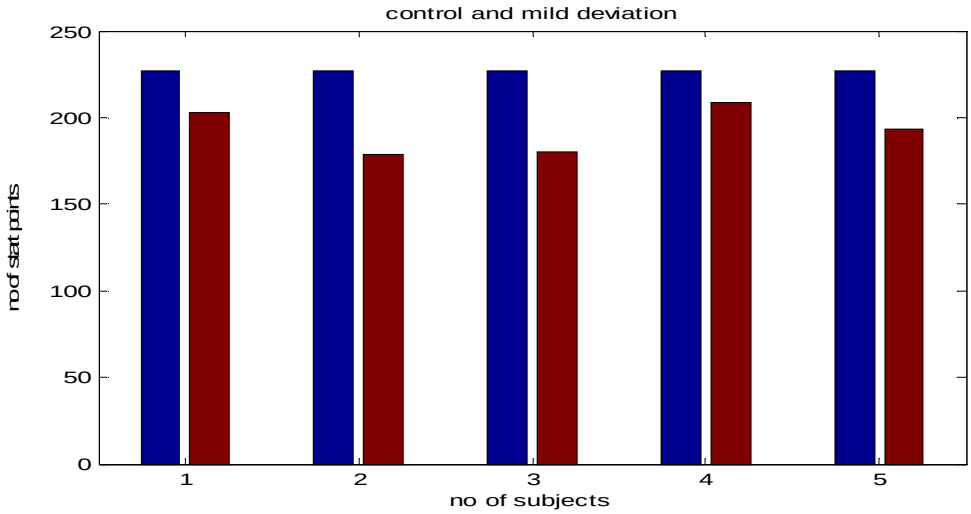


Fig.10 Comparison between start points of Reference and mild patients

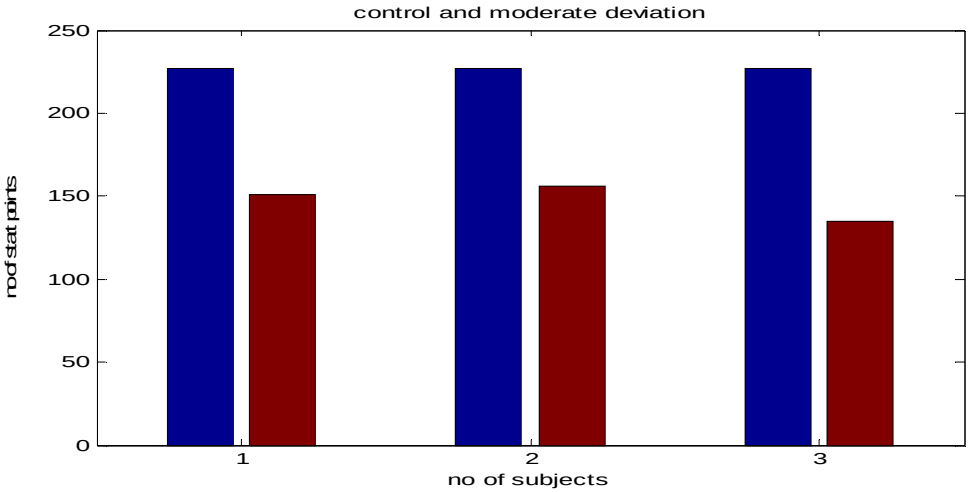


Fig.11Comparison between start points of Reference and moderate patients

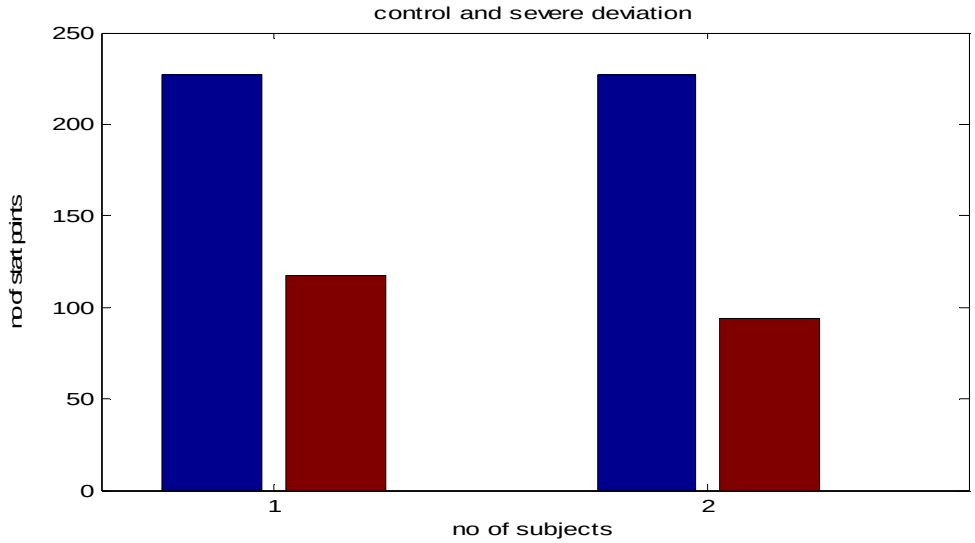


Fig.12 Comparison between start points of Reference and severe patients

TABLE I
VALUES USED FOR DETERMINATION OF SEVERITY

Subject	Number of Start Points	Time taken for analysis through Haar wavelet	Time taken for analysis through Gauss wavelet
Control	210-240	7.293486 seconds	6.380683 seconds
Mild	175-200		
Moderate	135-160		
Severe	Below 120		

IV. CONCLUSIONS

In this work, gait of normal control subjects is considered and is compared with that of pathological subjects suffering from ALS and severity level of disease is determined using wavelet analysis. Mild severity cases can also be treated, as the disease is detected at the early stage.Such early detection also helps in preventing the further growth of disease with proper medical treatment. Two different wavelets are used to determine the severity and both the wavelets yield similar results in the analysis and time taken by them is also compared. This method is less time consuming and can be used to judge the improvement in gait after treatment of the disease by medical practitioner.

V. ACKNOWLEDGMENT

The authors would like to thank the Management and Head of Institution of Global Academy of Technology, Rajarajeshwari Nagar, Bengaluru, India, for their encouragement and extended support by providing necessary facilities in executing the present work.

REFERENCES

[1] Jeffrey M. Hausdorff, [1, 2, 4]Apinya Lertratanakul,[1] Merit E. Cudkowicz[3,4] Amie L. Peterson,[2] David Kaliton,[2] and Ary L. Goldberger[1,4] "Dynamic markers of altered gait rhythm in amyotrophic lateral sclerosis" J ApplPhysiol 88: 2045–2053, 2000.

[2] Jeffrey M. Hausdorff, [1] Susan l. Mitchell,[1,2] Renee Firtion,[3] C. K. Peng,[4] Merit E. Cudkowicz,[5]Jeanney. Wei,[1] and Ary L. Goldberger[3,4] ,"Altered fractal dynamics of gait: reduced stride-interval correlations with aging and Huntington's disease", 1997 the American Physiological Society,pp.262-269.

[3] Jeffrey M. Hausdorff, PhD, $"Merit E. Cudkowicz, MD, 'y§RenCeFirtion, BS, *'FiiJeanneY . Wei, MD, PhD, and T Ary L. Goldberger, MD," Gait Variability and Basal Ganglia Disorders: Stride-to-Stride Variations of Gait Cycle Timing in Parkinson's Disease and Huntington's Disease" Movement Disorders Vol. 13, No. 3, 1998, pp.428-437.

[4] Jeffrey M Hausdorff "gait variability: methods, modeling and meaning" Journal of NeuroEngineering and Rehabilitation2005, pp.2:19.

[5] Yunfeng Wu* and Sin Chun Ng ," A PDF-Based Classification of Gait Cadence Patterns in Patients with Amyotrophic Lateral Sclerosis" 32nd Annual International Conference of the IEEE EMBS Buenos Aires, Argentina, August 31 - September 4, 2010, pp.1304-1307.

[6] Wajid Aziz Æ Muhammad Arif," Complexity analysis of stride interval time series by threshold dependent symbolic entropy" Eur J ApplPhysiol (2006) 98: 30–40.

[7] Yunfeng Wu Æ Sridhar Krishnan," Computer-aided analysis of gait rhythm fluctuations in amyotrophic lateral sclerosis", Med BiolEngComput (2009) 47:1165–1171.

[8] Yi Xia,[1]Qiang Ye,[2]Qingwei Gao,[1]Yixiang Lu,[1] and Dexiang Zhang[1], "Symmetry Analysis of Gait between Left and Right Limb Using Cross-Fuzzy Entropy" Hindawi Publishing Corporation Computational and Mathematical Methods in Medicine Volume 2016, Article ID 1737953, pp. 1-9.

[9] SasaRadovanović, Milena Milićev, StojanPerić, IvanaBasta, and ZoricaStević, "Gait in amyotrophic lateral sclerosis: Is gait pattern differently affected in spinal and bulbar onset of the disease during dual task walking?", Amyotrophic Lateral Sclerosis and Frontotemporal Degeneration, Vol. 15, Iss. 7-8 2014, pp 488-493."PDCA12-70 data sheet," Opto Speed SA, Mezzovico, Switzerland.

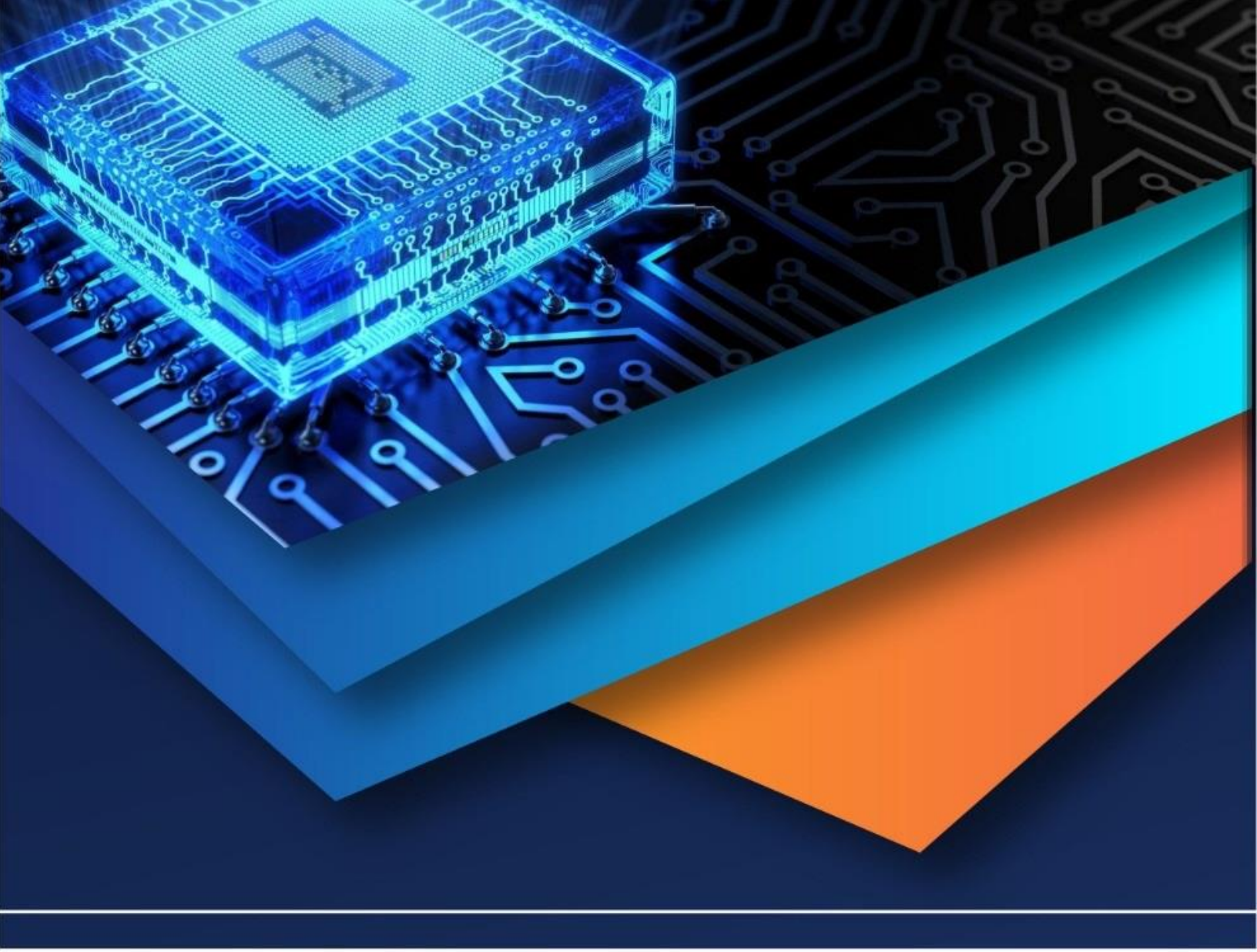
[10] Wu Y, Shi L. "Analysis of altered gait cycle duration in amyotrophic lateral sclerosis based on nonparametric probability density function estimation" , Med Eng Phys. 2011 Apr;33(3):347-55.

[11] Aishwarya DKS, H K Shreedhar, Anandthirtha B Gudi, "Estimation of Severity of Amyotrophic Lateral sclerosis Using Signal Processing Techniques", ICSPACE -2017.

[12] www.physionet.org.

[13] Mohammad Reza Daliri, "Automatic diagnosis of neuro-degenerative diseases using gait dynamics",Measurement, Journal of the International Measurement Confederation , Volume 45, Issue 7, August 2012,pp. 1729-1734

[14] SuleymanBilgin, "The impact of feature extraction for the classification of amyotrophic lateral sclerosis among neurodegenerative diseases and healthy subjects", Biomedical Signal Processing and Control-2017, Volume 31, pp 288-297.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY