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Abstract **-** Parkinson's disease (PD) is a gradual progressive central neurodegenerative disorder that affects body movement and is characterized by symptoms such as muscle rigidity, resting tremors, loss of facial expression, hypophonia, diminished blinking, and akinesia [4]. This work aims at providing new insights on the Parkinson's disease fragmentation problem using wavelets [1, 2, 3]. The present work describes a computer model to provide a more accurate picture of the Parkinson's disease (PD) signal processing via Wavelet Transform [7, 8, 9, 10]. The Matlab techniques have been uses which provide a system oriented scientific decision making modal [7, 8]. Within this practice the applied signal has been compared in a sequential order with dissimilar cases in attendance in the database. Special biomedical signals have been considered from Gait in Aging and Disease Database [6] and Physio bank [5]. Analyze the signal under consideration and renowned the holder 100% truthfully.

Keywords— *Parkinson's disease (PD), Matlab, Short Time Fourier Transform (STFT) Continuous Wavelet Transform (CWT).*

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I. CONTINUOUS WAVELET TRANSFORM

The continuous wavelet transform (CWT) is a time–frequency analysis method which differs from the more traditional short time Fourier transform (STFT) by allowing arbitrarily high localization in time of high frequency signal features. The CWT does this by having a variable window width, which is related to the scale of observation—a flexibility that allows for the isolation of the high frequency features. Another important distinction from the STFT is that the CWT is not limited to using sinusoidal analyzing functions. Rather, a large selection of localized waveforms can be employed as long as they satisfy predefined mathematical criteria [2, 3].

Virtues of Wavelet transform in contrast with STFT and Wigner-Ville Distribution [3].

- The Fourier transforms of the windowed signals are not taken, and therefore single peak will be seen corresponding to a sinusoid, i.e., negative frequencies are not computed.
- The width of the window is changed as the transform is computed for every single spectral component, which is probably the most significant characteristic of the Wavelet transform.
- No cross term calculations and aliasing effect as in the Wigner-Ville Distribution which is have much better resolution than STFT.

II. OVERVIEW OF PARKINSON'S DISEASE.

Parkinson's disease is a neurodegenerative brain disorder that progresses slowly in most people. Brain cells or neurons in the human brain that produce dopamine. Dopamine is a chemical that relays messages between the substantia nigra and other parts of the brain to control movements of the human body. Dopamine helps humans to have smooth coordinated muscle movements. When approximately 60 to 80% of the dopamine-producing cells are damaged, and do not produce enough dopamine, the motor symptoms of Parkinson's disease appear. This process of impairment of brain cells is called neurodegeneration [4].

A. Symptoms in Parkinson's disease [4].

Motor Symptoms:

- Bradykinesia (slowness of movement)
- Rigidity (stiffness of movement)
- Tremor (involuntary shaking of the hands, feet, arms, legs, jaw, or tongue, usually more prominent at rest)
- Postural Instability (tendency to fall without explanation, usually when pivoting)

Non-Motor Symptoms:

- Mood (depression, anxiety, irritability)

- Cognitive changes (attention, visuo-spatial problems, memory problems, personality changes, psychosis/hallucinations).
- Orthostatic hypotension (lightheaded and low blood pressure upon standing)
- Constipation and early satiety (a feeling of fullness after eating small amounts)
- Hyperhidrosis (excessive sweating), especially of hands and feet
- Seborrhea dermatitis (dry skin) dandruff
- Urinary urgency, frequency and incontinence
- Loss of sense of smell (Anosmia)
- Sleep disorders
- Insomnia, Excessive Daytime Sleepiness (EDS), Rapid Eye Movement Behavioral Disorder (RBD) or active dreaming, dream enactment, involuntary movements and vocalizations during sleep, Restless Legs Syndrome (RLS)/Periodic Leg Movements Disorder (PLMD)
- Sensory (pain, tightness, tingling, burning)

Mixed Motor and Non-Motor Symptoms:

- Drooling due to slowed swallowing (Sialorrhea)
- Speech and swallowing problem

B. 10 Early Warning Signs of Parkinson's Disease [4].

Sometimes it is hard to tell that you might have Parkinson's disease. If you do have Parkinson's, you can feel better by taking a pill that helps your body to replace that chemical dopamine. Parkinson's disease will get worse slowly over time, and your doctor can help you stay healthy longer. Some of the problems listed here could be signs of Parkinson's disease.

1. Tremor or Shaking.
2. Small Handwriting.
3. Loss of Smell.
4. Trouble Sleeping.
5. Trouble Moving or Walking.
6. Constipation.
7. A Soft or Low voice.
8. Masked Face.
9. Dizziness and Fainting.
10. Stooping or Hunching Over.

If more than one symptom is persisting, it should be advisable to make an appointment to talk with a doctor. Early diagnosis of Parkinson's disease gives the best chance of a longer, healthier life.

C. First steps of a man can do if he does have Parkinson's disease:

- Work with a doctor to create a plan to stay healthy.
- Start a regular exercise program to delay further symptoms.
- Talk with family and friends who can provide the support that is needed.

D. Diagnosis [4].

There is no "one way" to diagnose Parkinson's disease (PD). However, there are various symptoms and diagnostic tests used in combination. One of the most important things to remember about diagnosing PD is that there must be two of the four main symptoms present over a period of time for a neurologist to consider a PD diagnosis as given bellow.

- Shaking or tremor.
- Slowness of movement, called bradykinesia.
- Stiffness or rigidity of the arms, legs or trunk.
- Trouble with balance and possible falls, also called postural instability.

A neurologist will make a thorough diagnosis based on

- A detailed medical history and physical examination.
- A detailed history of your current and past medications, to make sure you are not taking medications that can cause symptoms similar to PD.
- A detailed neurological examination during which a neurologist will ask you to perform tasks to assess the agility of arms and legs, muscle tone, your gait and your balance.
- You may notice that a neurologist records your exam into a table, called United Parkinson's Disease Rating Scale (UPDRS). UPDRS is a universal scale of PD symptoms and it was created to comprehensively assess and document the exam of the patient with PD and be able to compare it with patient's future follow up visits, or to communicate about the progression of the PD symptoms in each patient with other neurologists.
- The response to medications (that imitate or stimulate the production of Dopamine) causing a significant improvement in symptoms is how the diagnosis of PD is made clinically.

A number of patients with Parkinsonism do not have PD. Only 85% of all Parkinsonian syndromes are due to Parkinson's disease. Certain medications, vascular problems, and other neurodegenerative diseases can cause the symptoms similar to Parkinson's disease. In fact, early in the disease process it may be difficult to know whether a patient has typical Parkinson's disease or a syndrome that mimics it. The development of additional symptoms and the subsequent course of the disease generally points to the correct diagnosis.

Neurodegenerative diseases causing Parkinsonism are commonly grouped together under the category of Atypical Parkinsonism or Parkinsonism – plus syndromes. The plus part means, that in addition to expected symptoms of PD, patients have some atypical symptoms as well. Atypical Parkinsonism should be considered particularly in patients with:

- Poor response to dopamine
- Early loss of balance
- Prominent intellectual changes (dementia)
- Rapid onset or progression
- Conspicuous postural hypotension, urinary and bowel incontinence
- Little or no tremor.

E. Treatment for Parkinson's disease[4].

Currently, there is no cure for Parkinson's disease. Instead, therapy is directed at treating the symptoms that are most bothersome to an individual with Parkinson's disease. For this reason, there is no standard or "best" treatment for Parkinson's disease that applies to every patient.

Treatment approaches include

- Medication therapy
- Surgical therapy
- Complementary Treatment
- General lifestyle modifications (rest and exercise),
- Physical therapy,
- Support groups,
- Occupational therapy and speech therapy
- Swallowing therapy

Recent studies have implicated that a treatment is better than no treatment. In other words, medications and therapies may modify the progression of Parkinson's disease.

III. SIGNAL DATA

This data has been collected from Gait in Aging and Disease Database. Walking stride interval time series included are from 3 subjects: 1 healthy young adult (23 years old), 1 healthy old adult (74 years old), and 1 older adult (60 years old) with Parkinson's disease [5, 6]. Subjects walked continuously on level ground around an obstacle-free path. The stride interval was measured using ultra-thin, force sensitive resistors placed inside the shoe. The analog force signal was sampled at 300 Hz with a 12 bit A/D converter, using an ambulatory, ankle-worn microcomputer that also recorded the data. Subsequently, the time between foot-strikes was automatically computed.

Data were collected from the healthy subjects as they walked in a roughly circular path for 15 minutes and from the subject with Parkinson's disease as they walked for 6 minutes up and down a long hallway.

IV. PROJECT IMPLEMENTATION

This project has implemented by developing system model software in Matlab by means of continuous wavelet transform [7, 8]. In general the biomedical signals are in waveform appearance. The signals of the proposed project are transformed into numerical vales using a specified soft ware [9, 10]. Wavelet coefficients or mathematical polynomials are generated and a data bank has developed. A case classification programme has established to categorize the given signal by comparing it with all those signals present in the data bank [9, 10].

The present work describes the appliance of Wavelet Transform to provide a more perfect picture for case identification under consideration via the localized time-scale features.

V. PROJECT RESULS

A. Case1: Parkinson's disease person database signal.

The order of the equations P1, P2 …P47 is 5 and the coefficients are arranged in decreasing order. The total numbers of samples 222 are shaped into 47 parts [7, 8] for better accuracy in matching points.

Part P1: (1.820534923502013e-003)*x^5

+ (-2.397428629402537e-001)*x^4

+ (1.259547282799776e+001)*x^3

+ (-3.300065994458325e+002)*x^2

+ (4.312028543014423e+003)*x^1

+ (-2.247862248109630e+004)*x^0

For a time interval

22.9400< t < 29.9467

Part P47:(5.331961090358508e-013)*x^5

*+ (7.830016804990667e-012)*x^4*

+ (2.602935468695543e-008)*x^3

*+ (-4.007274452064722e-006)*x^2*

*+ (-1.214317913252819e-003)*x^1*

*+ (-3.661033047232897e-038)*x^0*

For a time interval

297.8967 < t < 299.2133

After analyzing and processing the signal an equation is consequent for each part using the continuous wavelet transforms and the resultant is plotted [8, 9] as shown in Fig.1.

The first subplot shown in Fig. 1 represents the equation plot superimposed on the original plot for the purpose of knowing the difference between actual signal and generated signal. This superimposed plot is being in solitary color which represents that the two signals are precisely identical. The second subplot in Fig.1 represents original plot and the third subplot represents the Equation plot.

The Wavelet coefficients of the resultant for the above signal have been plotted in MATLAB [9, 10] as shown in Fig. 2.

B. Case2: 23 years old person database.

The order of the equations B1, B2 …B67 is 5 and the coefficients are arranged in decreasing order. The total numbers of samples 730 are shaped into 67 parts [7, 8] for better accuracy in matching points.

Part B1: (-3.198544128366736e-008)*x^5

*+ (7.211037489213341e-006)*x^4*

+ (-6.271256705645551e-004)*x^3

*+ (2.619021689316892e-002)*x^2*

*+ (-5.235644716471661e-001)*x^1*

*+ (5.123196155490905e+000)*x^0*

For a time interval

30.893 < t < 68.9530

Part B67 : (-4.162158619155750e-010)*x^5

*+ (1.968726534746877e-006)*x^4*

+ (-3.241513193948995e-003)*x^3

*+ (2.266189670954448e+000)*x^2*

*+ (-5.760455965281478e+002)*x^1*

*+ (-8.365844378226234e-016)*x^0*

For a time interval

865.4900 < t < 868.8830

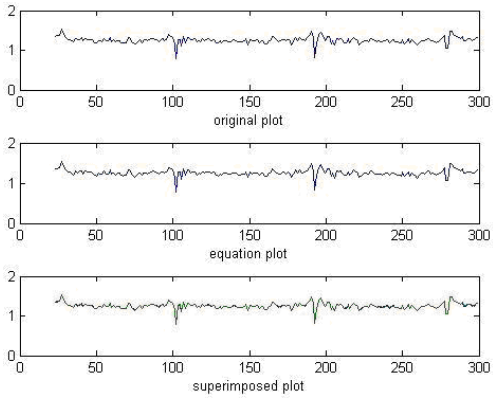

Figure 1.Parkinson's disease person database signal.

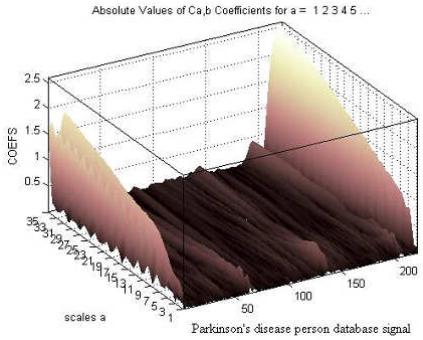

Figure 2.Parkinson's disease person database signal

After analyzing and processing the signal an equation is consequent for each part using the continuous wavelet transforms and the resultant is plotted [8, 9] as shown in Fig.3.

The first subplot shown in Fig. 3 represents the equation plot superimposed on the original plot for the purpose of knowing the difference between actual signal and generated signal.

This superimposed plot is being in solitary color which represents that the two signals are precisely identical. The second subplot in Fig.3 represents original plot and the third subplot represents the Equation plot.

The Wavelet coefficients of the resultant for the above signal have been plotted in MATLAB [9, 10] as shown in Fig. 4.

C. Case3: 74 years old person database.

The order of the equations C1, C2 …C138 is 5 and the coefficients are arranged in decreasing order. The total numbers of samples 720 are shaped into 138 parts [7, 8] for better accuracy in matching points.

Part C1 : (-4.805055538242150e-003)*x^5

*+ (7.937914255001837e-001)*x^4*

+ (-5.240562131419815e+001)*x^3

*+ (1.728319691792455e+003)*x^2*

*+ (-2.847384653026902e+004)*x^1*

*+ (1.874725469057422e+005)*x^0*

For a time interval

30.290 < t < 35.9870

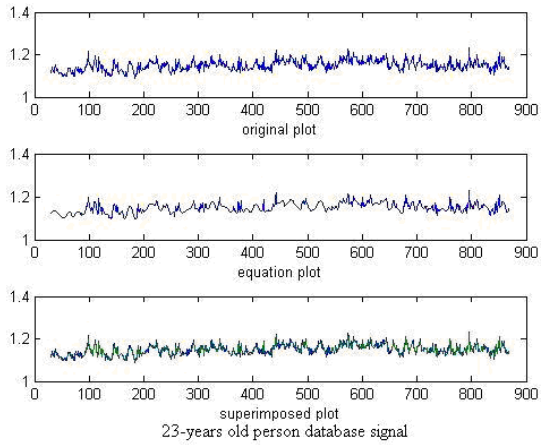

Figure 3.23-Years' old person database signal

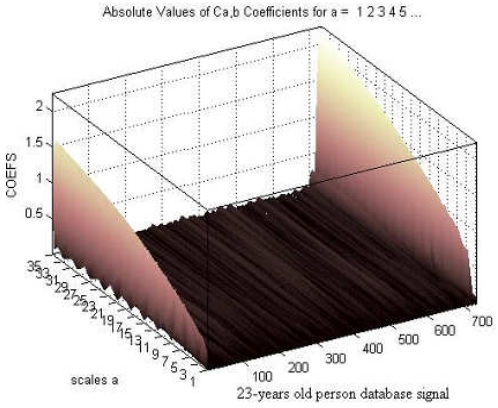

Figure 4.23-Years' old person database signal

Part C138 : (4.594339744688165e-009)*x^5

+ (-2.357194019661304e-005)*x^4

+ (4.060132536782893e-002)*x^3

+ (-2.922313556770773e+001)*x^2

+ (7.583093172275871e+003)*x^1

+ (-1.251203854008103e-014)*x^0

For a time interval

866.4630 < t < 869.8730

After analyzing and processing the signal an equation is consequent for each part using the continuous wavelet transforms and the resultant is plotted [8, 9] as shown in Fig.5.

The first subplot shown in Fig. 5 represents the equation plot superimposed on the original plot for the purpose of knowing the difference between actual signal and generated signal.

This superimposed plot is being in solitary color which represents that the two signals are precisely identical. The second subplot in Fig.5 represents original plot and the third subplot represents the Equation plot.

The Wavelet coefficients of the resultant for the above signal have been plotted in MATLAB [9, 10] as shown in Fig. 6.

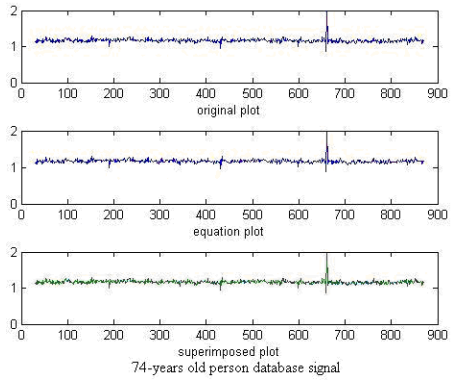

Figure 5.74 -Years' old person database signal

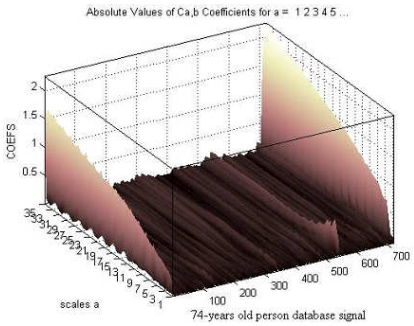

Figure 6.74-Years' old person database signal

VI. ASSESSMENT

Form figures 1, 3 and 5 at different time instants those are at 100, 200, 300sec. in these three Fig., and 400, 500, 600, and 700 sec. in Fig.3 and 5 it is the imperative summit to learn. In these figures and the signal strength is comparable. Considering subplots 2 or 3 in figures 1, 3 and 5 the signal strength is swindle to infer erroneous diagnosis. Similarly from figures 2, 4 and 6 at around different samples location which are at 50,150 &200 samples in Fig.2 and 300,400,500 & 600 in addition in Fig.4 &6 it can be easily identifies the difference among them. An analogous intricacy in the midst of cases exposed in figures 2 and 4. As considered at 60 and 140 samples in figures 2 and 350 and 550 at higher frequency scale, the coefficients strength is harmonizing and at stumpy frequency scale it is quite difficult to identify the disparity. Hence likelihood for deceitful diagnosis. The complexity in building a declaration has been eliminated efficiently with this exertion.

VII. CONCLUSIONS

Most prominently as the signal is analyses through system oriented it eliminates the human indiscretion which may be allied with a medical doctor in the Parkinson's disease psychoanalysis. This medical diagnosis is safer and more rapid. The Gait in Aging and Disease Database signal so analyzed can be premeditated by an expert sitting at aloofness through internet thereby enabling long distance diagnoses possible.

VIII. PROSPECT INNOVATION

In the deficiency of a doctor, the program can itself give the report of the stipulation of the patient. Emergent an embedded system it is quite possible to assist the medical practitioners in making further precise and swift diagnosis.

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