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A NOVEL APPROACH FOR FILTERING EEG SIGNALS

Syed Mohammad Imran Ali[1],Shaik Shahnaaz Mehtaj[2],Shaik Abdul Basith[3]

ABSTRACT

A novel neural data handling design propelled by quantum mechanics and fusing the notable Schrodinger wave condition is proposed in this paper. The proposed engineering alluded to as intermittent quantum neural system (RQNN) can portray a no stationary stochastic flag as time-shifting wave parcels. A hearty unsupervised learning calculation empowers the RQNN to successfully catch the measurable conduct of the info flag and encourages the estimation of flag inserted in clamor with obscure attributes. The outcomes from various benchmark tests demonstrate that basic flags, for example, dc, staircase dc, and sinusoidal signs installed inside high clamor can be precisely filtered and molecule swarm enhancement can be utilized to choose show parameters. The RQNN separating method is connected in a two-class engine symbolism based brain–computer interface where the goal was to channel electroencephalogram (EEG) motions before highlight extraction and classification to build flag distinguishableness. A two-stage inner–outer fivefold cross-approval approach is used to choose the calculation parameters subject-particularly for nine subjects. It is demonstrated that the subject-specific RQNN EEG filtering essentially enhances brain–computer interface execution contrasted with utilizing just the crude EEG or Savitzky–Golay separated EEG over different sessions.

Index Terms: Brain–Computer Interface (BCI), Electroencephalogram (EEG), Recurrent Quantum Neural Network (RQNN)

I. INTRODUCTION

The enabling technology that encompasses the fundamental theory, applications, algorithms, and implementations of processing or transferring information contained in many different physical, symbolic, or abstract formats broadly designated as signals is called signal processing.

The Various techniques for improving the accuracy and reliability of digital communications is called digital signal processing. Clarifying, or standardizing, the levels or states of a digital signal is done by DSP.Signal processing is a very important field of study and one that makes possible various other fields such as communications. ... Speech recognition systems such as dictation software need to analyze and process signal data to identify individual words in a spoken sentence. The signals processed in this manner are a sequence of numbers that represent samples of a continuous variable in a domain such as time, space, or frequency.Digital signal processing and analog signal processing are subfields of signal processing. ... DSP is applicable to both streaming data and static (stored) data.

Digital signal processing has a wide variety of applications, including:

- Audio and video compression (the quality depends on the sampling rate chosen - higher sampling rate = higher quality. The file size can be compressed by applying source coding, such as Huffman coding.)
- Audio signal processing (example: applying a low pass or bandpass filter to reduce external noise from an audio recording).
- Image processing (example: using FFT, filtering and inverse FFT in order to remove noise from an image.
- Medical applications (example: applying a histogram equalization to enhance an x-ray image).

BRAIN–COMPUTER interface (BCI) innovation is a method for correspondence that permits people with extreme development inability to speak with outside assistive gadgets
utilizing the electroencephalogram (EEG) or other cerebrum signals. In engine symbolism (MI)- based BCIs, the subject plays out a mental creative energy of specific developments. This MI is converted into a control motion by arranging the specific EEG design that is normal for the subject's envisioned errand, e.g., development of hands or potentially foot. These crude EEG signals have a low flag to-clamor (SNR)proportion in light of the obstruction from the electrical cable, movement antiquities, electromyogram (EMG)/electrooculogram impedance. Preprocessing is done to evacuate such undesirable segments installed inside the EEG flag and great preprocessing brings about increment in flag qual-ity bringing about better component distinguishableness and arrangement execution

II. EXSISTING METHOD

A few critical adjustments have been made with reference to [1]. To begin with, the determination of subject-particular RQNN demonstrate parameters utilizing a two-stage inner–outer fivefold cross-approval and a molecule swarm streamlining (PSO) ,procedure, and second, the scaling of the information EEG flag bringing about diminishing the scope of development of the wave parcel and in addition the quantity of spatial neurons. As talked about in Section IX, this model is exhibited to deliver a stable sifted EEG that outcomes in a measurably upgrade in the execution of BCI framework which is relevant over various sessions and is additionally superior to anything a portion of the current separating strategies in the field including Savitzky–Golay (SG) and Kalman channel.

QM hypothesis is to a great degree effective in portraying the procedure we find in nature [3]. Dawes in [4] and [5],[7] proposed a novel model—aparametric torrential slide stochastic channel utilizing the idea of time-changing pdf proposed by Bucy in [9]. This paper was enhanced by Behera et al. [2], [6], [8] utilizing most extreme probability estimation (MLE) rather than converse channel in the criticism circle. Advance, Ivancevic in [18] gave an expository examination of nonlinear Schrodinger condition and utilized the shut frame answer for the concerned application. Since the RQNN approach does not make any suspicion about the nature and state of the clamor that is inserted in the flag to be sifted, this approach is most appropriate for those signs where the qualities of the implanted commotion is not known. EEG signs are one of these sorts of signs where the qualities

of the implanted clamor is not known and consequently this paper exhibited here on EEG flag separating is firmly roused by these works.

III. PROPOSED METHOD

This paper concentrates on EEG flag preprocessing using the ideas of quantum mechanics (QM) and neural system hypothesis in a structure alluded to as repetitive quantum neural system (RQNN).

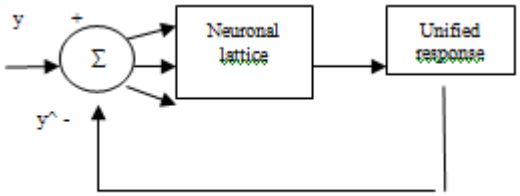

Fig1: Conceptual Frame Work Of RQNN Model

Above figure demonstrates a fundamental design of RQNN model in which every neuron intervenes a spatio-worldly fi with a bound together quantum enactment work as Gaussian that totals pdf data from the watched loud information flag. Hence the arrangement of SWE (which is perplexing esteemed and whose modulus square is the pdf that confines the position of quantum question in the vector space) gives us the initiation work. From a scientific perspective, the time-subordinate single-measurement nonlinear SWE is a fractional differential condition portraying the progression of wave parcel (modulus-square of this wave is the pdf) within the sight of a potential field (or capacity) (which is the drive field in which the particles characterized by the wave capacity are compelled to move) [12]. In this manner the RQNN model depends on novel idea that a quantum protest intercedes the aggregate reaction of a neural grid (a spatial structure of a variety of neurons where every neuron is a basic computational unit as appeared in Fig. 1 and clarified in detail in Section II) [13], [14].

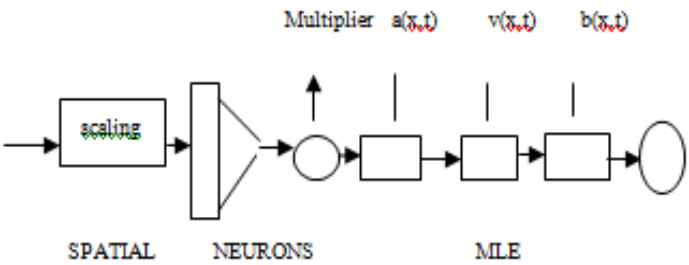

Fig2: Signal Estimation using RQNN model

In the design utilized as a part of this paper (Fig. 2), the spatial neurons are energized by the information flag y(t). The contrast between the yield of spatial neuronal system and the pdf deciphered as the discrete form of

quantum space with the determination inside this discrete space being alluded to as δx (taken as 0.1 in this paper). Consequently all the conceivable estimations of x will develop the quantity of spatial neurons N for RQNN model.On the premise of MLE, the weights are refreshed and another potential V (x , t) is set up for whenever advancement. It is normal that the synaptic weights W (x , t) advance in such a way in order to drive the ψ capacity to convey the correct data of pdf of the sifted flag yˆ(t). To accomplish this objective, the weights are refreshed utilizing the accompanying learning guideline

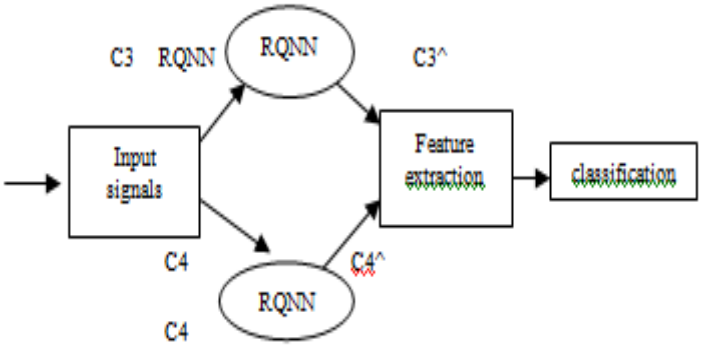

Fig 3:RQNN Frame Model for EEG Signal Enhancement

Fig. 3 demonstrates the position of RQNN model inside the BCI framework. The crude EEG flag is bolstered one specimen at any given moment and an improved flag is gotten subsequently of sifting procedure. The crude EEG is initially scaled in the range 0–2 preceding it is sustained to the RQNN show. Amid the disconnected classifier preparing process, every one of the trials from a specific channel of EEG are accessible. Accordingly, the entire EEG is scaled utilizing the most extreme of abundancy incentive from that particular channel. Amid the online procedure, the EEG flag is roughly scaled in the range 0–2 utilizing the greatest of adequacy esteem acquired from the disconnected preparing information of that particular channel. The net impact is that the info motion amid the online procedure is additionally kept up roughly in the locale 0–2, and this empowers the following of test utilizing a lessened scope of the development of wave parcel. Likewise, the quantity of spatial neurons has additionally been diminished along the x - pivot from a prior estimation of 401 to 612 in the present case. The essential supposition in doing this is the obscure nonstationary and advancing EEG motion amid the assessment stage will remain inside the bound of the scope of 61 spatial neurons which can cover them input flag run up to three. On the off chance that the scaling of the info flag is not executed, then the quantity of neurons required to cover the information flag range will be bigger along these lines prompting to an expanded computational cost. This is an imperative alteration in [19] and the scaling of EEG is presently managed according to the preparation informational index. Amid the disconnected preparing process, the total arrangement of scaled EEG motion (here signs from channels C3 and C4 examined in Section VI) is bolstered through the two RQNNs, separately (see Fig. 3), and a separated gauge of the flag is acquired for the specimens from both these channels.

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IV. SIMULATION RESULTS

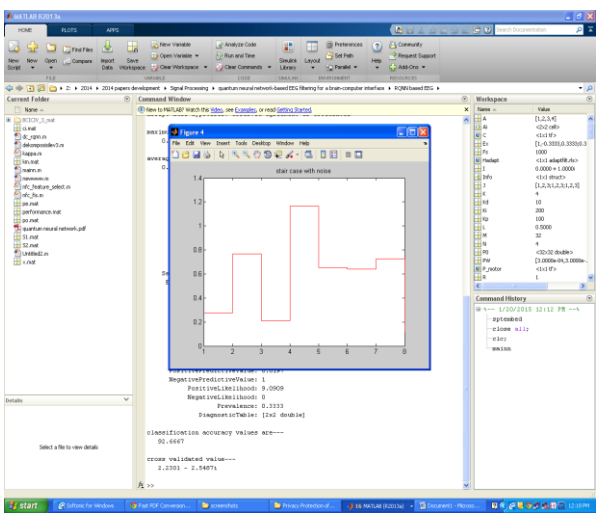

FIG 1:STAIRCASE WITH NOISE

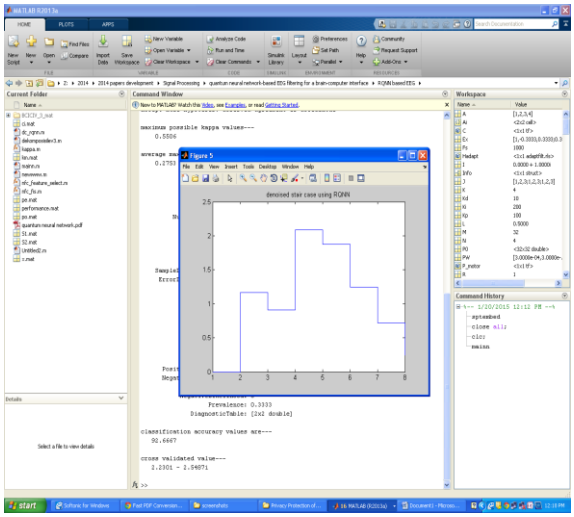

FIG 2: DENOISED STAIRCASE USING RQNN

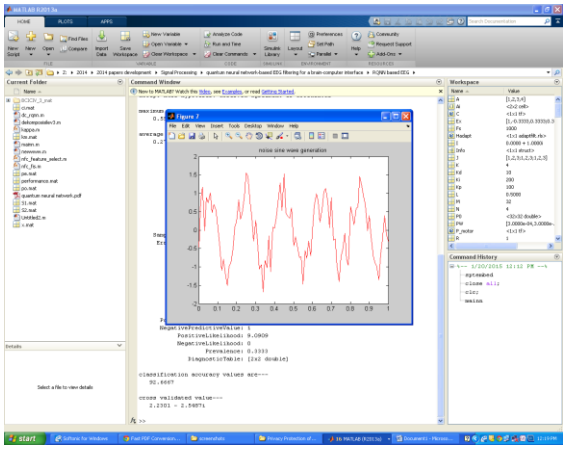

FIG 3:NOISE SINE WAVE GENERATION

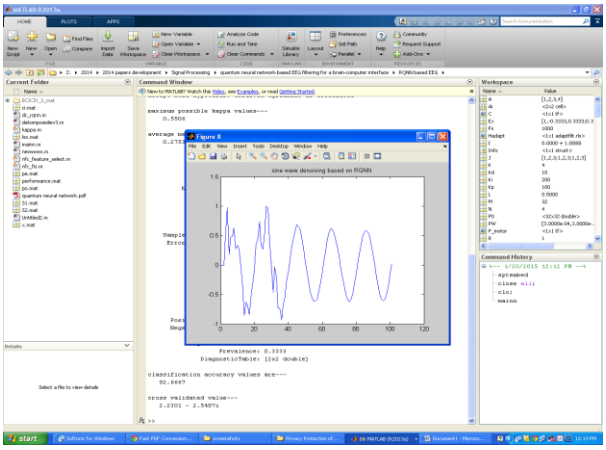

FIG 4:SINE WAVE DENOISING BASED ON RQNN

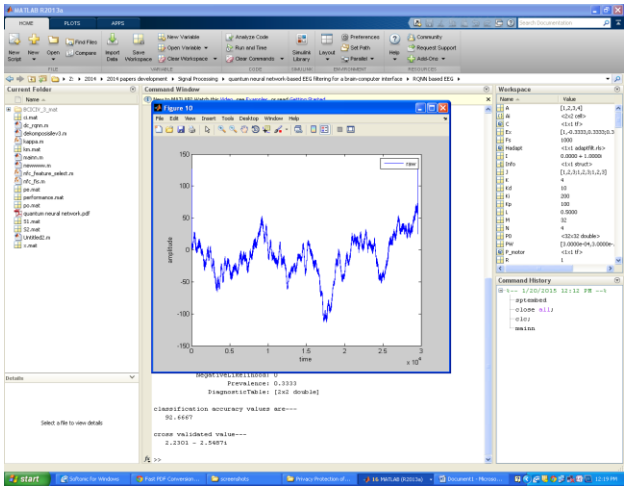

FIG 5: A RAW EEG SIGNAL

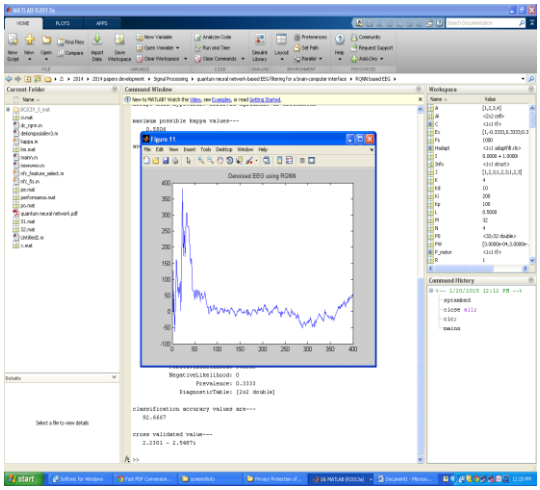

FIG 6: A DENOISED EEG SIGNAL

IV. CONCLUSION

The RQNN was assessed with contextual analyses of straightforward signs and the outcomes demonstrate that the RQNN is essentially superior to the Kalman channel while separating the dc flag included with three distinctive commotion levels. The learning design at the assessment stage to look at the execution utilizing diverse techniques. From the outcomes showed in Table VII, specifi watching the execution of subject B03, there is by all accounts an enormous distinction in the most extreme of kappa qualities acquired with BSP (0.29)/PSD (0.27) contrasted with that with the crude (0.84) and the RQNN (0.89) approaches. This might be on the grounds that, the BSP and PSD systems are recurrence based, while the crude and the RQNN methods in this paper have utilized a blend of recurrence (band power) and worldly based (Hjorth) highlights. To substantiate this, we actualized the inner–outer fivefold cross-approval utilizing just the band control highlights for both the crude and the RQNN. The subsequent normal execution for assessment organizes as far as CA (and greatest of kappa qualities) for subject B03 was 61.9 (0.25) and 58.12 (0.16), separately, with the RQNN and the crude methodologies. In this way it might be expressed here that the RQNN sifting upgrades the execution of BCI when contrasted with the crude EEG, yet the expansion in execution when contrasted with BSP and PSD may likewise be ascribed to the utilization of a mix of recurrence and fleeting components. It can in this manner be closed from these outcomes that the RQNN enhances the normal execution of BCI framework for every one of the subjects amid both the preparation and the assessment stages when contrasted with the unfiltered EEG, SG-sifted EEG, and even PSD and BSP highlights based methodologies. Similar informational indexes were additionally handled and classify by a few prestigious specialists as contenders of BCI Competition IV 2b-informational collection [45] which is likewise talked about in [35]. The execution of RQNN (Table VII) is additionally essentially superior to anything the ones acquired by the victors of BCI rivalry in [45]6 The opposition champ utilized the channel bank CSP procedure for FE alongside the Naive Bayes Parzen window classifier. The runner-up gathering utilized normal spatial subspace decay strategy for FE took after by LDA classifier. The third gathering utilized a CSP took after by log-fluctuation systems for FE and the best (at preparing stages) of LDA and SVM classifier. The fourth gathering utilized wavelet method took after by a LDA classifier and it utilized ghastly elements before a neural system classifi . The 6th gathering gauges 75 band control highlights with their cursive component disposal system with a Bayesian LDA classifier [35]. A portion of the contenders of Competition IV utilized just session 3 for preparing, while some utilized joined sessions from the three instructional meetings (consolidating 1, 3, or 1, 2, or 1, 2, 3) distinctively for various subjects and assessed on session 4 and 5 [46]–[51]. In this paper, just session 3 is utilized for preparing, while the sessions 4 and 5 are utilized for assessment. The outcomes consequently demonstrate that without earlier learning of the kind of commotion qualities exhibit in EEG, the RQNN can be used to improve EEG flag distinctness and that the quantum approach-based separating strategy can be utilized as a flag preprocessing technique for BCI.

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Mr.S.MD.Imran Ali has pursued his B.Tech from SAFA College of Engg.& Tech, Kurnool and M.Tech from SKTMCE , Kondair. Presently he is working as Asst.Prof in Dept of ECE of Brindavan Institute of Technology & science, Kurnool. He has published 6 International Journals .His research areas of interest are VLSI for signal & Image processing, Wireless communications, Antenna design, Analog & Digital communications, Digital integrated circuit design.

Miss Shaik Shahnaaz Mehtaj is pursuing B.Tech from BITS in the department of ECE

Mr Shaik Abdul Basith is pursuing B.Tech from BITS in the department of ECE