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A Novel Approach for Video Encryption Based on FRFT-DWT with Shifting Wavelets

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EDITORIAL BOARD EXCERPT Initially at the Time of Submission (ToS) submitted paper had a 3% plagiarism, which is an accepted percentage for publication. The editorial board is of an observation that paper had a successive close watch by the blind reviewer's which at a later stage had been rectified and amended by the authors (Sudhansh) in various phases as and when required to do so. The reviewers' had in a preliminary stages remark with minor revisions which at a short span were restructured by the author. The comments related to this manuscript are tremendously noticeable related to the **An Approach for Video Encryption Based on FRFT-DWT with Shifting Wavelets** both subject-wise and research wise by the reviewers during evaluation and further at blind review process too. The authors have crafted the paper in a structured manner. As in the internet era sharing of data has become very insecure. Available encryption technologies are not proper and suitable for video data. The paper has very well presented the encryption based on FRFT-DWT, for the security of videos to make retrieval of information almost impossible. Overall the paper promises to open newer facets of studies. All the comments had been shared at a variety of dates by the author in due course of time and same had been integrated by the author in calculation. By and large all the editorial and reviewers' comments had been incorporated in paper at the end and further the manuscript had been earmarked and decided under "**Empirical Research Paper**" as an encryption technique for video encryption based on FRFT-DWT is presented in the study. Results are noteworthy and remarkable.

ABSTRACT

Purpose: Due to increase in speed and use of internet, data becoming more and more insecure. In such case, if you are sharing your useful data over internet, meansinviting data insecurity. One important data is video which can be personal or criminal evidence. Sharing is a video is common nowadays but one issue is, how one can share its personal video to friends or trustworthy person over the internet. Although,there are many encryption techniques available but they are usually suitable for textual data. Traditional encryption is not good for video which is such large multidimensional data, hence such method computationally inefficient. Therefore, we present a novel encryption technique for video encryption based on FRFT-DWT, which can encrypt the video in such way information cannot be detected by human eye. Also, computational retrieving information through program is impossible without knowing key.

Design/Methodology Approach: The study has conducted an experiment based on FRFT-DWT, to develop a new video encryption to make tampering to it almost impossible

Originality/Value: The study has made a comprehensive literature review as the base and the results are supported by proper experiments.

Findings: The study has concluded that FRFT-DWT with shift can be good option for video encryption since it uses the fractional order and shift as key and decrypting the image without knowing method and exact value fractions are impossible.

KEYWORDS Video Encryption | FRFT | DWT

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Introduction

Fractional transforms are waving topics among the researchers during last two-three decades. There are many fractional transforms [1-9] has been found of conventional transforms such as Fourier [10], cosine, sine Hartley, wavelet and others. The discrete version of these transforms [5,7,9] are also available for discrete and digital signals. Although every fractional transform has their own properties, but FrFT is more commonly used in various applications [2]. The most important reason are FrFT implementations, which easy as compare to other and wide range of applicability. V. Ashok [3] gives algorithm for FrFT which pre-compute the U matrix. This reduces the computational time drastically, since the major complexity of FrFT is eigenvalues and eigenvector [11] computation. Here they claimed time complexity L(N/2)+1 and L(N/2)-1 for eigenvectors and eigenvalues. In literature, FrFT have been used for image security as given in [1,6]. Gaurav bhatnagar et. al.[1] used FR-DWT encrypting a biometrics image especially figure prints. The combination of FRFT and DWT has been given. This paper has organized in five sections, In section 2, we will discuss the basic FrFT and DWT. In section 3, we will give our technique of video encryption, followed by experiment and result in section 4. And in last section conclusion will be given.

Definition of Fractional Fourier transform: The definition of FrFT given in more details in [4]. The most of properties of FrFT are mactche with Fourier Transform as given in paper [4]. The variation of FrFT such as shortFrFT(SFRFT) weighted FrFT(WFRFT)[17] which overcome the certain limitation of FrFT. The definition of FrFT is given below

$$X\alpha = F\alpha(u) = \int_{-\infty}^{+\infty} x(t)K_{\alpha}(u,t)du \qquad \ldots (1)$$

Where K_{α} fractional kernel defined as-

$$K\alpha = K\alpha(u,t) = \begin{cases} \sqrt{(1-jcot\alpha)}e^{j\pi(t^2cot\alpha-2utcsc\alpha+u^2cot\alpha)} & \alpha \neq n\pi \\ \delta(t-u) & \alpha = 2n\pi, \\ \delta(t+u) & \alpha = (2n+1)\pi \end{cases}$$

Two dimensional FrFT can be computes by taking FrFT along first dimension and the FrFT along second dimension. For example we took image of size 50 x 50 generated by random numbersand setting some pixels to 1 for demonstration purpose. In figure 1, We can clearly see 3D plot of Fourier transform of this image concentrated zero. Whereas, the 3D plot of FrFt with fraction order 0.4 shows more wider distribution and if we increase the fraction to a=0.8 the distribution start compacting towards zeros. This means that power of spectrum is spread everywhere in u-v plane which show more faded output in result. And at very low values, identifying the image characteristics is become difficult. This properties of FrFT can be used in image encryption.

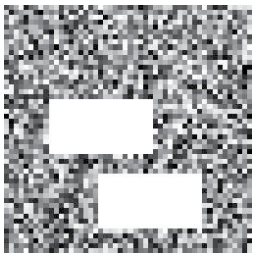

Figure 1(a)original image

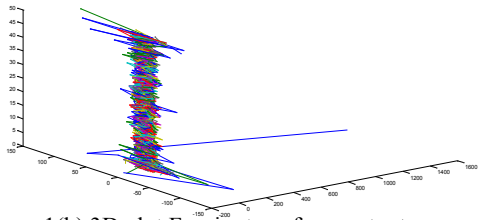

Figure 1(b) 3D plot Fourier transform output

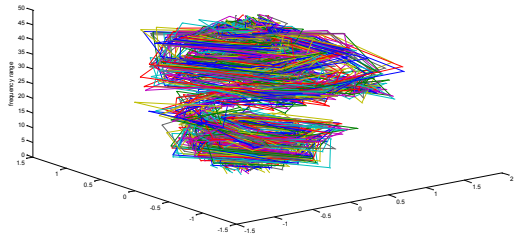

Figure 1(b) 3D plot FRFT with order a=0.8

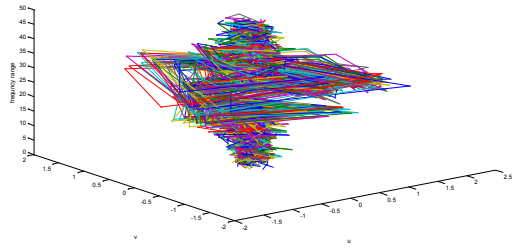

Figure 1(c) 3D plot FRFT with order a=0.4

Discrete wavelet transforms (DWT)

DWT is very popular tools for image analysis since it can analyze local characteristics of signals. Whereas Fourier transform and FrFT analyze whole signals. DWT usesa little wave, are called wavelets. Wavelets are concentrated in both time and frequency around a point. According to Heisenberg principle "we can have either high frequency resolution and poor time resolution or poor frequency resolution and good temporal resolution". In wavelet, both resolutions can be managed. Wavelet transforms use a mother wavelets such as Haar, Debuntchies, morelet etc. these serve as basis function for computing wavelet transform. Wavelet transforms are

follows multi-resolution characteristicswhich mean any signal can be suppressed or stretched from level N to level 1. Where $N=2^k$ is numbers of discrete points of signal f(t). Wavelet transform can be defined as :

$$F(a,b) = \int_{-\infty}^{\infty} f(t)\,\Psi^*_{a,b}(t)dt \quad \ldots (3)$$

Where F(a,b) is a wavelet transform between interval a and b. f(t) is input signal and $\Psi^*_{a,b}(t)$ is a wavelet kernel. As wavelet series expansion theory a function can be expressed as ainfinite sum of multiple scaling and wavelet functions.

$$f(x) = \sum_k c_{j_0}(k)\varphi_{j_0,k}(x) + \sum_{j=j_0}^{\infty}\sum_k d_j(k)\psi_{j,k}(x) \quad \ldots (4)$$

Where $c_{j_0}(k)'s$ are coefficients of scaling functions $\varphi_{j_0,k}(x)$, and $d_j(k)'$s are coefficients of wavelet functions. Wvaelet transform uses two main function called scaling andwavelet functions. Haar v mother wavelet at half close interval [a,b[is defined as :

$$\Psi_{[a,b[}(r) = \begin{cases} 1 & if\ a \le r < \frac{a+b}{2} \\ -1 & if\ \frac{a+b}{2} \le r < b \end{cases} \quad \ldots(5)$$

A set of function is defind in terms of scaling function as $(x) = 2^{j/2}\varphi(2^j x - k)$ ….(6)

Where k determine th position of $\varphi_{j,k}(x)$ function along th x axis and $2^{j/2}$ contols the applitude. Unit sacaling funtion given by haar is

Type equation here.

$$\varphi(x) = \begin{cases} 1 & 0 \le x < 1 \\ 0 & otherwise \end{cases}$$

due to its multi-resolution properties wavelets transform can be used for compressing the image since its information energy lies top-left corner. Also DWT gives the band pass filtering output in information block and rest are low pass and high pass.

Marc Antoniniet. al. describe beautifully with help of example how image can be encoded using DWT. they also gave compression technique using wavelets and describe the study why DWT compression is so important.

FRFT-DWT with shifting wavelets

As we have seen various method of cryptography available, but encrypting a video is huge tasks since it contains very large information. Our method for encryption is simple to understand but not easy for cryptanalysis. In figure 1, Block diagram shows the processing of this algorithm. We first take a video and store into frame buffer. Picking one frame at time and divide it into three different frames based on color channels RGBand apply the algorithm. This technique uses power of FRFT and DWT in different steps of algorithm.Purpose of including shift here to dilute the information block since it always appears in top left corner. Due to which visually identification of information block lost. More no levels make this algorithm more robust. We are also incrementing the shift values whenever frame changes. We can understand by following example.

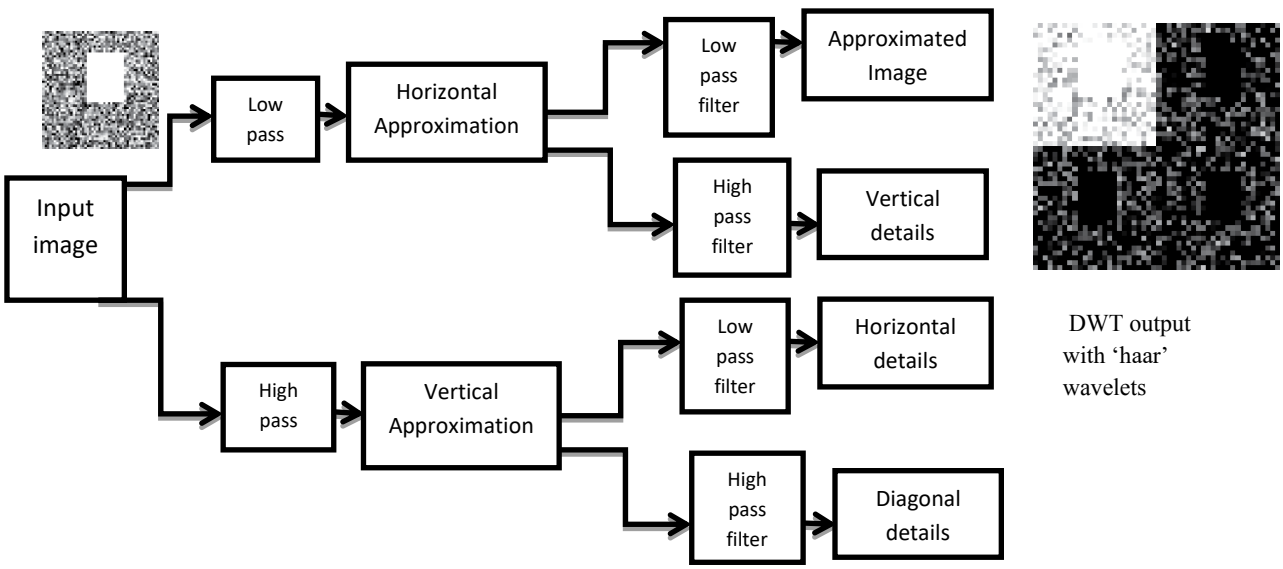

Figure 2 block diagram of wavelet transform

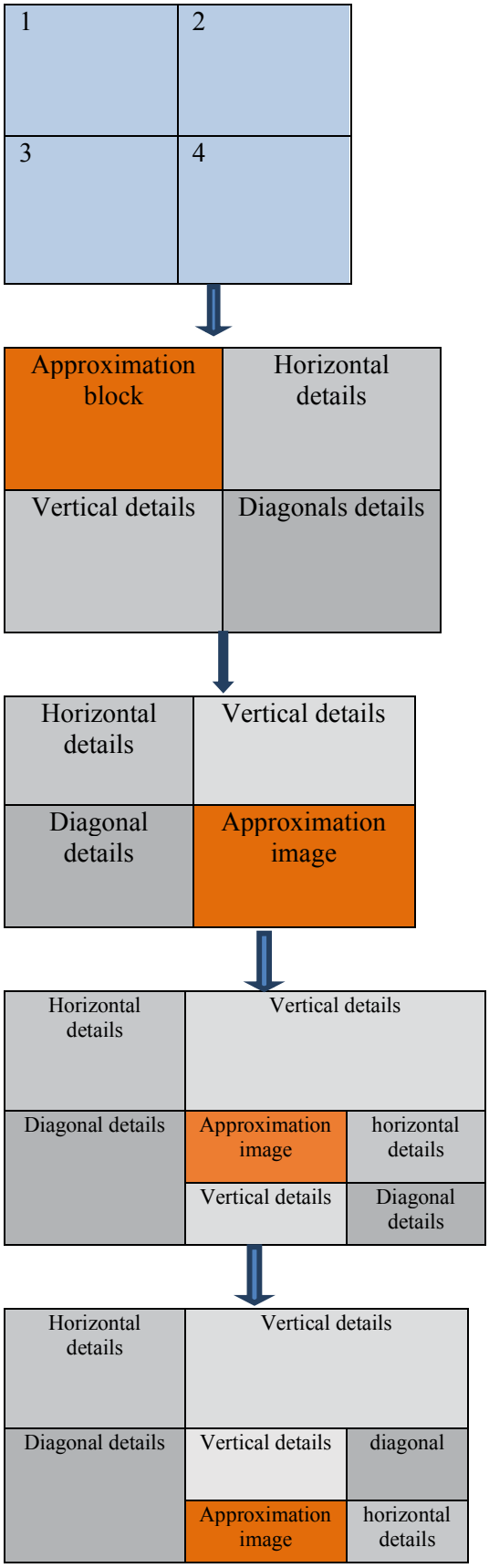

Figure 3 shift process in wavelets

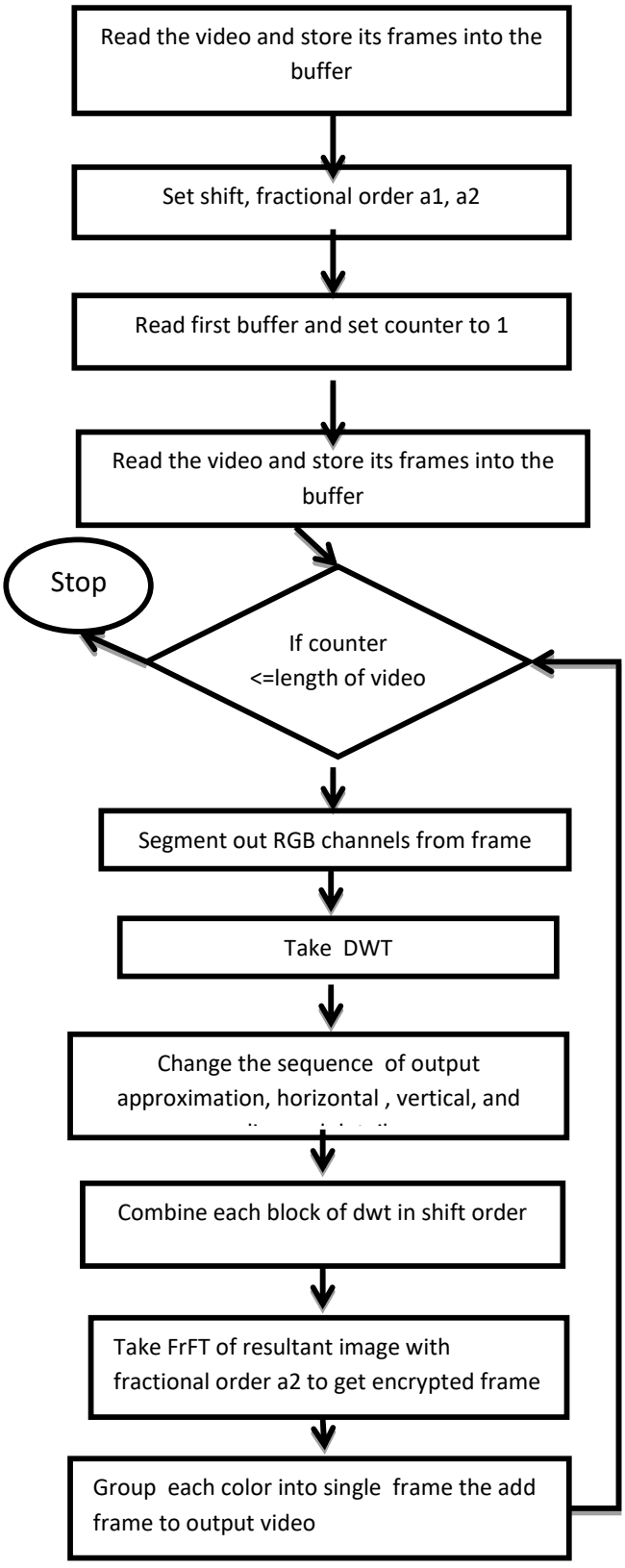

Figure 4(a): Block diagram of encryption algorithm

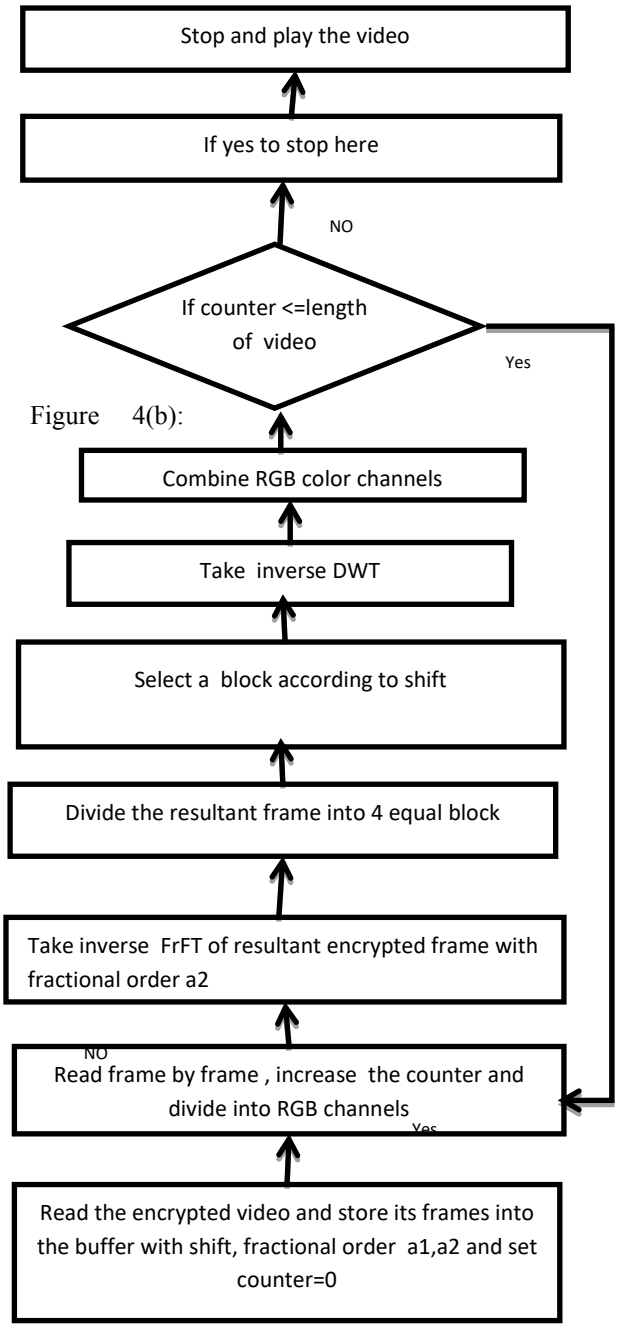

Figure 4(b):

Figure 4(b): Block diagram of algorithm

Experiment and results

We have used UCF11 video dataset for our experiment take video subset horse riding for our demonstration in this paper. In this experiment we found that video is reconstructed by giving correct parameters to video. Figure 5(a) shows the original 10 frames of video v_riding_07_03.mpg. figure 5(b) show encrypted output of this video and 5(c) shows the reconstructed output from encrypted video.

Figure 5(b) original frames

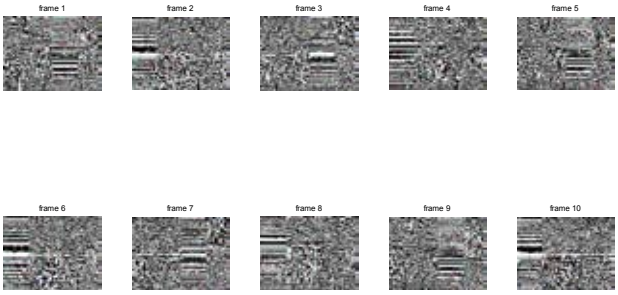

Figure 5(b) encrypted frames

Figure 5(c) decrypted frames

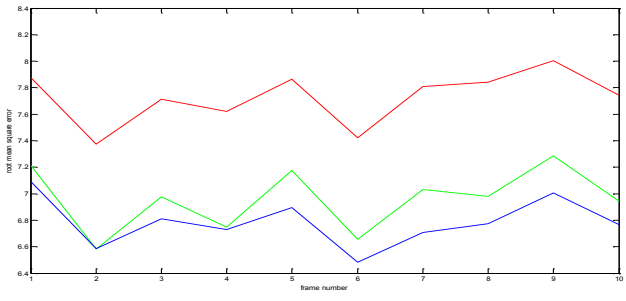

Figure 5(d) is showing the graph of mean square error varying with frame by frame. By looking this figure we can MSE is not stable in each frame. Graph of MSE for each color looks similar. Red color MSE is higher than other two colors since there is high red component present in image.

Conclusion

In this paper, we study the fractional Fourier transform and wavelet transform. Taking fraction order and wavelet compression we successfully encrypt and decrypt the video. After examining theory and experiments, we can conclude that FrFT-DWT with shift can be good option for video encryption since it uses the fractional order and shift as key and decrypting the image without knowing method and exact value fractions are impossible. In future, we can develop more robust technique with these mix feature of both transform .

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The Editorial Board had used the turnitin plagiarism [http://www.turnitin.com] tool to check the originality and further affixed the similarity index which is 3% in this case (See Annexure-I). Thus the reviewers and editors are of view to find it suitable to publish in this Volume-11, Issue-2, Apr-June, 2019

Annexure 1

Submission Date	Submission Id	Word Count	Character Count
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ORIGINALITY REPORT

3%	2%	4%	0%
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Reviewers Comments

Reviewer's comment 1:
The paper is well structured. Introduction portion is quite strong and informative.

Reviewer's comment 2:
The paper is quite presentable. Figures, graphs and charts are making the paper more lucid to understand.

Reviewer's comment 3:
Introduction clearly explains the need and significance of the study. And this manuscript not only satisfy the need of the study but also opens doors for future researches.

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