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Mathematical Analysis of Hymns for Meditation

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Abstract — *In this work we study the mantra and Vedic chants used for meditation and convert them to time series with the frequency of 44100 Hertz. We then perform the mathematical and statistical analysis of these chants and compare these results with few of the popular known songs in Hindi, Kannada and Spanish/English. We also consider the Tirumala temple bell sound for our analysis and study. We conclude that the meditation songs are lyapunov stable and in fact they are asumptotically stable. And hence are perfect for meditation.*

Keywords — *Correlation, Entropy, Lyapunov Spectrum, Power Spectrum, Time Series*

I. INTRODUCTION

India is a very mysterious country. We find its mystery in its diversity, not just in the flora and fauna, but also in the tradition of the people and more importantly the influences on them and the cultural diversity. Yet some things have never changed. The Chanting of Vedic hymns and mantras are one such example. Today most of the yoga gurus and people use many of the Vedic chants as powerful form of meditation. Youtube has popularized them extensively. Thus many questions arise. Are these connected in any way as many of them are used for the similar purpose? Can we study their patterns?

With the invention of nonlinear time series analysis tools by Hegger Kantz and Shcrieber [1] in late decades of the previous century, I felt that such a study is possible. Thanks to them that there is a freely available codes on internet as TISEAN 3.0.0 which executes these studies on any time series fed as data.

Here we first describe the Vedic chants amd other songs which have been used for the study in the first section. In the next section about how the data have been extracted and what are the different studies and analysis done on the data. The third section discusses the analysis and interpretation and finally the fourth is the conclusion.

II. MATERIALS AND METHODS

1. THE DATA

For this study I considered the following mantras and downloaded them from the websites which provide them freely.

1. Maha Mryuthyunjaya Mantra chanted 108 times by Adi Yoga guru
2. Om Mantra chanting
3. Shivastuti for meditation freely available from a website
4. Maha Mrythyunjaya Mantra fewer times available freely from a website.
5. Tirumala temple bell sounds
6. “Sonide nakhare” a Hindi film song.
7. “Ee sanje yakagide” a Kannada film song
8. “Bailamos” a Spanish song

One can argue that these songs or chants have to be understood first and then the music should suit in such a way that they can be useful for meditation. Hence I have chosen these from the websites which provide them for meditation. The temple bell for its sound resembling the Om mantra and other songs from films and pop music only for the sake of comparison. Also though Mathematically I will not be able to say anything regarding the meaning of the chants, the rendering and the chant when converted in the form of numbers would give out some patterns which is explained in this paper.

I first downloaded the mp3 files from the websites. Then converted the mp3 to .wav format using audacity. Audacity converts the file into left and right stereo audio files with the frequency of 44100 Hz. Then the audioread of OCTAVE was used to convert the .wav to data points.

Though the number of data points generated for these mantras were different from each other, the analysis is made in such a way that there is uniformity in them.

2 THE TOOL AND THE ANALYSIS

The basic assumption here had been that the time series generated is nonlinear. Hence the power spectrum of each was found and observed that they are nonlinear. As if they were linear then they would have given a single power spectrum or a sequence of maxima, but if you observe the figure 1 where I have plotted the power spectrum of each of these data points separately, there is no visible concrete harmonics and subharmonics, which clearly indicate that the data is nonlinear.

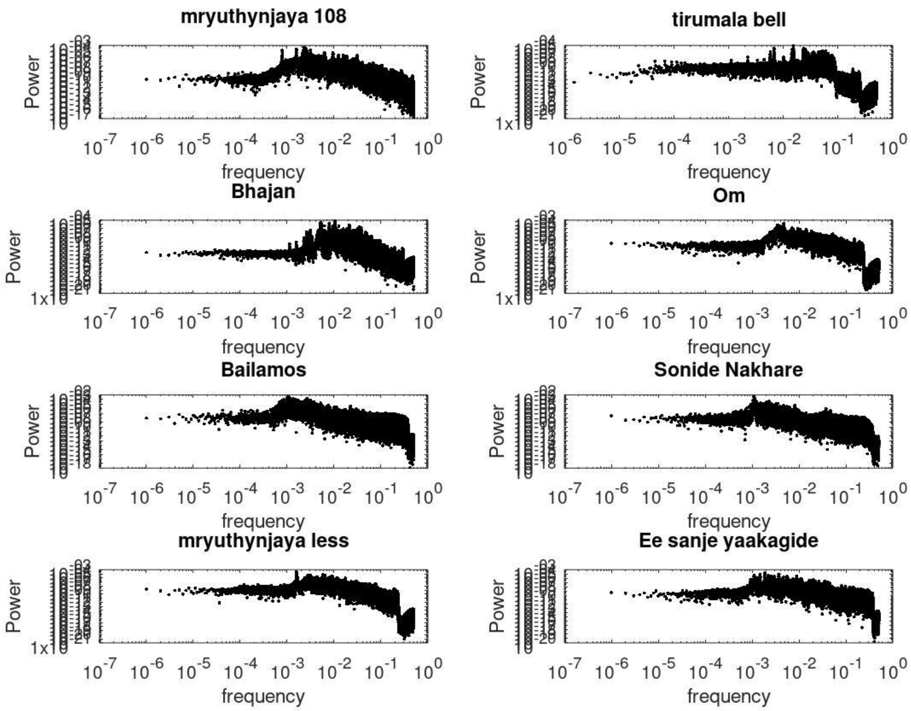

Fig 1: power spectrum plots of the chantings. X axis is the normalized range of data and Y axis is the power spectra of the left audio stereo data with frequency 44100 Hertz.

From the power spectral plot which is in log log scale we observe that the 4 chants and other songs have similar range of frequencies, which could tell us that all of them have similar pattern. Then is every music the same. The further investigations will throw some light on this, their similarity and differences.

We visualize the stationarity of the time series obtained of the different songs and music. To visualize it we construct the space time separation plots through the procedure described by Provenzale et al. [2]. The stp of Tisean gave the output as shown in the figure fig 2. We observe that the most of the data the state space separation plot lies at zero and even otherwise the maximum distance is less than 0.4. We note that the difference between the time series from Bailamos and others have been the most being 0.4 for Bailamos. Remaining all show stationarity. All the data more or less seems to be stationary and correlated well within themselves.

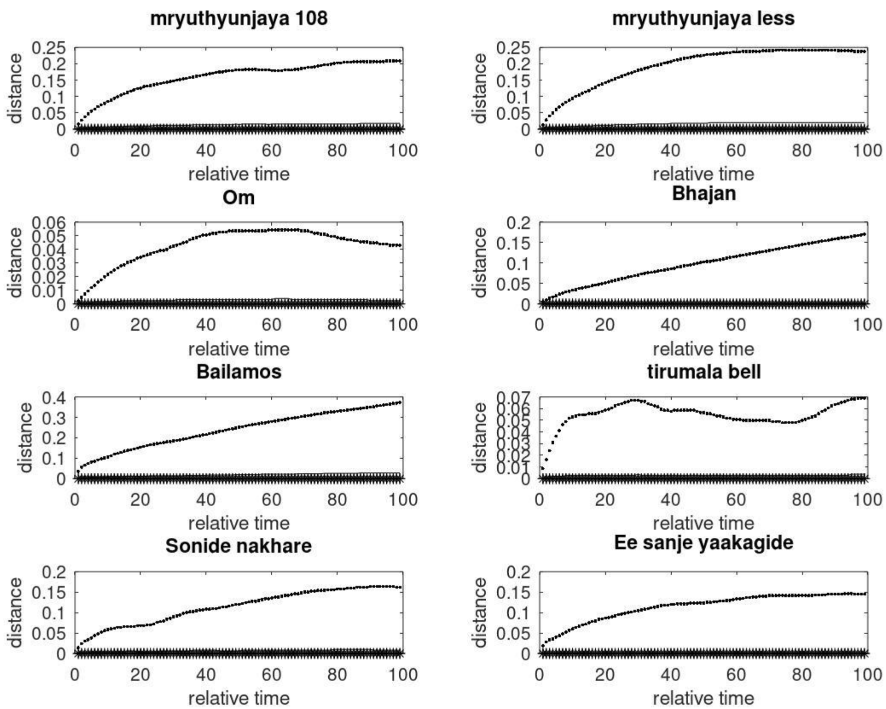

Fig 2: Space time separation plots

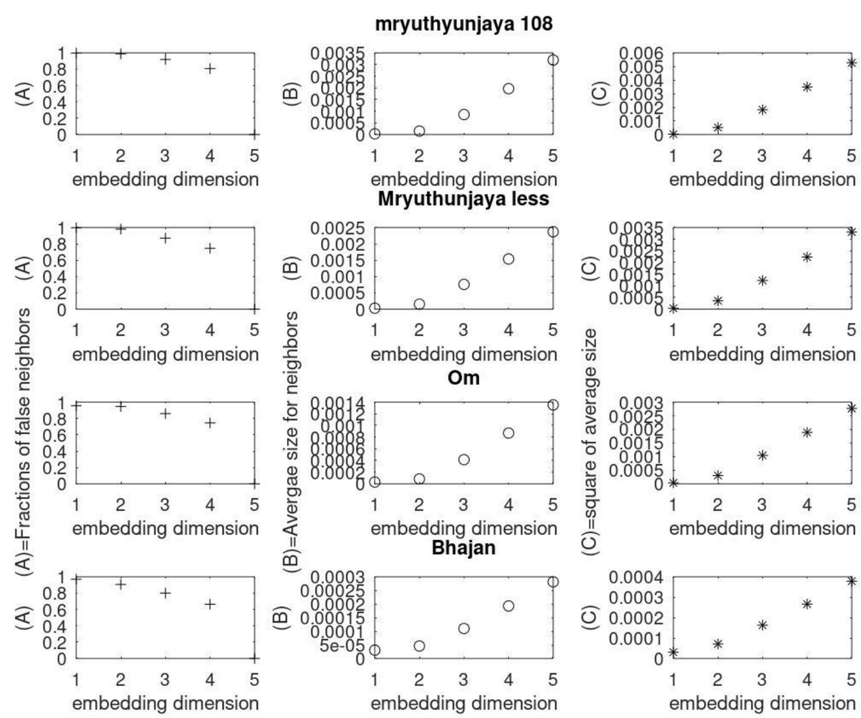

Fig 3(a): Computation of False nearest neigbors for the first four data.

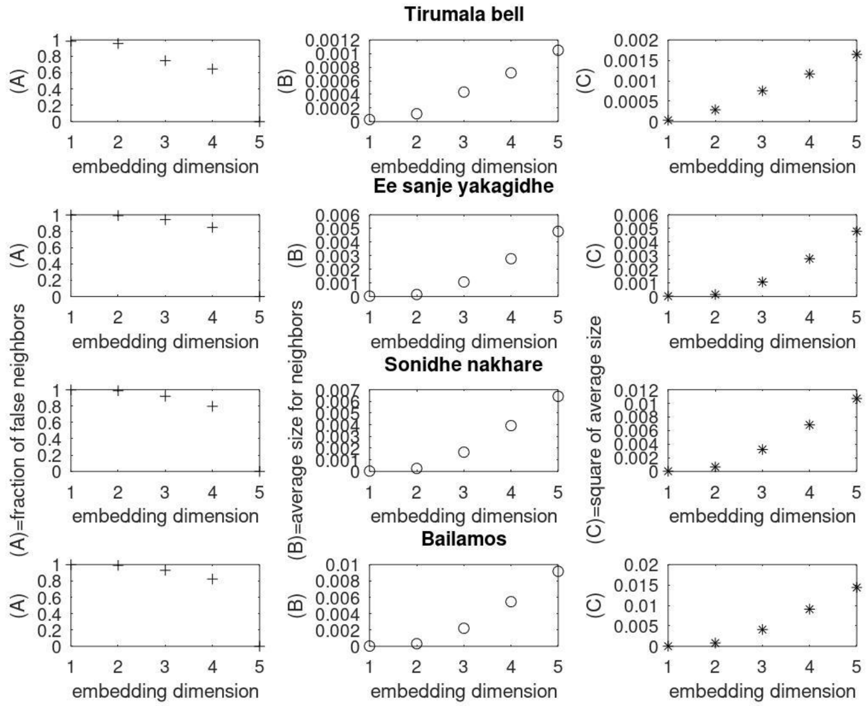

Fig 3(b): Computation of False nearest neighbors for next 4 data

The next linear tool used was finding the false nearest neighbors, a method designed by Kennel et al [3] to estimate the embedding dimension of the data. This analysis would give us the estimates of the points which are false neighbors and the embedding dimensions of the data. From the figures Fig 3(a) and Fig 3(b) it can be observed that the embedding dimension for all the data is approximately equal to 1 as the false nearest neighbor is very far at 1 when compare to other values of embedding dimension. The Correlation dimension of the data can be estimated by the d2 command of Tisean. This would also enable us to obtain the embedding dimension approximation, as by Taken's embedding theorem [4], we know that if the correlation dimension is 1, then the embedding dimension cannot exceed 3. The next figure Fig (4) shows the plot showing the plot between Renyi entropy and the difference in the time step. It also shows the plots between the difference and the derivative of the Renyi entropy. It is based on the Grassberger – Proccacia [5] scheme. The graph shows that the entropy is zero at around time delay of 1 or 2. Hence for the sake of convenience and less entropy, I chose the time delay for all the data as 1. However the initial values from the figure Fig (4) does not give any estimation of correlation dimension hence we plot the Entropies, sum and dimensions the computation of embedding dimension. Also the average mutual information plot reveals that the time delay of ther data cannot exceed 1 as shown in figure Fig (5). This can also be confirmed from the correlation dimension and the correlation entropies and the Correlation sum figures below Fig (6), Fig (7) and Fig (8) respectively. Hence all the figures hint that the dimension of the data is 1.

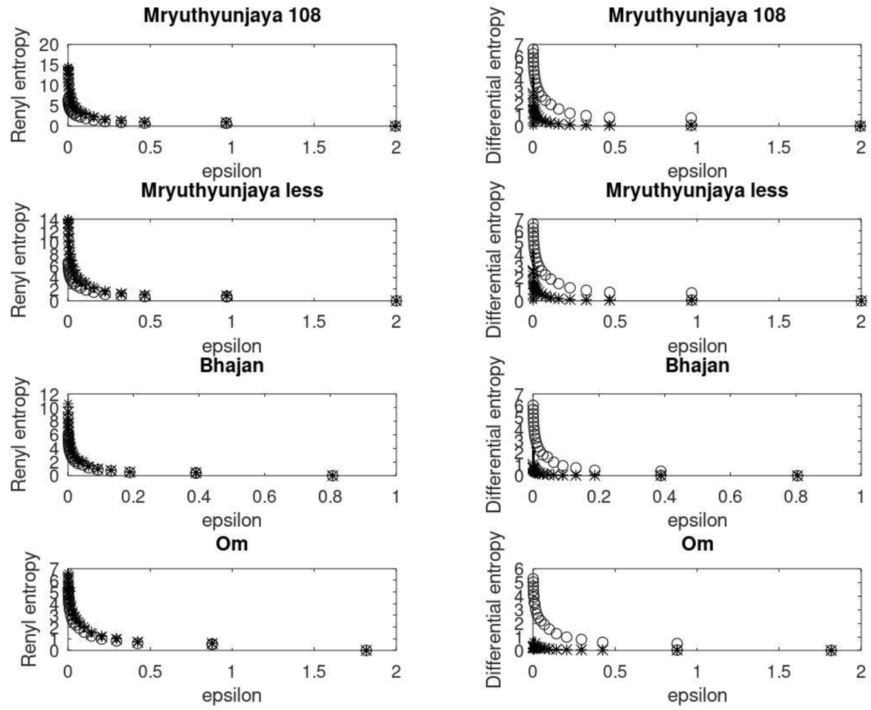

Fig 4a: Renyi and differential entropies

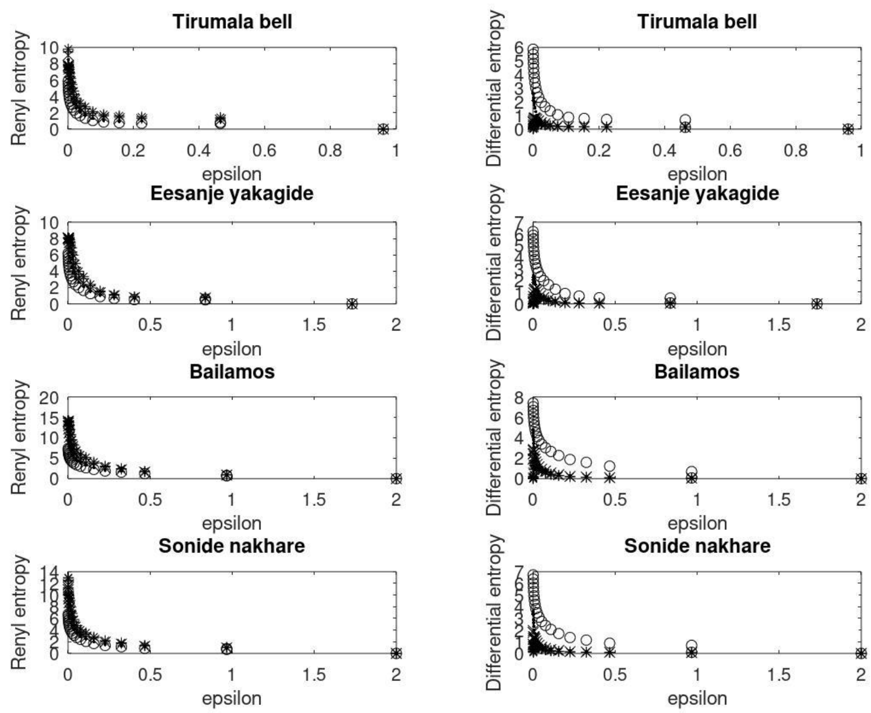

Fig 4b: Renyi and Differential entropies

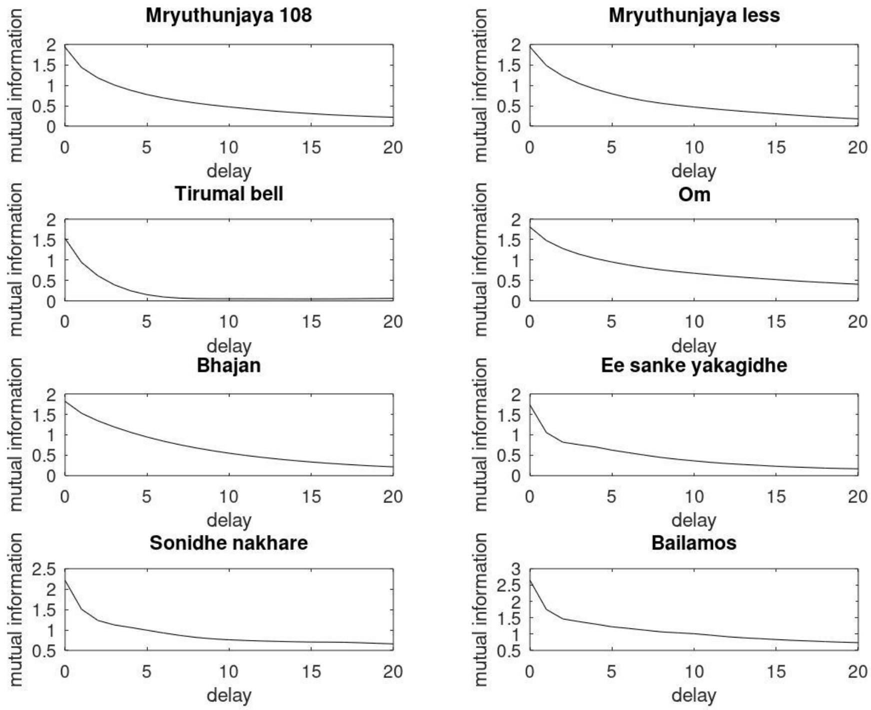

Fig 5: average mutual information plot

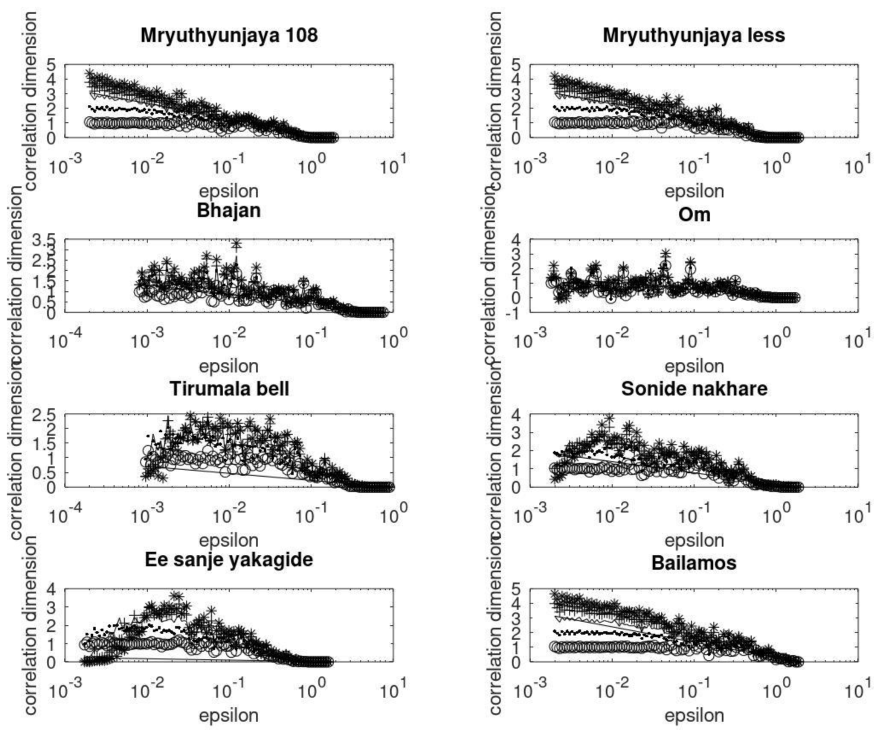

Fig 6: correlation dimension

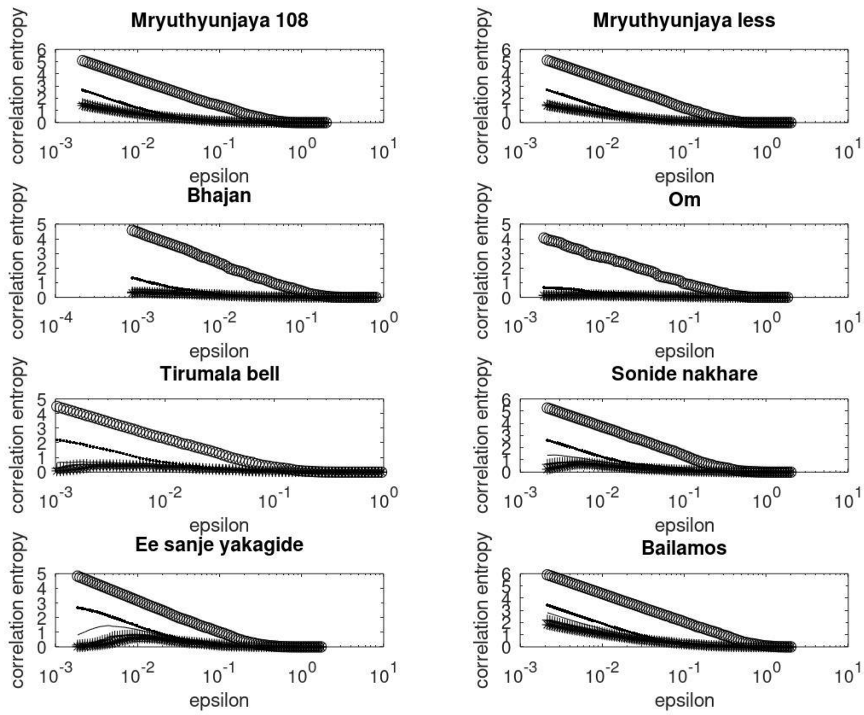

Fig 7: correlation entropy

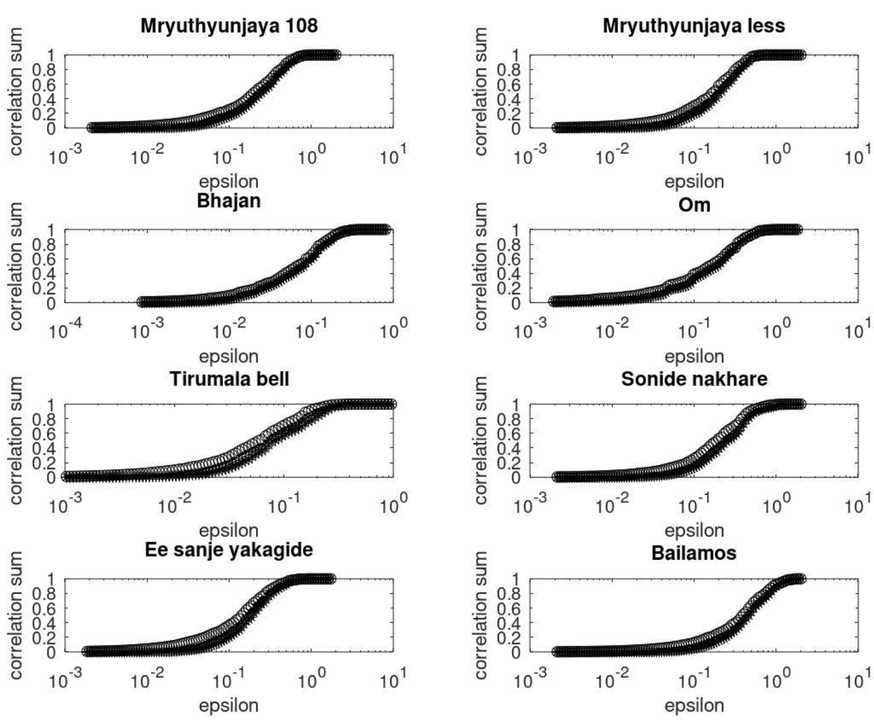

Fig 8: Correlation sum

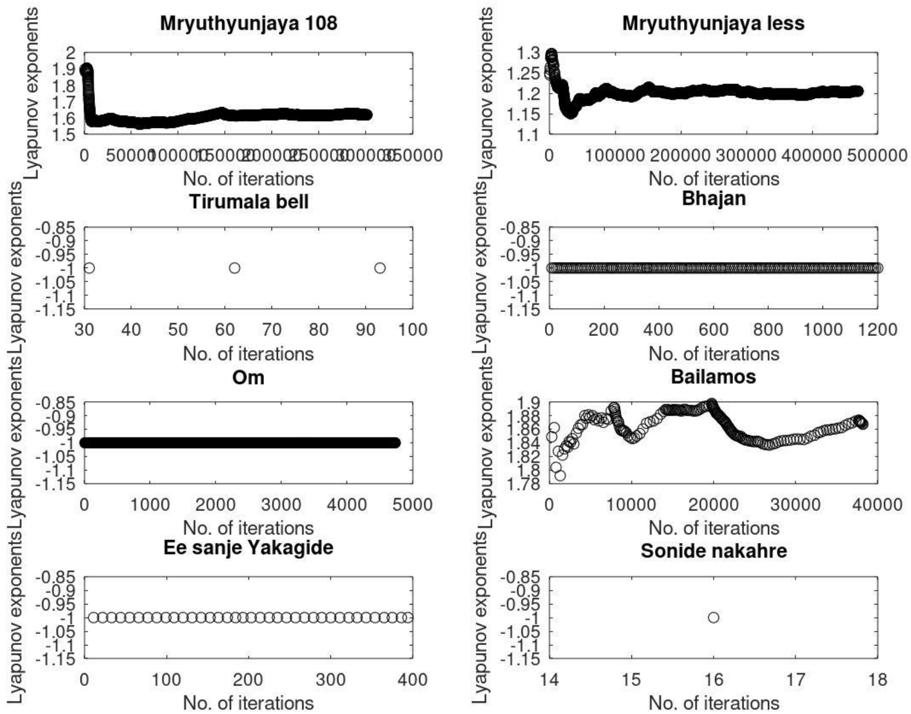

Fig 9: Lyapunov Spectrum

Hence the dimension and delay for all the data was chosen to be 1. This helps us in finding the Lyapunov exponent and hence a spectrum for various number of iterations. The Lyapunov spectrum for most of the hymns remained at -1 where as for the three data of Mryuthunjaya 108, mryuthyunjaya less and Bailamos it was positive. This means that these three data are not useful for meditation as the spectrum is in the positive range. According to Sano and Sawada [6].

III. RESULTS AND DISCUSSIONS

From the above figures for Renyi entropy, average mutual information, false nearest neighbors and correlation plots one can arrive at a conclusion that the embedding dimension and the time delay of the data are 1. With this one final analysis was done of to find the Lyapunov spectrum.

Lyapunov spectrum gives the case where the data is nonlinear and it estimates the nature of the data as to chaotic, stable and asymptotically stable. The figures with the constant Lyapunov exponent such as Om chants, Bhajan, Tirumala bell and interestingly the Kannada song ‘ee sanje yakagide’ all were found to be asymptotically stable. It perhaps maintains the minimal energy and hence are very well suited for meditation. However the exclusion were that of the mryuthyunjaya mantras whether rendered 108 times or less they were found to be not stable. As the name of the mantras tell they are for evoking people from death to life. Hence the spectrum at 1.9 and above 1 show that they posess greater energy and hence are apt for perturbing the person so that he is getting activated. The same effect can be seen from the Spanish song ‘Bailamos’ with the maximum Lyapunov exponent of all the data. Visibily chaotic and possess lots of energy. It showed this pattern very well in such a way that the spectrum was not able to completely be evaluated as their occurred a singularity and the spectrum ceased from being computed.

One more interesting song was the Hindi song ‘sonide nakhare’ this ceased from getting computed at all and hence only one dot was seen in the spectrum. However it begin from -1 and was divergent.

Thus out of all these song data the one with Lyapounov spectrum being consistent at -1 can be considered to be the most suitable for meditation as they are asymptotically stable.

IV. CONCLUSION

The songs and the meditataion hymns and their rendering were analysed in this work by converting them to time series. It was primarily observed from power spectrum that the data seemed to be nonlinear stationary. Hence further investigation was probed. The first and foremost thing was to get an estimate of the embedding dimension and the time delay to compute the Lyapunov exponent and eventually the Lyapunov spectrum. The plots showed consistently and hint that the embedding dimension can be 1 and the time delay could also be 1. Interestingly these values were used to find the Lyapunov exponents and spectrum. It was found that several data showed consistency and the spectrum were asymptotically stable. This meant that the data reflected the minimum energy and hence I conclude that these data were most apt for meditation. However if someone needs to get activated and charged then this can be achieved from the mryuthunjaya mantra whose spectrum are respectively at 1.2 and 1.6. Similarly since the Lyapunov spectrum for the Hindi song rendering and for the Spanish song were a single value and a singular value respectively Iam undecisive and inconclusive of these data.

V. ACKNOWLEDGEMENT

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