COMPSIG NITT

In This Issue...

Dear friends! COMPSIG NITT is a monthly newsletter to share the research work done in the Pattern recognition and computational intelligence laboratory, Department of Electronics and Communication Engineering, National Institute of Technology Trichy.

Concepts, Ideas pertaining to Computational intelligence, Pattern recognition and Signal processing are also included in this newsletter.

We expect the feedback, comments and articles from you all.

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Team members

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Empirical Match Algorithm

The task of determining the primary user activity sequence using the estimated HMM parameters like prior probability (π), state transition probabilities (p_{10}, p_{01}) & channel transition probabilities (h_{10}, h_{01}) and the secondary user observation sequence is conventionally done using the Viterbi algorithm. "**Empirical Match**" an alternative approach to the Viterbi algorithm in estimating the primary user activity is proposed. The Empirical Match algorithm is based on minimizing the **Sum Squared Error (SSE)** between the parameters obtained by iterative updation of the estimated sequence and the estimated HMM parameters, which is an outcome of Particle Swarm Optimization (PSO). It is assumed that the primary user activity sequence is known for **3.33%** of the total length of sequence (100×3000 slots). The performance of the classical Viterbi algorithm is compared with the novel Empirical Match algorithm as number of the matches between the estimated and actual sequences. The estimation of primary user activity is done for the rest **96.67%** of the sequence. A comparison of the Viterbi algorithm and the Empirical match algorithm which is based on the number of matches between the actual and the estimated PU activity sequence is given in the table. An average improvement of 10.0592% is achieved using the proposed algorithm which accounts for a improved match of around 3 lakh slots. This article is accepted as a reviewed book chapter in the edited volume of "**Computational Intelligence for Pattern Recognition**" in **Springer publications**.

HMM parameters					Conventional Viterbi (match)	Empirical Match (match)
π	p_{10}	p_{01}	h_{10}	h_{01}		
0.35	0.15	0.14	0.55	0.56	144822000	182910300
0.2	0.36	0.15	0.53	0.8	88452300	129995100
0.4	0.21	0.25	0.6	0.54	162921000	169519200
0.25	0.32	0.22	0.7	0.48	122220300	157807500
0.2	0.28	0.25	0.62	0.6	141595200	170666700

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Decomposition of signal space and noise space

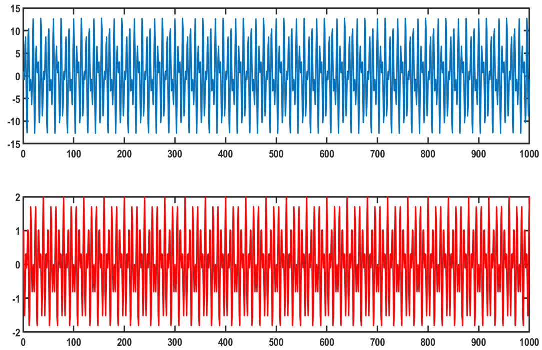

Fig. 1

The summation of two discrete sinusoidal sequences (with two different frequencies) with arbitrary phase and amplitude can be viewed as the outcome of the random process(x_n). The elements of the random vector $\mathbf{x}$ are obtained by collecting the data points across the process at time instant n and $n-1$ $\forall$ n. The vector space spanned by the collected random vectors form the signal space. If the basis vectors of the identified space are chosen $[x_n x_{n-1}]^T$ and $[x_{n-1} x_{n-2}]^T$, we can think of generating the sinusoidal sequence as the linear combinations of these vectors in the recursive manner. The co-efficients are obtained using MMSE technique. Summation of the two sinusoidal signals (refer Fig.1) obtained using the recursive technique (red color) and is compared with the actual sinusoidal signal (blue color).

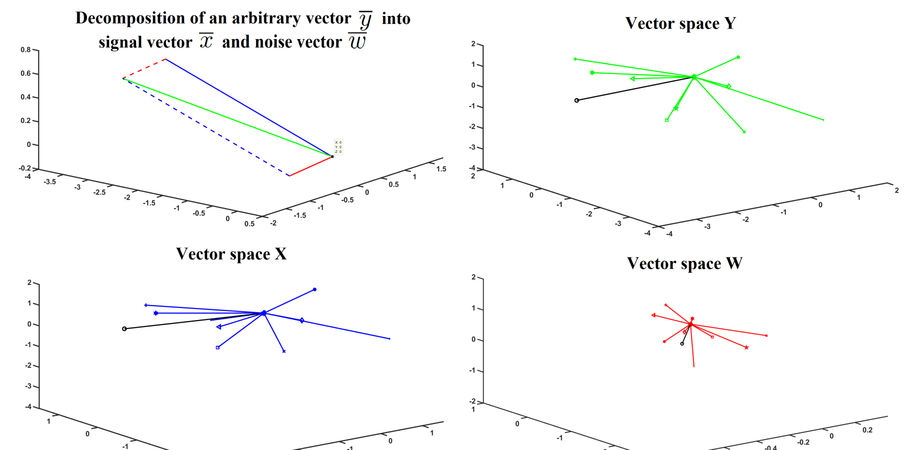

Fig. 2

Sinusoidal sequence (x_n) is added with white noise random process(w_n) to obtain the random process $y_n = x_n + w_n$. Consider the vector space (**Y**) spanned by collecting the vectors (with elements sampled at time instant n, $n-1$ and $n-2$ $\forall$ n of y_n). We compute the eigen basis of this considered vector space (dimension 3) corresponding to the three eigenvalues. The eigenvector corresponding to the lowest eigenvalue corresponds to the noise space (**W**) and the other two eigenvectors belongs to the signal space (**X**). In Fig. 2, the subplot $(1,1)$ illustrates the decomposition of an arbitrary vector $\overline{y}$, into signal vector $\overline{x}$ and the noise vector $\overline{w}$. The subplot $(1,2)$, $(2,1)$ and $(2,2)$ illustrates the sample vectors (3×1) belonging to the vector space **Y**, **X** and **W** respectively.

Link to the m-file: Signal and noise space

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Quotes

> *"Don't read success stories, you will only get a message. Read failure stories, you will get some ideas to get success."* — Dr. A.P.J.Abdul Kalam

On-going Research

- Constructing a Sunflower plant database and perform off-type identification using morphological features.
- Application of machine learning techniques in next generation wireless communication.
- Classification of Music composition styles using probabilistic generative model
- Computational intelligence for transmit power control policy of Energy Harvesting Sensors
- Estimation of Primary User Parameters in Cognitive Radio using Computational Intelligence

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Feedback

COMPSIG NITT invites articles and innovative ideas from readers for the Reader's Space column. We expect feedback and comments to monthly newsletter COMPSIG NITT . Readers can share their views in our facebook page, "COMPSIG-NITT". Those who are interested can be a part of the facebook group.

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