

Satyam Kumar

Curriculum Vitae

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Research Interests

Brain-Computer Interfaces, Machine Learning, Riemannian Geometry, Signal Processing

Education

- 2013–2018 **Indian Institute of Technology Kanpur**, *Integrated BTech - MTech Electrical Engineering*, GPA: 8.67/10.
- 2012 **Modern Senior Secondary School**, Kota, Rajasthan, Percentage: 85%.
- 2010 **Modern Senior Secondary School**, *Matriculation*, Kota, Rajasthan, GPA: 8.6/10.0.

Publications

1. **Kumar, S.**, Reddy, T., Behera, L., “*EEG based Motor imagery classification using instantaneous phase difference sequence*”, **Accepted** for oral presentation at IEEE conference on **Systems, Man and Cybernetics, 2018**
2. Tharun Kumar Reddy, Vipul Arora, **Satyam Kumar**, Laxmidhar Behera, Y K Wang, CT Lin, “*Electroencephalogram based reaction time prediction with Differential Phase Synchrony representations using co-operative multitask learning Deep Neural Networks*” **Accepted** for publication in Special issue on New Advances in Deep-Transfer Learning, **IEEE Transactions on Emerging topics in Computational Intelligence** (Id: TETCI-2018-0173)

Masters Thesis

- Aug'17 – **Enhancing the classification accuracy of Motor Imagery Brain-Computer Interface.**
Feb'18 **Prof. Laxmidhar Behera (IIT Kanpur) & Prof. Roger Gassert (ETH Zurich, Switzerland)**
- Analyzed different phase synchrony statistics during motor imagery
 - Implemented and compared common spatial pattern (**CSP**) algorithm with **Lasso** regularized sparse filter bank approach (**SFBCSP**) on BCI competition datasets
 - Formulated novel approach based on instantaneous phase difference sequences to extract phase synchrony information
 - The approach beats published results that use single trial phase locking value on BCI competition IV dataset IIa. When combined with complementary power features, the classification accuracies are further increased
- Mar'18 – **Subspace analysis in Motor Imagery Brain-Computer Interface.**
Jul'18 **Prof. Laxmidhar Behera (IIT Kanpur)**
- Implemented stationary subspace analysis and divergence based framework of common spatial pattern algorithm for binary class
 - Extended the binary class divergence framework to classic One-versus-Rest divergence framework for multiclass motor imagery
 - Proposed a novel framework for optimization of stationarity in multiclass motor imagery brain-computer interface using an information theoretic interpretation of Joint Approximate Diagonalization

Research Experience

- Sept'18– **Adaptive Riemannian approaches in Brain Computer Interface.**
Ongoing **Fabien Lotte (INRIA Bordeaux, France) & Prof. Florian Yger (Université Paris-Dauphine, Paris)**

- Implemented state of the art Riemannian Geometry Algorithms for classification of motor imagery BCIs
- Implemented the classical adaptive algorithms based on CSP for supervised and unsupervised adaptation
- Proposed several different frameworks for doing adaptation using riemannian geometry classifiers. The initial results has been submitted for review to a conference.
- Aug'16 – **Imagined speech classification Using EEG Signals .**
- Dec'16 **Prof. Laxmidhar Behera (IIT Kanpur)**
 - Designed the experimental paradigm and recorded EEG signals of participants, imagining 2 phonemes: "ba" and "ku"
 - Applied two broad approaches for classifying the signals:1) Matricization of the input tensor followed by dimensionality reduction and feature extraction, and 2) **Tensor decomposition** of the input tensor
 - Standard classifiers like LDA, SVM, kernel SVM used for binary classification
- May'16 – **Optimization of electrode positions in Brain-Computer Interfaces.**
- July'16 **Prof. Francesco P. Andriulli (Telecom Bretagne, France)**
 - Studied different forward and inverse methods deployed for EEG source localization in the human brain model
 - Explored epilepsy and epileptic seizures occurring in Human Brain Using **Para-View, MATLAB** and learned about different channel selection algorithms.
 - Proposed and implemented the **Genetic algorithm** to simultaneously optimize channel selection and classification performance of Motor imagery BCI.
- Jan'16 – **Eye blink classification Using EOG signal .**
- May'16 **Prof. Laxmidhar Behera (IIT Kanpur)**
 - Designed the experimental setup and recorded EOG signals of the subjects performing voluntary eye movements
 - Performed the feature extraction using spectral and temporal characteristics of EOG signals
 - Softmax and SVM's were used for classification

Awards and Honors

- Aug'18 **Travel Grant** winner, IEEE conference on Systems, Man and Cybernetics
- Aug'17 **Teaching assistant fellowship**, awarded by Ministry of Human Resource Development, India on the basis of academic performance.
- Apr'16 **Charpak research Scholarship**, one of the 25 recipients from India.
- Nov'14 **Overall Best Project award**, *Course project for TA-201*, Received the award for building a windmill driven pump
- Jun'13 **JEE Advanced** All India Rank 679, (*top 99.993 percentile*)
- Jun'13 **Youngest ever across India to clear JEE advanced**

Relevant Works

- Aug'17 **Image generation through Variational Autoencoders .**
Implemented variational autoencoder architecture in tensorflow on MNIST database to generate image of digits
- Jun–Jul'17 **Dimensionality reduction using Autoencoders for classification of P300.**
Used Denoising Autoencoders on *EPFL's* publicly available dataset to generate a sparse representation of P300 signals and further classified them using Softmax and LDA classification algorithms
- Apr'17 **Classification of handwritten digits using Multi-layer perceptron, Prof. Laxmidhar Behera.**
Wrote a MATLAB model of Restricted Boltzmann machine for classification of handwritten digits

- Mar'17 **Personalization of HRTF from anthropometric features** , *Prof. Rajesh M. Hegde.*
Compared **Isomap** and **PCA** dimensionality reduction techniques on full and intraconic head related transfer function. Multi-layer perceptron was used for learning the anthropometric features extracted from CIPIC database
- Mar'17 **Human cognitive processes**, *Prof. Devpriya Kumar.*
Wrote a term paper on brain-computer interfaces and its uses
- Feb'17 **Bio-informatics and computational biology**, *Prof. Nitin Gupta .*
A report on the reliability of DNA fingerprinting in criminal conviction
- Nov'16 **Neurobiology**, *Prof. Nitin Gupta .*
A report on the analysis of lateralization of human intelligence in cortex

Relevant Courses

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|------------------------|---|
| Electrical Engineering | Neural networks Speech signal processing Control systems Basic of modern control systems Digital control Control system laboratory Signal systems & networks Digital signal processing Electromagnetic theory |
| Mathematics | Fundamental of computing Probability & statistics Linear algebra Complex variables Detection and estimation theory Numerical methods in engineering Bayesian machine learning |
| Biology | Introduction to biology Neurobiology Computational biology and bio-informatics Human cognitive processes |

Technical Skills

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| Advanced | MATLAB |
| Intermediate | Python \LaTeX AutoDesk Inventor Paraview EEG Setup |
| Basic | C Tensorflow Arduino Android Studio Microcap |

Teaching Experience

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| Jan-April'18 | Microelectronics Laboratory, EE381A |
| Aug-Oct'17 | Control System Laboratory, EE380A |

Test Scores

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|-------|---|
| GRE | Total: 322/340 Quantitative: 170/170 Verbal: 152/170 Analytical Writing: 3/6 |
| TOEFL | Total: 105/120 Listening: 29/30 Reading: 27/30 Writing: 26/30 Speaking: 23/30 |