UNIVERSITY OF CENTRAL FLORIDA

CENTER FOR RESEARCH IN COMPUTER VISION

FINAL ORAL EXAMINATION

OF

SOUMYABRATA DEY
B-TECH., WEST BENGAL UNIVERSITY OF TECH., 2005
M.S., UNIVERSITY OF CENTRAL FLORIDA, 2011

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

(COMPUTER SCIENCE)

Friday, Oct 10, 2014, 10:00 A.M.

101 Harris Corporation Engineering Center

DISSERTATION COMMITTEE

Professor Mubarak Shah, *Chairman*
Professor Sumit Kumar Jha
Professor Haiyan Nancy Hu
Professor Arthur Weeks
Dr. Ravishankar Rao

OUTLINE OF GRADUATE STUDIES

Major: **Computer Science**

Computer Vision	Tappen
Advanced Computer Vision	Shah
Computer Vision Systems	Shah
Image Processing	Foroosh
Neuroevolution and Generative and Dev. Sys.	Stanley

SELECTED PUBLICATIONS

- *Attributed graph distance measure for automatic detection of attention deficit hyperactive disordered subjects*, Soumyabrata Dey, Ravishankar Rao, Mubarak Shah, Frontiers in Neural Circuits, 2014.
- *Exploiting Brain's Network Structure in Classifying ADHD*, Soumyabrata Dey, Ravishankar Rao, Mubarak Shah, Frontiers in Systems Neuroscience, 2012.
- *Detection of independently Moving Objects in Non-planar Scenes via Multi-Frame Monocular Epipolar Constraint*, Soumyabrata Dey, Vladimir Reilly, Imran Saleemi, Mubarak Shah, European Conference on Computer Vision (ECCV), 2012.
- *ADHD Classification Using Bag of Words Approach on Network Features*, Berkan Solmaz, Soumyabrata Dey, Ravishankar Rao, Mubarak Shah, SPIE Medical Imaging, 2012.

PATENT

- *Method and System for Modeling and Processing fMRI Image Data Using a Bag-of-Words Approach*, Ravishankar Rao, Soumyabrata Dey, Mubarak Shah, Berkan Solmaz, U. S. Patent #13/757,102 (Pending).

DISSERTATION

Automatic Detection of Brain Functional Disorder Using Imaging Data

In this dissertation we aim to solve the problem of automatic diagnosis of the Attention Deficit Hyperactive Disorder (ADHD) affected subjects using their resting state functional Magnetic Resonance Imaging (rs-fMRI) data of brain. The problem is of importance as around 5-10% of the children all over the world are diagnosed with ADHD. In our approach, we model the functions of a brain as a connectivity network, which is expected to capture the information about how synchronous different brain regions are in terms of their functional activities.

We developed a simple method employing the Bag-of-Words (BoW) framework for the classification of the ADHD subjects. We represent each node in the connectivity network by a 4-D feature vector: 3-D location and the node degree. The final BoW representation of each subject is a histogram of node representations. The method is able to achieve 64% classification accuracy on the ADHD-200 data set. However, one major shortcoming of this approach is the use of features from the whole brain, which may not contain useful information.

In order to address the above shortcoming, we hypothesize that only a subset of the nodes of the network possesses important information. To identify the important nodes of the network, we developed a novel algorithm, which generates different random subset of nodes each time extracting the features from a subset to compute the feature vectors and perform classification. The subsets are then ranked based on the classification accuracy and the occurrences of each node in the top ranked subsets are measured. We improved the classification accuracy to 69.59% using this approach. One limitation of the approach is that the network features, which are computed for each node of the network, capture only the local structures ignoring the global topology of the network. Also, our method represents each voxel as a node which makes the node count of the network several thousand and increase the computational cost.

Next, in order to capture the global structure of the networks, we use Multi-Dimensional Scaling (MDS) technique to project all the subjects from an unknown network-space to a low dimensional space based on their inter-network distance measures. To reduce the network computation cost, the nodes of the network are constructed from clusters of highly active functionally homogeneous voxels which help to preserve the maximum relevant information with minimum redundancy. We achieve impressive classification accuracy (73.55%) using this method.

Finally, unlike our approach so far, we explored if structural brain images contain any useful information related to the diagnosis problem. Towards this end, we developed a new method to combine the information of structural and functional brain images in a late fusion framework. For structural data we use gray matter (GM) images of brain to input in a convolutional neural network (CNN). For the functional data we compute the average power of each voxel based on its fMRI time series. We achieve an accuracy of 79.14% using combined information.

SOUMYABRATA DEY

1982	Born in West Bengal, India
2005	B.S., West Bengal University of Tech., India
2005-08	Programmer Analyst, Cognizant Technology Solutions, India
2009	Intern, Acclaris, Tampa, FL
2011	M.S., University of Central Florida, Orlando, FL
2009-14	Ph.D., University of Central Florida, Orlando, FL
2014--	Chief Engineer, Samsung R&D Institute Bangalore, India

COMPETITIONS & AWARDS

2008	Achieved excel award twice from Cognizant Technology Solutions for bug free delivery of critical projects
2012	Ranked 12_{th} in ADHD-200 global competition