LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
(AUTONOMOUS)
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L.B.Reddy Nagar, Mylavaram-521230, Krishna Dist, Andhra Pradesh, India

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Report on Five day Online FDP

on

"Advances in Signal Processing "

Event Type : FACULTY DEVELOPMENT PROGRAM (FDP)

Date / Duration : 4^{th} – 8^{th} April, 2022 (Five days)

Resource Persons : Dr.G.L.N.Murthy ,Professor, Dept. of ECE, LBRCE

Dr. N.Sadagopan, Asst. professor, Dept. of CSE,IIITDM , Kancheepuram

Dr.A.Narasimhadan, Asst. Professor, Dept. of ECE, NIT, Suratkal

Dr.G.seetharaman, Head of the Department, IIIT, Tiruchirappalli

Dr.V.anil Kumar, Associate Professor, IIIT, Hyderabad

Convener : Dr. Y. Amar Babu, professor & HoD

Coordinator : Dr. G L N Murthy, Professor

Co Coordinators : (1). Mr.V.V. Ramakrishna

(2). Mr.M. Sivasankara Rao

(3). Mr.M.K. Linga Murthy

(4). Mr.M.Sambasiva Reddy

Target Audience : 250

Total no of Participants: 106 (Internal Count= 18 & External Count=88)

Objectives of the event:

1. To expose the faculty to graph signal Processing.
2. To make use of the basics of graph theory in solving the signal processing problems.
3. To introduce sampling of Finite rate of Innovation signals
4. To explore the developments in AI with relevance to signal processing.
5. To interrelate the VLSI Technology with signal processing applications

Outcome of event :

1. To Understand the basic concepts of Graph Signal Processing.
2. To Get awareness on areas of applications of graph Signal Processing.
3. To understand the underlying concepts of Signal reconstruction.
4. To acquire knowledge on the role of AI in speech processing applications.
5. To get exposed to development of VLSI based signal Processing systems.

Description / Report on Event:

The introductory session began with address by the head of the department Dr.Y.Amar Babu. It was told that many developments are happening in signal processing which the faculty must make use tom carry out further research. Further, one should not restrict to specific domain and carry out multi-disciplinary research. All the participants were informed about the facilities available in the department and utilize the same for their research work. This was followed by introduction of Graph signal Processing (GSP) by Dr.G.L.N.Murthy .Due to the developments in IoT, large amount of data is available from physical and logical networks , for further analysis.

Classical signal processing techniques cannot give fair amount of information from these complex structured networks. This necessitated the use of Graph signals in modelling and analysis of such data. However, the fundamental operations of Translation, Modulation and sampling cannot be directly applied on graphs by virtue of which graph spectral domain was developed. Whatever operations that cannot be performed in vertex domain can be carried out in the graph spectral domain. The basic constraint in graph signal processing is to convert a real time signal like EEG or ECG signal or an image or a video into a graph. If this is carried out effectively and a graph is formed, further analysis in spectral domain is not a trivial task. In the entire graph spectral domain, the Laplacian operator plays a vital role which is derived

from the degree and adjacency matrices. The role of GSP in EEG analysis and image denoising was also explained.

On day 2, Dr.Sadagopan Narasimhan has given an overview of graph theory and its role in signal Processing. In real time signals are present everywhere and certain amount of elementary processing is required to understand the signal. Modelling of signal is required to correlate various constituent components of the signal. Transformation from one form to another form, sampling and filtering are some operations involved in signal processing to solve a problem. For solving real-time problems three levels of thinking are needed abstract, computational and algorithmic thinking. Abstract thinking is aimed at modelling a problem and involves algebraic and trigonometric concepts. It will not involve experimentation but provides visualization of the problem. Computational thinking makes use of electronic gadgets for carrying out experimentation and this in turn needs algorithmic thinking. The session also included a overview of graph theory. Computational thinking makes use of electronic gadgets to process signals and involves experimentation. However, for simulation programs, procedures, or algorithms are needed. Graphs can be represented by matrices that give the relation between signals. These signals can be either image, videos, or simply 1 D signals. Adjacency matrices of undirected graphs are symmetric in nature while directed graphs have non symmetric adjacency.

On Day 3, Dr.A.V. Narasimhadan highlighted the tole of sampling in signal reconstruction. It was mentioned that all non-band limited signals can be reconstructed from the samples. And all band limited signals are Finite rate of Innovation (FRI) signals. Any type of signal can be obtained from the stream of Dirac pulses provided the sampling rate is known. According to sampling theorem of FRI signals, given FRI signal can be reconstructed from available samples if the number of samples are great than rate of Innovation. Prony's method used for identifying the location and weight of Dirac pulses was also discussed along with underlying stepwise procedure. The application of FRI in reconstructing the MRI image from raw data given by the scanner, which will be in the Fourier domain was also explained.

On Day 4, Dr.G.Seetharaman discussed about high speed digital circuits for Signal Processing and it's necessity. Various methodologies to increase the speed as well as reducing the power requirement were elaborated. It was told that for signal processing the important component is multiplier which is inherently available with FPGA. It was mentioned that for real time systems , synchronous non pipelined circuit is not advisable due longest path delay

have more number of functional elements necessitating synchronous pipeline system to increase the speed. In this the desired combinational circuit is divided in to multiple number of combinational logic blocks and introducing a shift register between them. Parallel processing increases the sampling rate by replicating hardware so that several inputs can be processed in parallel and several outputs can be produced at the same time. The session also covered wave pipelining which can be used for increasing the speed of the circuit without the insertion of register. The session concluded after introducing the need of an asynchronous systems and it's constituent parts.

Feedback/Suggestions:

- Conduct full day or extend to 2 weeks
- International speakers and participants can be invited for more informative sessions
- Implement Hands On session during FDP
- Need applications of Signal processing in different fields.
- Workshop in ML
- More advance topics must be included
- Any hands on specially on IoT

Comments on Feedback:

1. Initially it was thought of conducting sessions for full day but keeping in view of hectic academic activity for the faculty members, the duration was fixed at 2 hours. However, in future if any FDP is conducted off line definitely session will be for full day.
2. Mr.Antonio Ortega has already been contacted for giving one session in the domain of graph signal processing but sir has no interest . Further, in future based on the need, international resource persons will be invited.
3. MATLAB based simulation of signal processing algorithms will be added in the coming days when another FDP is conducted.
4. Current FDP covered EEG and image analysis as well as filter design. Other applications will be included in future.
5. Already last year one online FDP was conducted on deep learning and in future further advances along with applications will be covered.

6. No IoT session or FDP can be conducted under this signal Processing module. However. this suggestion will be forwarded for other research module coordinators.

Photographs:

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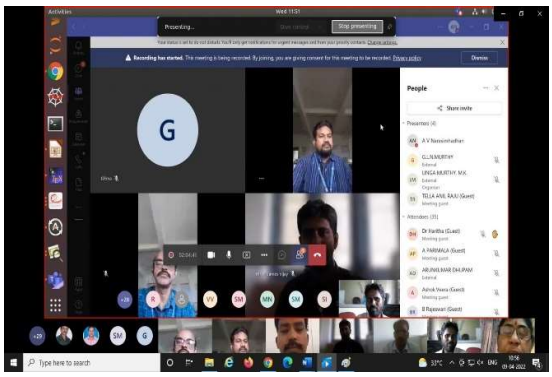
<td> 
Mr.T. Anil Raju introducing the resource person Dr.N. Sagadopan, Asst. professor, Dept. of CSE, IIITDM, Kancheepuram on Day 2</td>
<td> 
Participants with resource person, Dr.A.Narasimhadan, Asst. Professor, Dept. of ECE, NIT, Suratkal on Day 3</td>
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<td> 
Mr.T.Anil Raju introducing resource person, Dr.G.Seetharaman, Head, Dept of ECE,IIIT,Trichy on Day4</td>
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Participants with resource person, Dr.Anil Kumar Vuppala, Associate Professor, IIIT, Hyderabad on Day 5</td>
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