ELECTRON WAVE

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MESSAGE from the Editor

It gives me a lot of pleasure to introduce before you Vol. 03 No. 02 of Electron Wave, the School of Computing and Electrical Engineering (SCEE) Newsletter. Years passed by and the School of Computing and Electrical Engineering has grown reasonably and diversified in its focus ranging from Signal processing and Communication to VLSI, Power Systems to Control Systems, Embedded Systems to Human Computer Interaction. A good number of faculty members from other institutions within and outside India have also visited IIT Mandi for long and short periods contributing to the intellectual growth of the institute. In this issue, we are publishing an interesting article on "Mind's eye" by Dr. Arnav Bhavsar. Like other issues, this issue is also publishing a faculty interview; this time Electron Wave is face to face with Dr. Anil Kumar Sao who has seen the institute since its dawn.

What's INSIDE

Faculty Perspective

"Mind's eye"
by Dr. Arnav Bhavsar

In the early years of the development of artificial intelligence, with a general goal of devising thinking machines, who can solve problems like or perhaps even better than humans, the role of computer vision was, arguably, considered as a small part of a bigger picture. After all, vision is just one of our perceptual mechanisms in the whole complex of the brain.

A famous anecdote, often quoted out of context, is that of a computer vision being portrayed as a 'summer project' [1] at MIT in 1966. Considering the overall proposal in [1], it should be noted that the work involved some thoughtfully planned specific fundamental tasks of computer vision (e.g. foreground/background segmentation and (by today's standards) some relatively simple object identification), which seemed ambitious but possible at the time. Obviously, it was not supposed to be the end of computer vision, but in fact one of the pioneering efforts. The 'summer project' is still on, and over the years, computer vision has immensely expanded in its scope, its applications, and its elegance.

From the modest beginnings in tasks such as figure-ground separation in images, image smoothing, some basic contrast variations, recognition of a handful of objects in images, we are now considering systems (machines, robots, vehicles, drones etc.) which can detect and recognize thousands of objects, understand complex scenes, perceive the world in 3D and 4D, understand complex actions, look into our bodies for improving healthcare, analyze our terrain, our biodiversity and our crops from the skies, and much more.

Obviously, like any other system, computer vision has also gone through its own evolution in its journey between the two extremes indicated above, supported by the progress in mathematics, as well as that in the development of computational tools. From a technical perspective this evolution involves simple scalar valued operations or pixels, to some basic analytical linear algebraic methods, to elegant algebraic geometry and physics paradigms, to models based on algebra, differential calculus, probability theory and graphs, to elegant optimization frameworks, which have now extended to looking for solutions in a space of tens of thousands of unknowns.

In the problem space, the areas that computer vision spans has grown too, and indeed, each area is growing in the scope of its complexity. For instance, the ancient task of image segmentation which started with separating foreground-background has evolved to consider colour, texture, shape (in 2D and 3D), motion (in videos), and finally even semantics (e.g. segmenting or localizing semantic structures such as trees, cars, people, organs, etc. irrespective of their inherent variations). Similarly other problem areas such as image enhancement and restoration (for contrast, resolution, motion-blur, fixing missing regions etc.), object and scene classification and descriptions (with numerous objects / scenes, very similar looking objects), 3D reconstruction (with complex structures, large scale monuments, and even city-scale reconstructions), recognizing activity (for long sequences, complex activities, and even emotions and behaviour), and many more (which presently, cannot be listed due to space constraints), have flourished and are still flourishing.I believe that some

paradigm shifts in computer vision can be noted when comparing the traditional view to the contemporary view for some aspects. For instance, in some areas the traditional view was focused on 'Analysis of images' (which is about inferring some aspects of images, or understanding the content of the images by the machine). A contemporary view also includes 'Synthesis of images (in 2D, 3D, 4D)', which, to me, signifies an important step towards the 'creative nature' of machines. Note that, even traditionally, image synthesis can be said to have existed in context of enhancing/restoring images (e.g. deblurring, dehazing, super-resolution etc.), where the machine is effectively making better images. However, while these are definitely hard problems in themselves, they do not highlight a larger spectrum of the creative aspect of the machines, like the contemporary image synthesis paradigms do.

Another interesting change is with respect to the traditional view of 'acquire then process', wherein the processing happens after the image has been captured. However, in recent decades, the area of computational photography and compressive sensing has essentially brought in the notion, wherein the processing task is inherently connected to the acquisition task.

An important paradigm shift, is the recent one of 'learning from data'. Some problems such as classification, object detection, segmentation etc. were even traditionally based on learning from data. However, in recent times, even some of the above mentioned tasks such as image restoration, super-resolution, 2D and 3D reconstruction etc., which traditionally employed model based frameworks are now being addressed quite successfully in learning paradigms, given enough data. Having said that, if enough training data is not available or cannot be synthesized, then the model based frameworks are still being used, having already reached a fairly mature level of theory, and performance.

So what next ?

Here is what I think (and I am sure many of you would have different perspectives, which is how it should be, for progress).

An important direction of research is to consider multitask learning. Most vision systems are great at performing a single task. However, there are few (like humans) who can learn different tasks. For instance, a face recognition system is not great at reading textbooks. There are already some very recent works on such systems, and I believe that this issue would receive more attention.

On the other hand, the AI community, in general is now looking at integrated systems, where different modalities can mutually benefit each other. This is where synergy of vision, with other modalities (such as sound, text, sensors), is being considered. Even in vision itself, one can have different modalities (e.g. different imaging devices, multi-spectral information).

Considering the above mechanisms of multi-task and multi-modal learning, I believe that, similar to brain, AI systems would consider mechanisms such as gating, attention, etc. which would essentially be need to selectively filter information from different modalities and in context of different tasks.

Finally, one can let our imagination take a leap, and perhaps even think of enhancing the capabilities of our brain itself via AI. For instance, there are already efforts in curing blindness with artificial vision. One can extend this further, and considering us humans 'seeing' multispectral information, reconstructing our images and videos from our thoughts, capturing images in the cloud while just seeing (neuro-cam), recording and inferring our dreams, even creating virtual (or real ?) worlds with imagination.

The machine's eye would become one with the mind's eye (or vice-versa).

Reference- https://dspace.mit.edu/handle/1721.1/6125

Recent Research Achievements

- ***Development of Innovative Prototypes for Disaster Risk Reduction (DRR)***

In October 2018, the Himachal Pradesh Government introduced a state-wide contest for the "Development of Innovative Prototypes for Disaster Preparedness and Response." Dr. Varun Dutt and Dr. K. V. Uday, Assistant Professors, Indian Institute of Technology (IIT) Mandi; and, the iIoTs group, a student – faculty group incubated by IIT Mandi's technology incubator, Catalyst, won the 3rd prize in this contest. The prize was given to the iIoTs team on the development and deployment of a low-cost landslide monitoring system (LMS) by Mrs. Manisha Nanda, IAS and Additional Chief Secretary (Revenue) during the celebration of International Day for Disaster Risk Reduction on 13th October 2018.

Dr. Varun Dutt and his iIoTs team collecting the 3rd prize in the Development of Innovative Prototypes for Disaster Risk Reduction (DRR). From iIoTs group (IIT Mandi), left to right: Priyanka, Praveen Kumar, Ankush Pathania, and Varun Dutt. From HP Government, left to right: Manisha Nanda; Additional Chief Secretary (Revenue), Sh. D.C. Rana, Special Secretary (Revenue-DM), Sh. G.C. Negi, ADM (P) Shimla

- ***A low cost urine albumin estimation system***

The proposed system is aimed at delivering a low cost solution to estimate the concentration of albumin in urine. The system uses near infrared spectroscopy to estimate the concentration of albumin in urine correct to a resolution of 3.3ug/dl. Using the system, the cost per test can be as low as INR. 30 per test. This is really useful in a developing country like India where cost for performing medical test can stand out as a barrier to medical diagnosis.System has been developed by team of student by Dr. Shubhajit Roy Chowdhury from SCEE and Dr. Subrata Ghosh and Dr. Prosenjit Mondal.

Recent Projects

- **Title:** Deployment of sensors for landslide monitoring and early warning
  PI: Dr. Varun Dutt
  CO-PI: Dr. Venkata Uday Kala
  Funding Authority: Deputy Commissioner Mandi (H.P.)
  Amount sanctioned: INR 3 Lakh
  Duration: 3 years.

- **Title:** design and Fabrication of interface Asic for Vibratory gyroscope sensor application.
  PI: Dr. Satinder Sharma
  Co-PI: Dr. Rahul shrestha,Dr. Hitesh Shrimali
  Funding Authority: ISRO, IISU Kerala.
  Amount sanctioned: INR 48,00,000/-
  Duration : 3 years.

- **Title:** Point of care monitoring of neuro-vascular interactions (especially inverse Neurovascular coupling) during spreading depolarizations in brain trauma using simultaneous recording of EEG and NIRS.
  PI: Dr. Shubhajit Roy Chowdhury
  Funding Authority: DST (IDP-BDTD)
  Amount sanctioned: INR 24.68 lacs

- **Title:** Establishment of Young Researcher Fellowship Programme 2018-2019

Faculty Achievements

- **Dr. Shubhajit Roy Chowdhury** was Elected as a member of Award Committee for Gandhian Young Technological Innovation (GYTI) Award by the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) in the area of Health Care devices in the year 2018.

Face to Face with Dr. Anil Kumar Sao

Dr. Anil Kumar sao has been doing research in the field of medical image analysis. He has authored several conferences and journals in the paper. He has seen IIT Mandi growing since its birth time. This time electron wave is pleased to meet Dr. Anil Kumar Sao.

1. Who are you and what do you do?

I am Anil Sao and I have been working as a faculty in SCEE IIT Mandi, since July 2010. I have done my B.E from GEC Raipur, Chhattisgarh, MS (by research) and PhD from Computer science department, IIT Madras. My research interest is in Medical Image Processing and Pattern recognition.

2. You are man seeing IIT Mandi from its dawn. What is your opinion regarding the growth of the institute across the years?

I would say it is my privilege and fortune to be part of this beautiful journey of IIT Mandi's growth since its inception. For the first few years all the academic and administrative activities were executed at the transit campus Vallabh degree college and Mandav block at Mandi. At that time the strength of students (undergraduate + MS/PhD) were close to 200 which has now increased up to 1300 and the faculty strength at present is more than 100. Several graduated students are performing very well in respective field and IIT Mandi faculty also have shown excellent growth in research work. By now the entire academic and administrative section is functional at permanent campus, Kamand. In my opinion, IIT Mandi has shown huge growth in all aspects in a short duration of time and it will continue so in the coming years too.

3. As an Associate Dean (Courses) what is your perspective on the current situation of academics at IIT Mandi?

It has been 9 months that I have taken the responsibility of associate dean course. In my opinion, academics at IIT Mandi is in a very good state. It comprises of unique concepts such as design practicum, practicum-based course and ISTP. These courses have been introduced as a part of the UG curriculum. This emphasizes the concept of learning by doing and the socially

relevant projects like ISTP is to contribute to the local society significantly through their scientific innovations. Even the same philosophies are being followed for PG curriculum. Since last three years, a unique concepts of Induction program has been introduced into the curriculum for the overall development of the students.

4. How do you like to take the academics of the Institute forward in the next 3-4 years?

In the coming 5 years the strength of students is expected to be more then 3000. Discussion on several new programs has been going on. It is planned to introduce these UG/PG programs in different phase so that resources and infrastructure for the same is in place.
Academic activities in any institute has three stakeholders: students, faculty and administrative staffs. The work for OAS (office automation) in academic activities is in progress so that all the stakeholders can get their work done much efficiently. The Dean office is working towards organizing the documents such curriculum/syllabus/notifications etc. in website.

5. It seems Medical Image Analysis is your aspiration. Is there any reason behind it?

My PhD thesis was in the area of face recognition and I continued with similar work for few years after joining IIT Mandi. Meanwhile, I got chance to work in a consultancy project with Bangalore based startup company. Our aim was to develop image processing-based approach to detect cervical cancer using PAP test. We got good success in the project and have filed the patent for the same. There onwards, I have been working on various problems in Medical Image Analysis. I believe that the use of technology (based on image processing and pattern recognition) will be of great use to the medical science. It is very much desirable in the country like India where the doctor's prevalence is one in1000 people.

6. You are the one of pioneers of Multimedia, Analytics, Networks and Systems (MANAS) group. How do you like to see the MANAS group going forward in the next 5-7 years?

MANAS group consist of faculty and students who are using pattern recognition based approach with complimentary strength for the analysis of information from several media, such as audio, video and network etc for different scientific purposes. In coming 5-7 years, I see that this group will be well known across the world for providing technological solutions in the area of multimedia processing.

7. How do you strike a good balance between teaching, research and administration?

Well, I feel it is possible because of the team work. I am fortunate to have team of good students and colleagues. The same holds true for administrative work where I get good co-operation from the administrative staffs and advice from our senior faculty. At times it becomes little tough but I try my best to strike a balance.

8. Give a word of advice to the students of IIT Mandi.

I feel each student is unique and I suggest them to follow their passion rather than falling in the habit of comparison. If some of you are unclear about your passion, then give your best effort in your current work that will open the way for your dream career. There is no alternative for hard work and at the end be a good citizen of this world.

Publications

- Journals: 16
- Conferences: 21
- Books and Book Chapters: 6

Patents

- V. Dutt, K. V. Uday, S. Agrawal, P. Kumar, A. Pathania, Priyanka, N. Mali **"Smart IoT based test bed system for lab-scale landslide monitoring experiments."** Indian Patent Application no. 201813039735 dated 22.10. 2018.
- S. Roy Chowdhury, S. Ghosh, P. Mondal, Y. Arora, B. Biswas, S. Mukherjee, V. Bedi, **"A system for detecting biological molecule and method of using the same."** Indian Patent Application no. 201811047739 dated 17.12.2018.

Student Achievements

•   Dr. Neha Sharma was awarded her Ph.D. for her thesis titled **"Decisions from Experience: Investigating Decisions in Bandit via Experimentation and computational Cognitive model"**

•   Ms. Palvi Aggarwal, Ph.D. candidate, SCEE, IIT Mandi successfully defended her thesis titled **"A Behavioral Game-Theoretic Analysis of Cyber-Security Scenarios Involving Deception and Intrusion detection system"**

Recent Distinguished lectures

- **Topic:** Lecture on "Near Infrared Spectroscopy for Stroke diagnosis: Erudite and Illusive" at Indian Institute of Engineering Science and Technology
  Date: July 09, 2018
  Speaker: Dr. Shubhajit Roy Chowdhury

- **Topic:** Landslide Early Warning System in the 3rd Himachal Pradesh Science Congress held at IIT Mandi
  Date: 23rd October, 2018.
  Speaker: Dr. Varun Dutt

- **Topic:** Innovation on Power Generation

  from Solar and Biowaste.

  Date: 17th August 2018
  Speaker: Prof. Hiranmay Saha from Centre of excellence for Green Energy and Sensor Systems , IIEST Shibpur.

- **Topic:** Landslide Early Warning System under Chief Minister Startup Scheme held at Government Post Graduate College, Kullu.
  Date: 17th July, 2018
  Speaker: Dr. Varun Dutt
- **Topic:** Landslide Mitigation and Detailed project report (DPR) preparation
  Date: 27th August, 2018.
 **Speaker:** Dr. Varun Dutt

- **Topic:** ASSISTECH: Assistive Technology Solutions for Mobility & Education of Visually Impaired.
  Date: 5th November, 2018
  Speaker: Prof. M. Balakrishnan, Department of Computer Science and Engineering, IIT Delhi .

- **Topic:** Landslide Mitigation and Non-Structural Strategies at the HPSDMA workshop
  Date: 13th November, 2018.
  Speaker: Dr. Varun Dutt

Recent Workshops

- **Topic:** International Workshop on Applied Deep Learning.
  Date: 16 July to 20 July 2018.
  Organizer: Dr. Aditya Nigam(IIT Mandi), Dr. Kamlesh Tiwari(BITS Pilani)
  Speakers: Dr. Aditya Nigam, Dr. Kamlesh Tiwari, Dr. Arnav Bhavsar, Dr. Dileep A.D.
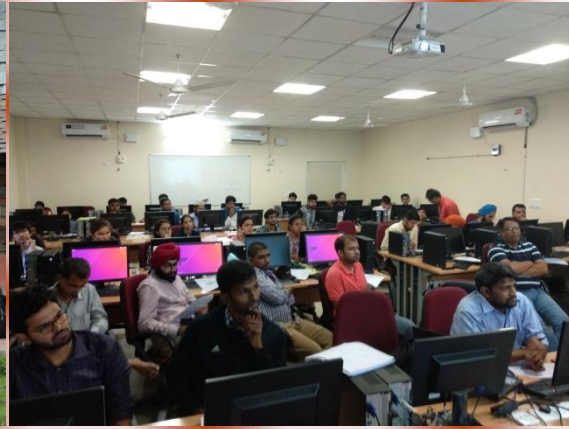
- **Topic:** Xilinx Vivado Design Flow through Zync FPGA architecture.
  Date: 13-15 october 2018
  Organizer: Dr. Shubhajit Roy Chowdhury

- **Topic:** International workshop on "Nano/Micro 2D-3D Fabrication, Manufacturing of Electronic–Biomedical Devices & Applications" (IWNEBD-2018).
  Date: 31st October to 2nd November 2018.
  Organizer: Patron-Prof. Timothy A Gonsalves,
  Speakers: Prof. Ashutosh Sharma, Dr. Ajay Kumar, Shri Ajay Prakash Sawhney, Prof. V. Ramgopal Rao, Dr. Vivek Singh, Prof. Nan M. Jokerst, Dr. Patrick Naulleau, Prof. Santanu Chaudhury, Prof. Habil. Jorg Schulze, Prof. M. Jagadesh Kumar, Prof. Ola L. A. Harrysson, Dr. M. S.
  M. Saifullah, Prof. Aaron D. Franklin, Prof. Nandita Dasgupta, Prof. Bodh Raj Mehta, Prof. Kuen-YuTsai, Ms. Allyson Hartzell, Prof. Kenneth Gonsalves, Prof. Kamaljit Rangra, Dr. Sourabh Ghosh, Prof. Enakshi Bhattacharya, Mr. Prashant Verma, Dr. Udayan Ganguly, Dr. Ajay Kumar Garg, Mr. Anant Naik, Shri D. Sam Dayala Dev, Mr. Paritosh Jain, Dr. Pushpraj Singh, Dr. Kasturi Saha, Dr. Suchandan Pal, Dr. Shailja Vaidya Gupta, Dr. Rajiv K Tayal

Recent SCEE Seminars

- **Title:** International symposium on information theory,Vail, CO, USA.
  Date: June 2018
  Speaker: Dr. Satyajit Thakor

- **Title:** A Minimal Set of Shannon-type Inequalities for MRF Structures with Functional Dependencies.
  Date: 30th august 2018
  Speaker: Dr. Satyajit Thakor

Upcoming Events

- **seminars and workshops:**
  Applied Cognitive Sciences (ACS) Lab, IIT Mandi in collaboration with University of Groningen, Netherland will be hosting the 1st Winter School on Cognitive Modeling in IIT Mandi from 4th February to 10th February 2019. For more details, please see: http://www.acslab.org/winterschool/home.html

- **Distinguished Lectures:**
  Dr Varun Dutt has been invited to give the Plenary speech in the 8th International Advance Computing Conference (IACC 2018) to held in Bennett University, Noida on 14 and 15th December, 2018.

IIT Mandi SCEE Family

Statistics of Students

No. of current M.S. students: 21

No. of current Ph.D. students: 75

Statistics of SCEE faculty members:

Total no. of regular Faculty members: 32

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