DEPARTMENT OF ELECTRICAL COMMUNICATION ENGINEERING

M.Tech PROJECTS

The following projects are being offered to the ECE students in Communication & Networks and Signal Processing streams. You are requested to give a list of at least SIX faculty members (in the order of preference) who have announced projects for your stream (Communication & Networks/Signal Processing) in the prescribed form to Mr. R. Srinivasamurthy in the ECE office.
The deadline for submission of this form is **30th November 2018 for MTech (C&N)** students, and **14th December 2018 for MTech (SP) students.**

VINOD SHARMA

VS-UM – 1 Routing and scheduling in wireless multihop networks for quality of service satisfaction. (C&N; Jointly with Prof. Utpal Mukherji)

VS – 2 Privacy preserving signal processing (SP only).

(For Communication & Networks and Signal Processing students)

B SUNDAR RAJAN

BSR – 1 Coding for multi-user communication (C&N)
BSR – 2 Index coding and coded caching (C&N)
BSR – 3 Coding for straggler mitigation in distributed computing (C&N)
BSR – 4 Modulation and coding for MIMO systems (C&N; SP)
BSR – 5 Space-Time signal processing and coding (SP; C&N)

(For Communication & Networks and Signal Processing students)

P VIJAY KUMAR

PVK – 1 Codes for modern applications: streaming data, big-data storage, coded computation, private information retrieval and block chains; polar codes. (1 student)

PVK – 2 Codes for modern applications: streaming data, big-data storage, coded computation, private information retrieval and block chains; polar codes. (1 student).

(For Communication and Networks students)

K V S HARI

FOR MTech(CN) students
KVSH-CN1: Signal Processing Algorithms for 5G Communication Systems (channel estimation, synchronization algorithms etc)

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KVSH – 2 Signal Processing Algorithms for 5G Communication Systems (mm-wave beam steering)
KVSH – 3 Signal Processing Algorithms for Radar Systems
KVSH – 4 Deep Neural Networks for Autonomous Navigation

FOR MTech(SP) students
KVSH – 1 Deep Neural Networks for Autonomous Navigation
KVSH – 2 Magnetic Resonance Imaging (MRI) Signal Processing Algorithms
KVSH – 3 Sparse Signal Processing algorithms

(For Communication & Networks and Signal Processing students)

A CHOCKALINGAM

AC – 1 OTFS modulation for 5G and beyond
AC – 2 Media-based modulation for 5G and beyond
AC – 3 Machine learning for wireless communications
AC – 4 Visible light wireless communications

(For Communication and Networks students)

K J VINOY

KJV – 1 Implementation of hybrid (analog + digital) beam steering for mm wave 5g systems
KJV – 2 System design for RF sensors for agricultural application

(For Communication and Networks students)

BHARADWAJ AMRUTUR

BA – 1 Connected Autonomous Drones Open to MTech (C&N), (SP), (Micro)
Project will involve looking at systems aspects of setting up low latency and reliable links for controlling a group of drones. This will be work done as part of the 5G project in collaboration with 5G faculty

BA – 2 Learning based control of robots Open to MTech(SP), (C&N), (Micro)
Project will involve end-to-end control of a robot arm (or a drone) driven by vision and using ML techniques.

BA – 3 Hardware acceleration of vision based inference
Open to MTech(Micro), MTech(SP), MTech(C&N)
Project will involve exploring h/w architectures for end-to-end inferencing & control based on ML techniques like deep networks.

BA – 4 Model Predictive Control on embedded Micro-Controllers (jointly with TI)
Open to MTech(Micro), MTech(SP), MTech(CN)
Project will involve implementing and characterising model predictive control on embedded micro-controllers. A test robot platform will be used to drive this research.

(For Communication & Networks, Signal Processing and Microelectronics students)

NEELESH B MEHTA

NBM – 1 New techniques for next generation 5G systems
NBM – 2 Machine learning techniques for reducing feedback overhead in 5G systems
NBM – 3 Green energy harvesting sensor networks: Design and analysis

(For Communication and Networks students)

NAVIN KASHYAP

NK – 1 Coding for privacy and security in distributed data storage
NK – 2 Maximally recoverable codes
NK – 3 Sampling from a probability distribution supported on a lattice.
NK – 4 2-D coding schemes for data storage devices

(For Communication and Networks students)

T SRINIVAS

TS – 1 Photonic Bandgap Structure based Chemical and Bio-Sensors.
TS – 2 Photonic Integrated Circuits for Quantum Communications.

Note: Student should be inclined to do experimental work. Otherwise knowledge of differential equations is required.

(For Communication and Networks students)

CHANDRA R MURTHY

CRM – 1 Detecting causal relationships between time-series data. [CN and SP]

In many IoT applications, one has a set of sensors observing the environment. These observations are communicated to the cloud over a wireless network. One of the goals at the cloud could be to detect causal relationships between the observations at the networks. In this framework, many interesting problems arise. For example, data quantization and hierarchical architectures for data collection under the rate constraints and network topologies, distributed and sequential algorithms for causality detection, performance analysis, model based vs. model-free (machine learning) based approaches, etc.

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CRM – 2 Massive MIMO systems under channel aging. [CN and SP]

Channel aging is a phenomenon that is inherent to all coherent communication systems, as they are based on estimating the channel at one point in time and using the channel estimate at a later time. The resulting outdated channel estimates degrade the SNR, increase interference, and reduce the achievable throughput. This becomes exacerbated in massive MIMO systems, as the number of "moving parts" in the system scales linearly with the number of antenna elements. We will investigate algorithms and architectures that can mitigate the problem of channel aging, and ask fundamental questions such as the frequency of training vs. accuracy of training tradeoff, power allocation for training vs. data, intra-cell and inter-cell interference due to aging, etc.

CRM – 3 Bayesian models for learning. [SP]

How does the brain learn relationships between different entities? For example, suppose there are five boxes placed in a row, and each box contains a ball of a different color. We are tasked with the problem of learning which box has which colored ball. An experiment consists of showing us one color, and asking us to choose a box. If the correct box is chosen, we get a reward. Clearly, after a few experiments, we learn the association. Now, suppose the association is changed. How quickly can we re-learn this association? The process of learning for these simple problems can be modeled in a Bayesian framework, where the brain tries to learn the posterior probabilities for each color over time. We want to develop such models and understand which models best explain the process of learning in various experiments.

CRM – 4 Understanding deep neural networks. [SP]

We want to understand how a deep neural network learns to solve simple detection problems such as detection of a signal in noise. For example, if the underlying detection problem admits a simple solution, does the neural network also learn a simple architecture? Why/why not? How does the architecture evolve as the size of the training data set is increased?

CRM – 5 Energy efficiency in 5G. [CN]

Energy efficiency is one of the key performance metrics for 5G communication systems. The specific problem that needs to be addressed depends on the application scenario. In particular, in massive machine-type communication, random access based protocols, e.g., coded slotted aloha or sparse code multiple access, are promising candidates to improve the energy efficiency and reduce the overhead involved in short packet communications. The goal of this project is to analyze the energy efficiency of such protocols and propose techniques to improve the energy efficiency while meeting the data rate and latency requirements of the system.

CRM – 6 Sparsity and sparse signal recovery techniques applied to communication systems. [CN and SP]

Sparse signal recovery techniques have been successfully applied to several problems in communication systems, e.g., channel estimation, direction of arrival estimation, user activity detection, etc. This project will involve other novel applications of sparsity and sparse recovery techniques in 5G communication systems. Further, the relationship between these architectures and deep learning based approaches will be explored.

(For Communication & Networks and Signal Processing students)

PARIMAL PARAG

PP – 1 Control of autonomous vehicles over wireless networks (C&N and SP)
PP – 2 Asynchronous distributed stochastic gradient descent (C&N and SP)
PP – 3 Distributed learning over networks (C&N and SP)
PP – 4 Fault detection over large data center networks (C&N)
PP – 5 Age-sensitive storage updates (C&N)

(For Communication & Networks and Signal Processing students)

HIMANSHU TYAGI

HT – 1 Information constrained machine learning
Description: We will explore variants of machine learning algorithms under various information constraints such as communication, privacy, and information structure constraints. The student will be expected to develop and implement algorithms on real data sets. Students interested in information theory, algorithms, and implementations can consider this project.

HT – 2 Experiments with blockchains
Description: We will setup a private blockchain network and experiment with its various components. While the particular focus of this project will be on anonymous transactions and Byzantine agreements, depending on student's interest and bandwidth, we can also take up test implementations of various cryptography primitives such as Seeded Extractors, Authentication, Digital Signatures, and Secure Computing. Students interested in information theory, cryptography, and coding (not only of the error correcting variety!) can consider this project.

HT – 3 Evaluation and comparison of LPWAN techniques for large scale IoT deployments
Description: We will review different aspects of LPWAN techniques proposed in recent years and evaluate their performance using NS-3 simulations. Our focus will be on use of algorithms and learning techniques to improve system efficiency and make it more adaptive. Students well-versed with wireless communication, networks and coding, and interested in [illegible] machine learning can consider this project.

HT – 4 Information theory for X
Description: Anyone interested in mastering theoretical aspects of information of any kind can take-up this project. The exact topic will be decided only after discussion with the student, but the topics of interest include information constrained learning and testing, information theoretic cryptography, information bounds in complexity theory, and quantum information theory. Although we will largely deal with elementary analysis and probability, this will be a proof-heavy project and interested students must love lemmas and die for theorems.

HT – 5 Distributed control and learning for coordinated search and rescue
Faculty offering: Aditya Gopalan and Himanshu Tyagi

Description: We are setting-up a robotic testbed to enable campus-wide coordinated search and rescue by robotic nodes connected via a multimodal communication network. We are offering an M.Tech. project to develop and simulate control algorithms for this project. This will include distributed implementations of various control algorithms with model uncertainty, missing information, delays, and other constraints that are driving research in machine learning for control. Students interested in control, statistics, machine learning, algorithms and testbed implementations can consider this project.

(For Communication & Networks and Signal Processing studentts)

RAJIV SOUNDARARAJAN

RJN – 1 VR Cloud Gaming: Quality assessment of immersive computer-generated gaming videos wirelessly transmitted to head mounted displays
RJN – 2 Image/video compression using deep CNNs and perceptual quality indices
RJN – 3 Low light image enhancement: Using near infra-red images to enhance visible light photographs

(For Communication & Networks and Signal Processing students)

SANDEEP CHEPURI

SC – 1 Graph Learning from Multidimensional Data
SC – 2 Active Imaging with One-bit Sparse Arrays

(For Communication & Networks and Signal Processing students)

ADITYA GOPALAN

AG – 1 Online learning in partially observed dynamical systems (1 student) [Solely by myself]
AG -2 Distributed control and learning for coordinated search and rescue [Joint with Himanshu Tyagi]
(For Communication & Networks students)

He will be joining as Asst. Professor to ECE in the month of

PRASANTA KUMAR GHOSH

PKG – 1 Data-driven text-to-articulatory gesture prediction for language learning
PKG – 2 Facial expression prediction from speech
PKG – 3 Conversion of esophageal speech to normal speech
PKG – 4 Non-invasive monitoring of blood pressure

(For Signal Processing students)

G N RATHNA

GNR – 1 Image denoising using FPGA.

(For Signal Processing students)

CHANDRA SEKHAR S

CSS – 1 Deep Learning Techniques for Solving Inverse Problems in Imaging
CSS – 2 Deep Learning Techniques for Speech Restoration

(For Signal Processing students)

SOMA BISWAS

SB – 1 Super-resolution of naturally degraded images
SB – 2 Few shot learning utilizing synthetically generated data

(For Signal Processing students)

A MUTHUVEL

AM – 1 Hierarchical Kernel Entropy Component Analysis for Image Feature Detection

(For Signal Processing students)

SRIRAM GANAPATHY

SG – 1 Understanding the neural processes in language learning.
SG – 2 Representation learning of speech using unsupervised deep learning.

(For Signal Processing students)

VENU MADHAV GOVINDU

VMG – 1 Hierarchical methods for large-scale 3D reconstruction from images

(NAVIN KASHYAP)
For Projects Committee

Department of Electrical Communication Engineering
Project Allotment Procedure for M.Tech. C&N Students
16 th November 2018

1. ECE office will send out an email to all faculty members requesting them to submit to ECE office the list of possible projects. The deadline for this will be 2:00pm on 16th November. Although there may be an upper limit to the number of students allotted to each faculty, they are encouraged to list as many projects (and mention the total number of students) as they wish to take up during the academic period.

2. ECE Office will announce the list of projects on 16th November. Students are encouraged to meet faculty members who have announced projects in their stream by 30th November.

3. An M.Tech. Project Option Sheet will be distributed to students. Students should submit their preferences to the ECE office by 30th November. Students are required to give a list of ALL faculty members (in order of preference) who have announced projects in their stream.

4. Faculty members who are interested in taking students should give their list of (all interested) students in the order of preferences to the ECE Office by 30th November. In their list, faculty members will have an option to give wider set of names (such as "anyone" or "anyone among a, b, c", or "anyone except x, y, z"). The faculty member should also indicate the maximum number of students (s)he wishes to take.

5. If the faculty member does not send his/her list of preferred students, or the list is insufficient, then projects announced by him/her will become non-operational.

6. Students will be allotted guides based on the preference lists given by faculty and students (see the project allocation algorithm). Although maximum efforts would be made to satisfy the interests of faculty and students, the best possible match between students and projects may not be guaranteed.

7. The Project Allotment Committee will prepare a tentative list of matchings by 6th December. The Chairman, ECE Dept, may convene a faculty meeting subsequently to ratify the allotments and to decide on situations that require special considerations.

8. The final project allotments will be announced on or before 14th December. The decision of the faculty meeting will be binding on all students and faculty [illegible] in the procedure.

Department of Electrical Communication Engineering
Project Allotment Algorithm for M.Tech. (C&N) Students
16th November 2018

Round 1

- **Step 0:** Randomly pick a student.
- **Step 1:** Look up the faculty member listed as the student's first preference. If the student appears on top of that faculty member's list, the match is made. In this case, mark the student as "ALLOCATED".
- If a faculty member gets ONE M.Tech. (C&N) student, either as the sole guide or as a co-guide, at any stage of Round 1, (s)he goes out of further contention in this round.
- In the event that the faculty member who is the student's first preference has not listed the student at all, the student's second preference is upgraded to become his/her first preference, This upgradation is also done in the event that the student's first preference has already gone out of contention in Round 1. In all other cases, the student goes back into the stack.
- Whenever an upgradation happens, a match as in Step 1 is attempted. If a match is made, mark the student as "ALLOCATED".
- Round 1 is kept operational until either all students are marked as "ALLOCATED" or the allotment process reaches a deadlock.

Round 2

- In this round, all faculty members who have offered projects are brought back in contention, including those who were allocated students in Round 1 (provided that they seek more than one student).
- Faculty and student preference lists are updated as follows. Students allocated in Round 1 are removed from all faculty members' lists. Students unallocated in Round 1 have their faculty preference lists restored to their initial states, as they were at the beginning of Round 1.
- A matching procedure as in Round 1 is executed, this time allowing each faculty member to be allocated a combined total (over Rounds 1 and 2) of TWO M.Tech. (C&N) students.
- Round 2 is kept operational until either all students are marked as "ALLOCATED" or the allotment process reaches a deadlock.

Round 3

- In Round 3, a best effort will be made to allocate students to those faculty members who have offered a project, but who were not allocated any students in Rounds 1 and 2. This will be done solely on the basis of the lists provided by the students and faculty. In this round, a match will be made between a faculty member and a student ONLY IF each appears on the other's list.
- Faculty can write "ANY STUDENT" in their list to maximize their chances of being allocated a student.

Round 4

- If, at the end of Rounds 1-3, there are any unallocated students still left, they will be encouraged to talk to faculty members to find a suitable project guide. The allocation of projects in these cases is finally at the discretion of the ECE Department Chair, based on a mutual understanding between the concerned students and faculty.

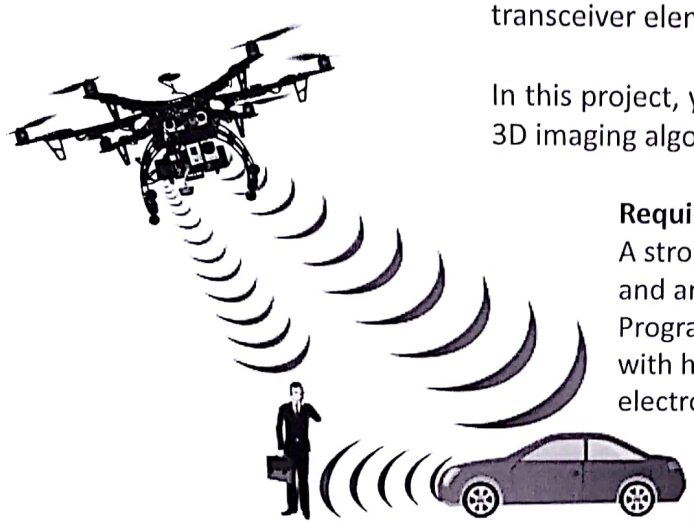
Remarks: M.Tech. (C&N) students who have already been allocated projects under the Texas [illegible] program will automatically be removed from the above projects allocations exercise. Their project guides for the TI projects will also be removed from contention in Round 1 of the algorithm outlined above.

projects in these cases is finally at the discretion of the ECE Department Chair, based on a mutual understanding between the concerned students and faculty.

Remarks: M.Tech. (C&N) students who have already been allocated projects under the Texas Instruments (TI) scholarship program will automatically be removed from the above projects allocations exercise. Their project guides for the TI projects will also be removed from contention in Round 1 of the algorithm outlined above.

M. Tech project opening:
Active Imaging with One-bit Sparse Arrays

With mmWave sensor arrays, we can accurately see objects under extremely poor visibility conditions. To reduce the sensing costs and power consumption, we wish to reduce the number of transceiver elements and acquire highly quantized one-bit data.



In this project, your task is to develop sparse sensing methods and 3D imaging algorithms to detect objects.

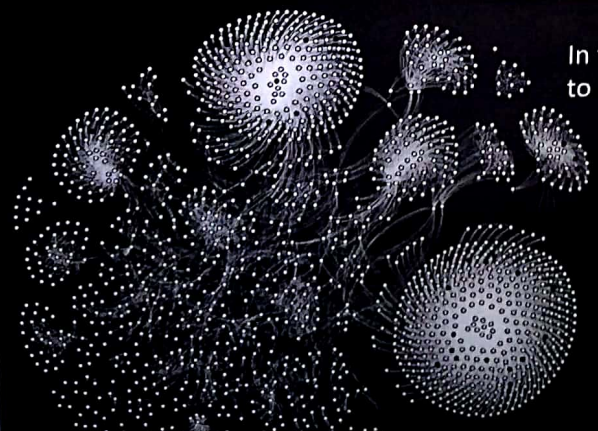
Requirements:
A strong background in linear algebra, statistical (radar and array) signal processing, and optimization theory. Programming skills and laboratory experience (working with hardware, measurement equipment, and electronics).

Interested M. Tech (SP or C&N) students contact:

Sundeep Prabhakar Chepuri
Assistant Professor, ECE dept., IISc
s.p.chepuri@tudelft.nl

M. Tech project opening:
Graph Learning from Multidimensional Data

Having a good quality graph is central to many signal processing and machine learning tasks appearing in network sciences.



In this project, your task is to develop scalable algorithms to learn network topologies from multidimensional data or tensors, e.g., time-varying network data.

Requirements:
A strong background in linear algebra, statistical signal processing, machine learning, and optimization theory. Programming skills in MATLAB or Python.

Interested M. Tech (SP or C&N) students contact:

Sundeep Prabhakar Chepuri
Assistant Professor, ECE dept., IISc
s.p.chepuri@tudelft.nl

M.Tech Project Description

Project Title: Codes for modern applications: streaming data, big-d
storage, coded computation, private information retrieval and bloc
chains; polar codes. (2 students)

Details on the above project will be given at a short presentation t
held on Monday November 19, at 3:45 pm in room ECE 1.08. The
meeting is open to all interested ECE M Tech students.

Thanks,

P. Vijay Kumar