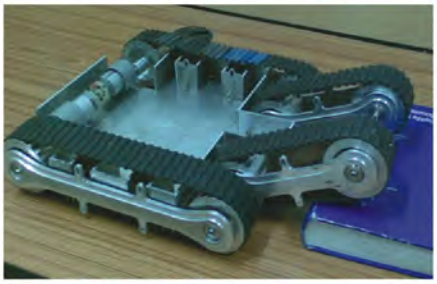
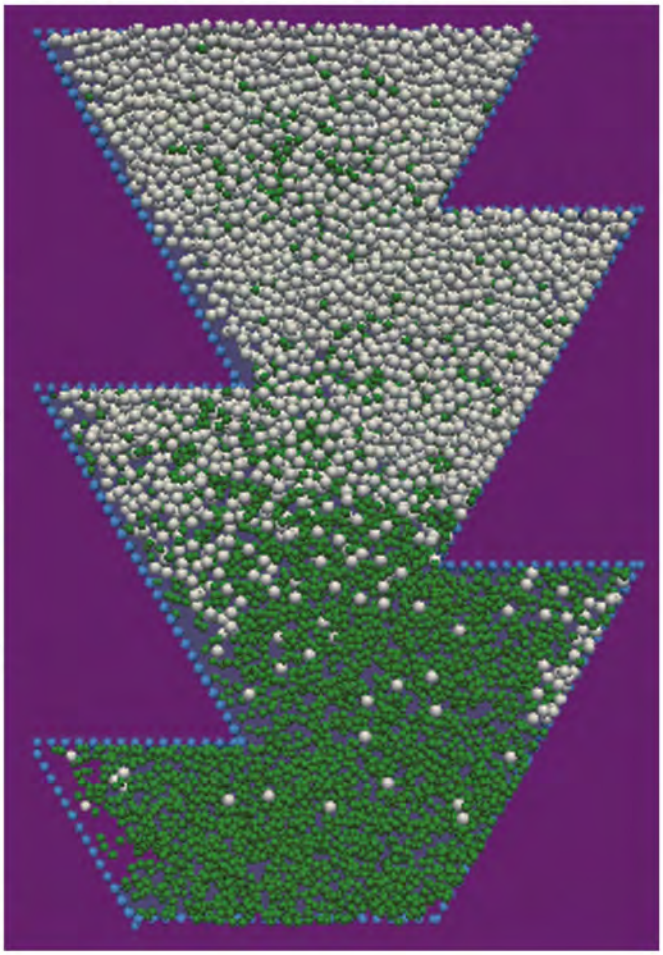
Volume 2, Issue 1

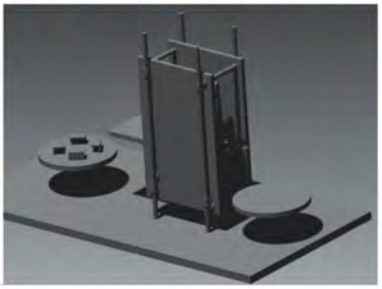
January 2014

R&D Newsletter

INDIAN INSTITUTE OF TECHNOLOGY KANPUR







soft copy of the newsletter is available at

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Synchronized Measurement Technology for Voltage Stability Monitoring and State Estimation of Power Systems

PI: Prof. Saikat Chakrabarti, Dept. of Electrical Engineering
Sponsor: Dept. of Science & Technology

Specific Objectives of the Project

- To develop methodologies to use SMT to monitor the voltage stability of a power system in real-time, and to design an early warning system for a potential voltage instability scenario.
- To develop the 'next generation' hybrid state estimator that will incorporate the synchronized as well as the conventional measurements in a power system.

Technical Results Obtained

- Techniques are developed for wide-area synchrophasor measurement based real-time monitoring of voltage stability of power systems, monitoring of total reactive power reserve in the system, and sensitivity-based voltage stability control of power systems. The proposed methodologies are validated using real time power system simulators.
- Algorithms for hybrid state estimation are developed and tested successfully. The completed work includes an L-curve based robust state estimator, an artificial neural network based hybrid estimator, algorithm to detect and identify bad data by using computational intelligence, methodologies for combining synchrophasors with conventional measurements so that the convergence characteristics and the accuracy of the existing state estimator increases, and methodologies for transformation of measurements while determining external network equivalents for state estimation.

Collaborator: University of Cyprus, Nicosia, Cyprus

Development of Video and Animated Scenarios for SJT as Part of De-novo Selection System for Selection of Officers for the Indian Armed Forces under Sub Programme-I.

PI: Prof. Braj Bhusan, Dept. of Humanities and Social Sciences
Sponsor: Defence Institute of Psychological Research, DRDO

Specific Objective of the Project

Situation Judgment Test (SJT) is a projective technique used for the assessment of personality. Due to the nature of video versions of the scenarios the items become richer and more detailed for behavioural assessment. This project developed and tested 60 video SJT scenarios and 2D animated scenarios, respectively.

Technical Results Obtained

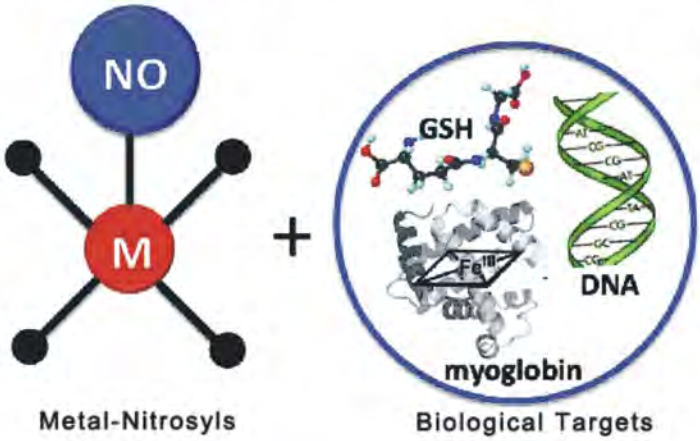
Conventionally paper-pencil format of SJT was being used by the concerned recruitment bodies. With technological advances it is now possible to develop video-based SJTs wherein the situations and possible responses can be presented in the video format. This is a relatively new phenomenon that has been used at selected places in the world and in India this is the first time that a video-based SJT has been developed. After development of the 60 SJT scenarios inter-rater judgment was performed to check the equivalence of written scenarios and the newly developed video version. This is likely to be used in the selection system for the assessment of personality by the concerned agency.

Nitric Oxide Delivery to Biological Targets from Transition Metal Nitrosyl Complexes

PI: Prof. Ashis K. Patra, Dept. of Chemistry
Sponsor: Science and Engineering Research Board

The biological importance of nitric oxide (NO) is well established. It plays key roles as a signaling molecule in a number of mammalian physiological and pathophysiological processes. The reactions of nitric oxide with transition metals are of great chemical interest and also key in understanding diverse biological processes.

The overlapping areas to be investigated in this project are:
(i) Design, synthesis, characterization of metal nitrosyls as potential NO donors.
(ii) Interactions of metal-nitrosyls with potential biological targets viz. nucleotides, nucleic acids, proteins and fate inside cellular environment.
(iii) Cytotoxicity and mechanism of actions will be studied to elucidate their efficiency as potential therapeutic agents.



Transfer of NO to biological targets

Macrobicyclic Cryptands as Platforms for Attachment of Donor and Acceptor Groups: Photo-Induced Energy and Charge Transfer

PI: Prof. P. K. Bharadwaj, Dept. of Chemistry
Sponsor: Science and Engineering Research Board

In systems containing more than one type of fluorophores substantial energy/charge transfer can take place depending upon the nature of the fluorophores. A cryptand as a platform is attractive for studying energy/charge transfer because it allows sequential addition of different fluorophores. Besides, it can undergo conformational changes to enable partial movement of one of the side arms with respect to another, which changes the distance and the orientation of the fluorophores with respect to one another, with implications on the energy/charge transfer efficiency. In continuation of the studies with these molecules, different donor and acceptor moieties will be attached to cryptands and acyclic molecules as well. This project is of fundamental nature with the ultimate aim of using solar energy for useful purposes.

Investigations into Compositionally Modulated Magnetoelectric Gallium Ferrite for Sensor and Transducer Applications

PI: Prof. Ashish Garg, Dept. of Materials Sc. and Engineering
Co-Pi: Professor Rajeev Gupta, Dept. of Physics

Sponsor: Science and Engineering Research Board

This project aims at exploring Gallium ferrite which is a known piezoelectric and ferrimagnetic material. The recent work demonstrated that the material also possesses significant magnetoelectric coupling as well as nanoscale ferroelectricity at or above room temperature making it a technologically important material, especially for applications related to sensors and transducers. However, despite all these attractive features, the biggest bottleneck to its device utility is its higher electrical leakage in both bulk and thin film form whose mechanism remains unknown. This project envisages to first understand the mechanism of electrical leakage in gallium ferrite by carrying out detailed impedance spectroscopy. Subsequently, defect chemistry as well as microstructure of gallium ferrite will be tailored by judicious substitution of cations in the material in the bulk form to reduce the electrical leakage. This will be followed by studies on selected compositions used in thin film form of Metal-Insulator-Metal (MIM) capacitor configuration for studying the device characteristics at a few 100nm thin film scale. The eventual goal of the project is to develop high insulation gallium ferrite to enable sensor and actuator devices for a variety of applications.

Investigations into Coherent to Semicoherent Transition of Precipitates in Nanoscale Systems

PI: Prof. Anand Subramaniam, Dept. of Materials Sc. and Engineering
Co-PI: Prof. Gouthama, Dept. of Materials Sc. and Engineering

Sponsor: Department of Science & Technology

Coherent precipitates on growth can become semi-coherent by the formation of interfacial misfit dislocation loops (beyond the critical size r*). In the current investigation the growth of a coherent precipitate and a dislocation loop is simulated by finite element method (FEM). Using a combined simulation of a precipitate and a dislocation loop the critical size r* is determined. Additionally, the critical size (r_c) at which the loop is locally stable in the radial direction is determined using FEM. The variation in critical sizes is studied as the size of the domain is reduced to nanoscale dimensions. A phase diagram will be evolved (with r* and domain size as axes) demarcating the regions of stability of coherent and semi-coherent states. Further, preliminary experimental investigations the Cu-Fe/Co system will be carried out to study precipitation in bulk and nanoscale systems (using Transmission Electron Microcopy).

Shapes, Stability and Dynamics of Granular Minor Planets

PI: Prof. Ishan Sharma, Dept. of Mechanical Engineering
Sponsor: Physical Research Laboratory, Ahmedabad

Objects such as asteroids and planetary satellites are called minor planets. Ongoing research suggests that these objects may not be solid, but, rather, be made of sand or pieces of rock that stay together because of self gravity. Figure 1. shows the image of asteroid Itokawa taken by the Japanese space probe Hayabusa. The image reveals Itokawa's surprisingly gravelly surface. This project aims to employ continuum mechanics and discrete element simulations to understand the behavior of these objects.

Figure 1: Asteroid Itokawa as photographed by the Japanese space probe Hayabusa.

This is crucial as India plans space missions to Moon, Mars, and even asteroids.

As part of this project, an in-house discrete element code will be extended to planetary bodies. Figure 2 shows an example of how this code has been used recently to analyze segregation in a novel grain sorter. This code has been developed by Prof. Ishan Sharma, PI of the project along with Prof. Jayant Singh of Chemical Engineering Department and their shared Ph.D. student Ashish Bhateja. Discrete elements simulations are computationally intensive, and part of the project's funding will be utilized to augment their lab's computational facilities.

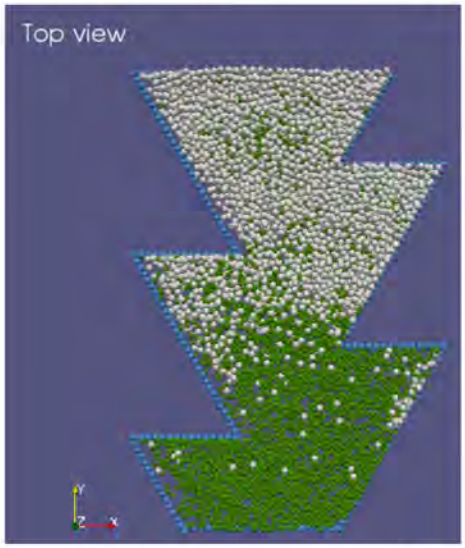


Figure 2: Example of use of the Code to analyze segregation in a novel grain sorter.

Stable Superhydrophobic Coating on Steel Surfaces for Corrosion Prevention and Water Drag Reduction

PI: Prof. Krishnacharya, Dept. of Physics
Sponsor: TATA Steel Limited

Steel is one of the most commonly used material now a days in every aspect of human life and corrosion is the most important issue associated with it. Corrosion is mainly due to water or moisture coming into contact with steel surfaces. If the water (even moisture) contact with steel surfaces can be controlled and minimized, corrosion could be prevented to a large extent. Interaction of water (and moisture) with steel surfaces could be minimized by decreasing its surface (interfacial) energy using appropriate low surface energy material's coating. Such coatings make steel surfaces superhydrophobic with water contact angle as large as 170°. Therefore the interaction of water (and moisture) with steel surfaces are minimized and the chances of corrosion are significantly reduced.

Analysis Of Human Gait And Design Of A Leg Exoskeleton For Rehabilitation

PI: Prof. Ashish Dutta, Dept. of Mechanical Engineering
Sponsor: Science and Engineering Research Board

The aim of this project is to develop a leg exoskeleton robot. The exoskeleton can be worn on the legs and would provide power and load sharing capacity during walk/exercise. First, the human leg motion during walk will be studied using a motion capture system, based on which the optimal leg exoskeleton will be designed. The leg joints will be designed using 4-bar mechanisms, motors and sensors that will provide support for load carrying and also emulate human motion. An experimental study will also be carried out to understand the relation between the surface EMG signals from the leg muscles and the leg force control in humans. Based on this study a learning based controller will be designed to control the exoskeleton using the wearers EMG signals.The developed exoskeleton will have applications in active prosthetics, support for the elderly and rehabilitation of persons with neuro-muscular disorder of lower limbs etc.

Ground Response Analysis of Soils from North India Considering Soil Strain

PI: Prof. N.R. Patra, Dept. of Civil Engineering
Co-PI: Prof. G. R. Reddy, BARC
Sponsor: Board of Research in Nuclear Sciences

One of the most important and most commonly encountered problems in geotechnical earthquake engineering is the evaluation of ground response. Ground response analysis is used to predict site natural periods, assess ground motion amplification, provides ground motions for development of design response spectra, evaluate potential for liquefaction, and to determine the forces induced due to an earthquake which can lead to instability of earth and earth slopes. To estimate the ground response of soil one shall have correct soil model which represent its dynamic properties. For this purpose, field tests (SPT, Seismic down hole tests) and laboratory tests (cyclic triaxial tests and geotechnical tests) will be carried out for soil sites from northern India. Using the laboratory and field test results, it is proposed to develop a model for dynamic deformation characteristics for northern Indian sites. The model proposed will be validated by applying recorded time history of bedrock and compares its free field response with the recorded free field time history. Liquefaction assessment will also be carried out using the site characteristics data and site response study results. The effects of soil strain, terrain properties, water table and earthquakes on Peak ground motion will be studied.

Efficient and Accurate Algorithms for Acoustic and Electromagnetic Scattering from Inhomogeneous Scatters in Two and Three Dimensions

PI: Prof. Akash Anand, Dept. of Mathematics & Statistics
Sponsor: Science and Engineering Research Board

The project proposes development of efficient, accurate and rapidly-convergent algorithms for the simulation of scattering of acoustic and electromagnetic fields within and around structures that consist of complex combinations of penetrable structures and possess complex geometrical characteristics. These are configurations of fundamental importance in diverse fields, with application in communications, remote sensing and surveillance, geophysical prospecting, materials science and biomedical imaging – amongst many others. The simulation of electromagnetic wave propagation in such complex structures gives rise to a host of significantcomputational challenges that arise from pres- ence of complex material arrangements, geometric singularities, cavity resonances, and ill-conditioning, amongst other complicating factors.

MUSIC-Group Delay based Source Localization and Tracking over Spherical Arrays

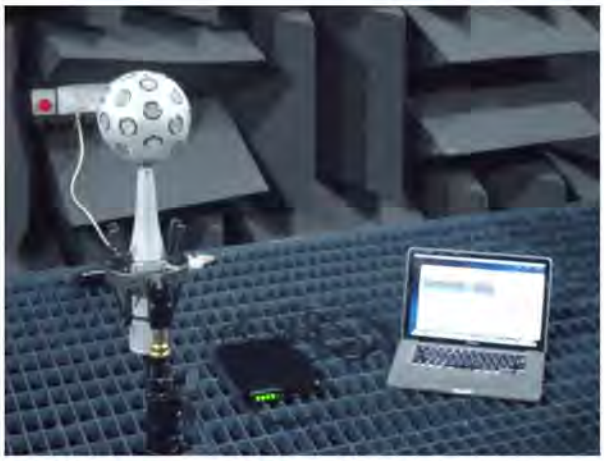
PI: Prof. Rajesh M. Hedge, Dept. of Electrical Engineering
Co-PI: Prof. Harish Karnick, Dept. of Computer Sc. & Engineering
Sponsor: Department of Science and Technology

Conventional methods for source localization requires large number of sensors for resolving closely spaced sources. Also, it gives many spurious Direction of Arrival (DOA) peaks which makes decision of DOA candidate peak difficult. Under such circumstances, tracking or Distant Speech Recognition of sources becomes difficult. Achieving high resolution source localization and tracking in spherical harmonics domain is objective of this proposal. In particular , the aim of the proposed research is to study the MUSIC-Group delay (MUSIC-GD) spectrum in spherical harmonics domain. MUSIC-GD spectrum is a novel, high resolution subspace-based method for source localization. This proposed research will try to utilize the advantages of the MUSIC-GD spectrum in a spherical harmonics framework, being computationally simple and more accurate. The objectives of the project are:

- Localization of speech sources
- Three dimensional real time tracking of speech sources
- Beamforming and Speech enhancement
- Distant speech recognition (DSR)
- Room acoustics measurement
- 3-D positional audio and head related transfer function (HRTF) measurement for rendering spatial audio.

Highlight of the Project

This will facilitate and augment a dual spherical microphone array set-up at IIT Kanpur, probably the first in India. This will also enable a research initiative on spherical array processing.



Spherical microphone array setup in an Anechoic Chamber at IIT Kanpur

MOU signed with RITES Ltd.

IIT Kanpur signed a Memorandum of Understanding with RITES Ltd. - a Public Sector Undertaking of Indian Railways on 21st November, 2013. The MOU will promote research cooperation between the two organizations for the development of internal combustion engine technology for diesel locomotives, emission compliant and fuel efficient high horsepower diesel engines, gas turbine based power units etc. for railway traction. Prof. Ajit Chaturvedi, Dean of Research and Development, Prof. Avinash Kumar Agarwal (ME), Prof. Tarun Gupta (CE), Prof. Bishakh Bhattacharya (ME) Prof. Nachiketa Tiwari (ME), Mr. Anil Gonade, AR (DORD) and Shri Pradeep Gupta, Group General Manager, Shri Anupam Sharma, General Manager, RITES Ltd. were present at the MoU signing ceremony.

17th International Heat Pipe Conference

Commemorating forty years of the successful organization of the International Heat Pipe Conference series, the 17th jubilee edition was organized in IIT Kanpur during October 13 to 17, 2013 by the Department of Mechanical Engineering, under the convenership of Dr. Sameer Khandekar. It was for the first time that India was the venue of this conference. The aim of the conference is to bring together experts, students, practicing engineers and industry representatives from across the world on a common platform to share state-of-the-art information, experiences and latest developments on the science and technology of all kinds of heat pipes and passive phase-change devices and thermal systems. Dr Ravi Grover, Director, Homi Bhabha National Institute, Mumbai (Chief Guest), Dr. M. Prahlada Rao, Director of Navigation Satellite Communications Group, ISRO Bangalore (Guest of Honor), and Deputy Director of IIT Kanpur, Prof. S. C. Srivastava, inaugurated the event. One hundred and thirty participants and experts from twenty-one countries presented more than 120 papers. Prof. Indranil Manna, Director, Indian Institute of Technology Kanpur distributed the George Grover Memorial Lifetime achievement award to Prof. Manfred Groll and Don Earnst Best Paper awards during the closing ceremony of the conference. A vibrant and colorful cultural program was also organised with the performance of hindustani classical music by Mrs. Pradnya Khandekar and group, Tabla and Harmonium Solo performance by the duo Mrs. Seema Shirodkar and Mr. Vishwanath Shirodkar and Gotipua Dance by Guru Vijay Kumar Sahu and his troupe.

Feedback/Suggestions

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