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Research Profile of IIITB

Complete listing of areas, for which there is ongoing active research at IIITB, as categorized in the seven research domains, is given here.

1. Computer Science
2. Data Sciences
3. Electronic Systems Design
4. Information Technology & Society
5. Mathematics & Basic Sciences
6. Networking Communications & Signal Processing
7. Software Engineering

COMPUTER SCIENCE

If Computer Science is about the use of computational techniques and thinking for solving problems, it stands to reason that computer science in turn can and must be applied to address the many critical problems of the 21st century, of which we may mention the need for smart machines and complex systems that can work with humans seamlessly and improve society as a whole, and sustainable development and usage of systems to make effective use of scarce and expensive resources such as energy. The tools and paradigms used to address such problems can themselves be new ones, other than merely the ones traditionally found in the repertoire of computer scientists. To this end, our work in the computer science research domain covers diverse topics dealing with theory as well as application areas, such as smart grids, supply chains and their optimization, algorithms, machine learning, cloud computing, dynamic modeling and control of servers, and renewable energy. With the tremendous rise in distributed computing applications, the issue of security and privacy in distributed applications has got tremendous attention from the research community in the past decade. A major theme of the cryptographic research at IIITB is secure distributed computing, with emphasis on secure multi-party computation (MPC) and verifiable computation, both at the theoretical as well as applied level. While we strive to be rigorous and thorough in all our research, whether theoretical or applied, we are also aware of the multi-disciplinary context and significance of our work, and strive to address issues that are relevant to society in general and industry in particular. The focus of work in Computational Topology at IIITB is towards using topological methods for improving visual representation and information extraction from scientific datasets.

Faculty Members
Prof. Amit Chattopadhyay, Prof. Ashish Choudhury, Prof. Meenakshi D'Souza, Prof. V. N. Muralidhara, Prof. Pradeesha Ashok, Prof. G. N. S. Prasanna, Prof. Sachit Rao, Prof. Shrisha Rao, Prof. G. Srinivasaraghavan.

DATA SCIENCES

The Data Sciences research domain focuses on all aspects of data management, processing, modeling, and information retrieval. The current areas of interest include: Database Design, Information Retrieval, Network Analysis, Mining Latent Semantics, Data Mining and Data Warehousing, Knowledge Representation and Reasoning, Linked Data and Semantic Web, NoSQL Databases, Stream Data Management, Multimedia Management using Control Theory, Analytics, Graphics & Visualization, and GPU Computing, Applied Machine Learning, Computational Social Sciences, Computational Topology.

Faculty Members
Prof. Amit Chattopadhyay, Prof. Chandrashekar Ramanathan, Prof. Dinesh Babu Jayagopi, Prof. Jaya Sreevalsan Nair, Prof. Sachit Rao, Prof. Srinath Srinivasa, Prof. G. Srinivasaraghavan, Prof. T. K. Srikanth.

ELECTRONIC SYSTEMS DESIGN

The Electronic Systems Design domain encompasses a broad range of topics covering several aspects of both, digital and analog hardware systems, implemented using FPGAs and custom fabricated VLSI circuits, design methodologies around EDA flows, verification and validation, and system prototyping; realization of real time embedded systems where both the hardware and the software components are treated agnostically based on end system requirements; embedded implementation of feedback control using variegated sensors. Emphasis is also placed on emerging technologies based on Micro and Nano-electro mechnical devices – fabrication of 2D/3D structures, characterization and system applications. Topics of active research may be summarized as Model Based Hardware-Software Co-Synthesis of Reconfigurable Embedded Systems; Electronic Design Automation, especially timing optimization; CNT modelling for 3D integrated circuits; Wideband antenna design; RF Circuit Design; Implementation issues for feedback control; Analog-and-Mixed-Signal circuit design; Deterministic embedded systems implementation for applications in motion control.

Faculty Members
Prof. Chetan Parikh, Prof. Madhav Rao, Prof. Sachit Rao, Prof. Srinath Naidu, Prof. Subajit Sen, Prof. Subir K. Roy.

INFORMATION TECHNOLOGY & SOCIETY

The Information Technology and Society research domain at IIITB is broadly concerned with the social role of information and communications technologies (ICTs) with a focus on the policy challenges and the institutional demands posed by technological change. Teaching and research in the stream focuses on three inter-related areas. First, it seeks to understand innovation and the organization of production in the ICT industry, or how, why and where ICTs are produced. A second area of interest is in how ICTs can be used to harness the legitimacy and the powers of bureaucracies and markets to address needs in different social domains. Of special interest are the domains of governance, education, health and manufacturing. A third area is the tools and analytical techniques that can be deployed to understand the production and consumption of ICTs. These include geographical information systems, modeling, simulation and visualization. The domain encourages inter-disciplinary research and has associated faculty members with expertise in social sciences, including in economics, economic geography, sociology, development, management, governance and public administration.

Faculty Members
Prof. Amit Prakash, Prof. Balaji Parthasarathy, Prof. Bidisha Chaudhari, Prof. Janaki Srinivasan, Prof. Preeti Mudliar, Prof. S. Rajagopalan, Prof. V. Sridhar.

MATHEMATICS & BASIC SCIENCES

The research at IIITB in Chemistry, Mathematics and Physics are given here.

In **CHEMISTRY**, the research at IIITB primarily is in the area of electronic structure calculations. Particularly, weak interactions (pi-pi, CH-pi etc.) present in various systems (small model systems, protein-ligand systems, DNA bases, nanotubes etc.) are investigated using quantum chemical methods (HF, MP2, CCSD(T) & DFT). Additionally, the work entails unravelling the role of such weak interactions in the field of drug-design, polymers, nano-devices and in new materials. Some of the recent research works show that pi-pi and CH-pi interactions are invariably present in the crystal structures of bio-molecules and play important role in their structure as well as functions.

Faculty Members
Prof. Brijesh Kumar Mishra.

Research in **MATHEMATICS** is principally in the area of Number Theory; in particular, Algebraic Number Theory, Galois Representations, Modular Forms, Iwasawa Theory. Diophantine Equations, Galois Module structure and Elliptic curves. Research is also conducted in the fields of Algebraic Complexity Theory and Cryptography. The following two problems are representative of the mathematics research in IIITB: Let E be an elliptic curve over number field K. For every prime P where E has good reduction at P, we get one imaginary quadratic field associated to E. We are trying to see if we can get all imaginary quadratic fields by this procedure?

Faculty Members
Prof. Manisha Kulkarni.

In **PHYSICS**, there are two sub-domains of research focus at IIITB: (a) One sub-domain of research focus is on soft condensed matter physics, complex systems & dynamical systems theory, instabilities & synchronization in nonlinear systems (both physical and biological), and macromolecular systems. Topics include bubble dynamics & cavitation, vesicular nanotubulation, polyelectrolytic solutions, combustion, phase transitions in computationally hard problems, models of sensory systems, precipitation phenomena, etc.; (b) The other sub-domain of physics research is in computational fluid mechanics, especially simulations & modeling of hydrodynamic and magnetohydrodynamic turbulent flows, reduced resistive MHD simulations, low resolution simulations of 3D-HD and MHD turbulent flows including rotation & helical forcing and 3D-anelastic HD and MHD code.

Faculty Members
Prof. Balakrishnan Ashok, Prof. Shiva Kumar Malapaka.

NETWORKING, COMMUNICATION & SIGNAL PROCESSING

The Networking, Communication and Signal Processing research domain focuses on all aspects of networking, communications, and signal processing. The current topics of interest are: Computer networks, Network security, Wireless communication, Signal processing, Medical signal processing, Computer vision, Control of unmanned systems using image processing and computer vision.

Faculty Members
Prof. Debabrata Das, Prof. Dinesh Babu Jayagopi, Prof. Jyotsna Bapat, Prof. Neelam Sinha, Prof. Sachit Rao, Prof. Tricha Anjali.

SOFTWARE ENGINEERING

Software engineering (SE) brings together interesting avenues of both fundamental and applied research contributing to the broad spectrum of activities involved in the creation of large, complex, industrial strength software systems having high quality, dependability and within reasonable resources. The current research covers a wide variety of areas ranging from empirical to formal aspects of SE. At IIITB, the research in SE covers both upstream (requirement and design) and downstream (testing and maintenance) SDLC activities cutting across a variety of application domains (enterprise, embedded etc). Here is a list of some of the broad areas in which our faculty members are working: Pattern oriented software engineering, software architecture, distributed software engineering, model driven software engineering (MDSE), software testing, verification and validation (V&V) of web-services and V&V of embedded software (cyber-physical systems and adaptive systems) among others.

Faculty Members
Prof. Chandrashekar Ramanathan, Prof. K. V. Dinesha, Prof. L. T. Jayprakash, Prof. Meenakshi D'Souza, Prof. Sujit Kumar Chakrabarti.