

#### **RESEARCH AREAS**

- Computer Vision
- > Cryptography
- Cyber-Physical Systems
- ➤ Data Mining
- Distributed Algorithms
- ➢ Formal Methods
- ≻ Game Theory
- ➤ Machine Learning
- > Network Security
- Software Engineering
- Wireless Sensor Networks

#### **Number of Publications**

#### 70

Journals

#### 142

**Conference Proceedings** 

PhD Student Guidance (completed/ongoing) 13

> DST and Consultancy Projects 10

Workshops/Seminars/Conferences Organized 4

Awards (best paper/poster/other)

#### 6

**Patents Granted/Filed** 

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Collaboration with Industries and Government Agencies DRDO, Bharat Electronics, Cisco, Emc2, Duke Energy, Infosys, KIST (South Korea) and IKST (Bangalore)

# INDIAN INSTITUTE OF TECHNOLOGY BHUBANESWAR School of Electrical Sciences (Department of Computer Science and Engineering)

# **SOME PRESENT RESEARCH TOPICS**

	High Density Crowd Flow Analysis (e.g. Ratha Yatra Surveillance)
	HCI Systems for Disabled
	Road and Traffic Surveillance (Smart City Traffic Control)
Reading Edit: Second Second 20 20 20 20 20 20 20 20 20 20	Sensor Guided Physical Rehabilitation
	AR/VR in Classroom Learning
CONTROLLER1 CONTROLLER2 Thread1 Thread2 Thread1 Thread2 Thread1 Thread2 Thread1 Thread2 Thre	Design of efficient Controller for Software Defined Networks
4 encrypt plaintest, C = E(p, M) 2 generate key 2 reply socrete key, p 1 request socrete key 2 reply socrete key 2 reply socrete key 4 encrypt plaintest, C = E(p, M) 2 generate key 2 reply socrete key 4 encrypt plaintest, C = E(p, M) 2 generate key 2 reply socrete key 4 encrypt plaintest, C = E(p, M) 2 generate key 4 en	Homomorphic Cryptosystem for Data Security
	Configuration Compliance checking, Security Policy verification and Threat Diagnosis for ECN
	Spatio-temporal Anomaly Event Detection
0 0 0 0 0 0 0 0 0 0 0 0 0 0	Modeling of Indian Monsoon Rainfall
End loT devices Intermediate workstations	Design and implementation of a large-scale testbed for research on Internet-of-Things
$\begin{array}{c c} Inputs & \stackrel{qr}{\longrightarrow} Transformed Inputs \\ \hline \\ AS & & & \\ \hline \\ Heart & & & \\ \hline \\ Heart & & & \\ \hline \\ Pr & & \\ \hline \\ \hline \\ Pr & & \\ \hline \\ \hline \\ Transformed Outputs & Outputs \\ \hline \end{array}$	Runtime Enforcement of Cyber-Physical Systems
Machine Research Game Interests Theory	Robust Machine Learning Algorithm with Game Theory
veserable device	Security of Pacemakers using Runtime Verification
	CPU-GPU Computing

# **RESEARCH LABS AND FACILITIES**



EMOTIV EEG Sensor

The department has full-fledged laboratories to train the undergraduate and research students from the very basics to modern trends in the field Computer Science Engineering. Students utilize the modern lab equipment to carry out design and testing of various projects.



# Security Enforcement Framework for Software Defined Networks

#### Challenges in SDN

- logical centralization of controllers' functions potential security violations
- heterogeneous and complex network policies
- distributed configuration and management of network policies
- inconsistency between the application layer and data layer

#### Research/Experimental Platform:

- Mininet platform with openflow controller and functionalities
- SSL based Certificate verification of the policy enforcing servers
- SAT based Satisfiability checking of inconsistencies of flow entries
  Yices SMT logic based verification of the security enforcement functions
- CVSS based risk assessment and mitigation



### Spatio-temporal Anomaly Event Detection

- To find "extended" anomaly event in spatio-temporal data, such as sensor observations at multiple locations and time-points.
- Anomaly event: A contiguous spatio-temporal region, where observations deviate significantly from usual eg. a drought covering a large area for several months.
- Methodology: Markov Random Field with latent state variables (anomaly/normal) and edge potential function to enforce spatio-temporal coherence.
- Application: Detection of temperature anomalies (heat wave) and rainfall anomalies (drought) over India.





Negative Rainfall Anomaly in 2000

Positive Rainfall Anomaly in 2001

# Runtime Enforcement of Cyber-Physical Systems



Cyber Physical Issues:

- Wide spread recalls of pacemakers and ICDs
  Model checking of such complex models is not always feasible
- Resort to model-based testing
- Runtime Enforcement as a solution:

   Bi-directional enforcement of Reactive CPS
   Using Discrete Timed Automata
   Algorithm implemented in SCCharts
- Algorithm implemented in SCCharts

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s) [-] tick / ptick(AS, VS, &AP, &VP)
AP / vi = 0 /P    VS icks / VP = true

### Security of Pacemakers using Runtime Verification

- Cardiac pacemaker security issues
   Life threatening security risks in pacemakers
- Hackers being able to pace the devices rapidly or could drain the battery
- Several pacemakers were recalled recently as they were vulnerable to hacking
- Formally based runtime verification approach as a solution
- Crucial safety policies defined formally as timed automata
- Synthesis of verification monitors from properties
- Monitor running on a wearable device to detect if a pacemaker has been compromised

\* Joint work with PRETzel group, University of Auckland



# **Modeling of Indian Monsoon Rainfall**

- How do monsoon rains set in over India, and proceed to cover the landmass?
- How do the intra-seasonal fluctuations look like? Which regions receive rainfall and which regions remain dry on any given day?
- We turn to Markov Random Field to identify common patterns of daily rainfall distribution over the Indian landmass.

