Internet of Things (EEE F411)

Dr. Vinay Chamola, Assistant Professor, EEE, BITS-Pilani

Brief Bio

- **Co-Founder, President and Director, Medsupervision Pvt. Ltd.** **July 2020- Present**

- **Assistant Professor, EEE Dept., BITS-Pilani, India** ***Aug. 2017-Present***

- National University of Singapore (NUS), **Singapore** ***July 2016- Mar 2017***

Post doctoral research fellow (Internet of Things)

- University of Southern California (USC), **USA** **May 2015- Aug 2015**

Visiting researcher (summer intern) at Autonomous Networks Research Group (ANRG), USC, **Collaborator**: Prof. Bhaskar Krishnamachari.

- National University of Singapore (NUS), **Singapore** ***Aug 2013- Aug 2016***
  Ph.D. in Electrical and Computer Engineering

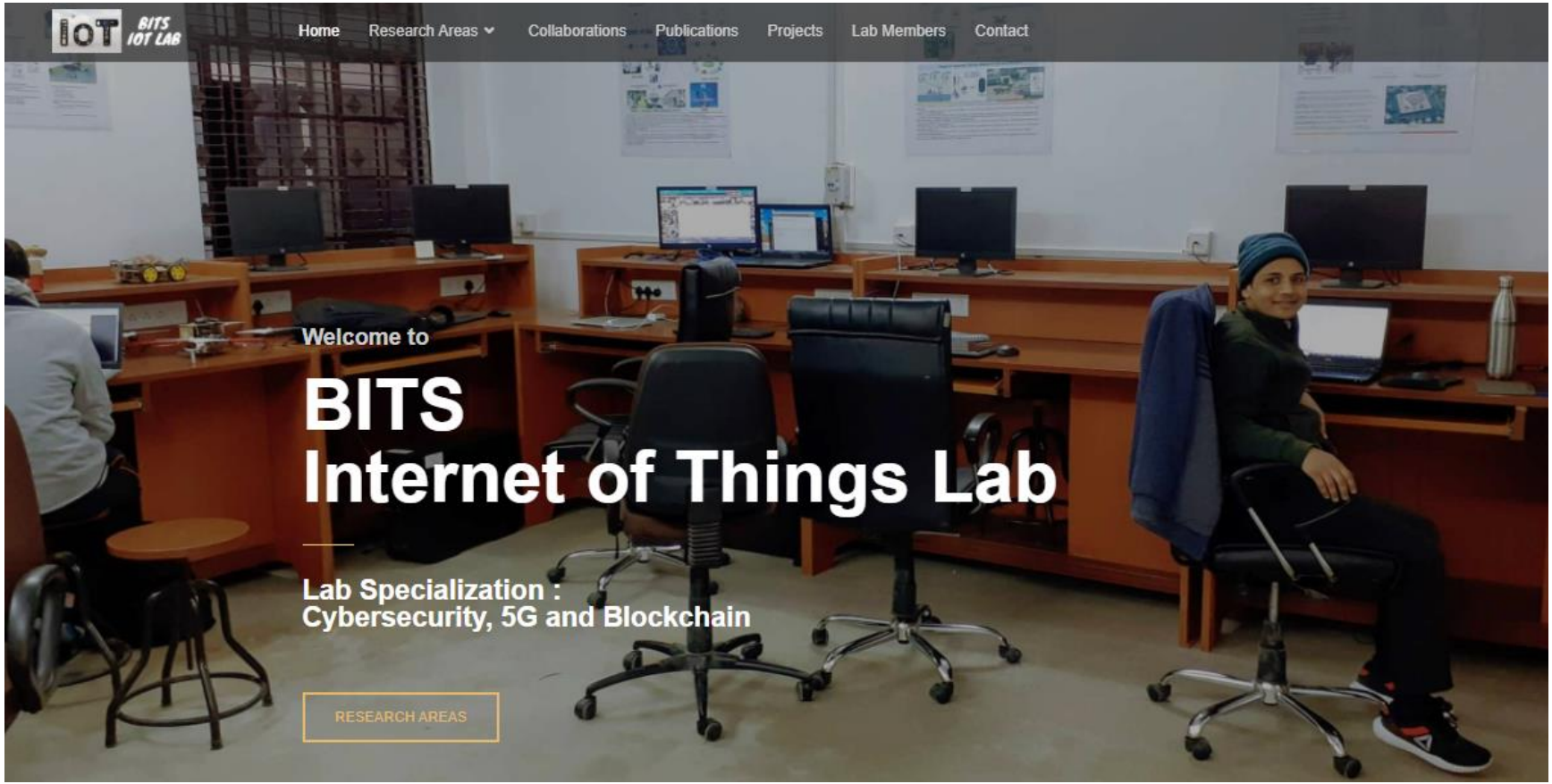
- BITS-Pilani, **Rajasthan** ***Jan 2011 – Dec 2012***

M.E. Communications Engineering [***CGPA*: 9.65/10 (**Discipline topper**)]

- BITS-Pilani, **Rajasthan** ***Aug 2006 – May 2010***

B.E. (Hons.) Electrical and Electronics Engineering **(2006A3PS040P ☺)**

BITS IoT Lab: https://bitsiotlab.tech/



.01

Internet of Things Security

This area focusses on Security provisioning for the various upcoming IoT Networks.

.02

Blockchain

The goal of this project is to apply Blockchain to solve various research challenges in 5G networks, VANETs, UAVNets, Finance etc.

.03

5G Cellular Networks

Our research focuses on Resource provisioning and resource management for 5G/ renewable energy powered Cellular networks.

.04

UAV & Drones

This project focuses on solving various issues related to networking in UAV's including security, charge scheduling etc.

.05

Vanets

This project focuses on solving various research issues pertaining to VANETs e.g. Vehicular communication, V2G operations etc.

.06

Edge Computing

To utilize the unused computational resources of edge/fog devices (in the internet of things) to provide better quality of service to users connected to them.

.07

Brain Computer Interfacing

The research focus is on studying, analyzing and developing new algorithms to classify EEG brain signals.

.08

Other Areas

- FPGA development
- Cloud computing

Rajkumar Buyya

IEEE FELLOW
UNIVERSITY OF MELBOURNE, AUSTRALIA

Prof. Rajkumar Buyya is a Redmond Barry Distinguished Professor and Director of the Cloud Computing and Distributed Systems (CLOUDS) Laboratory at the University of Melbourne, Australia

Mohsen Guizani

IEEE FELLOW
QATAR UNIVERSITY, QATAR

Prof. Mohsen Guizani research interests include wireless communications and mobile computing, computer networks, mobile cloud computing, security, and smart grid.

Nirwan Ansari

IEEE FELLOW
NJIT, USA

Prof. Nirwan Ansari is Distinguished Professor of Electrical and Computer Engineering at the New Jersey Institute of Technology (NJIT). He is a Fellow of IEEE and a Fellow of National Academy of Inventors.

F. Richard Yu

IEEE FELLOW
CARLETON UNIVERSITY, CANADA

Prof. F. Richard Yu joined Carleton School of Information Technology and the Department of Systems and Computer Engineering (cross-appointment) at Carleton University, Ottawa, in 2007, where he is currently a Professor.

Joel Rodrigues

IEEE FELLOW
FEDERAL UNIVERSITY OF PIAUÍ, BRAZIL

Prof. Joel J. P. C. Rodrigues (Fellow, IEEE) is currently a Professor with the National Institute of Telecommunications (Inatel), Brazil, a Senior Researcher with the Instituto de Telecomunicações, Portugal, and a Visiting Professor with the Federal University of Piauí, Brazil.

Dusit Niyato

IEEE FELLOW
NANYANG TECHNOLOGICAL UNIVERSITY, SINGAPORE

Prof Dusit Niyato is currently a Professor at the School of Computer Engineering, Nanyang Technological University. He is the area editor in IEEE TGCN, COMST and associate editor in leading journals like IEEE TCOM, IEEE TVT etc.

Kim-Kwang Raymond Choo

UTSA COLLEGE OF BUSINESS, USA

Prof. Kim-Kwang Raymond Choo is a Cloud Technology Endowed Professor at UTSA. He is also a Fellow of the Australian Computer Society, a Senior Member of IEEE and co-chair of IEEE Multimedia Communications technical Committee's Digital Rights Management for Multimedia Interest Group.

Bhaskar Krishnamachari

USC, CALIFORNIA, USA

Prof. Bhaskar Krishnamachari is Professor and Ming Hsieh Faculty Fellow in Electrical Engineering at the Viterbi School of Engineering, USC California. He is the Director of the Center for Cyber-Physical Systems and the Internet of Things, and the Autonomous Networks Research Group, and Co-Director of the Ming Hsieh Institute for Electrical Engineering.

Biplab Sikdar

NATIONAL UNIVERSITY OF SINGAPORE, SINGAPORE

Prof. Sikdar served as an Associate Editor for the IEEE Transactions on Communications from 2007 to 2012. He currently serves as an Associate Editor for the IEEE Transactions on Mobile Computing. He is a member of Eta Kappa Nu and Tau Beta Pi.

Sherali Zeadally

UNIVERSITY OF KENTUCKY, USA

Prof. Sherali Zeadally is an Associate Professor in the College of Communication and Information at the University of Kentucky. Dr. Zeadally is an IEEE Distinguished Lecturer for the IEEE Vehicular Technology Society (2018-2020) and an ACM Distinguished Speaker (2017-2020).

Salil Kanhere

UNIVERSITY OF NEW SOUTH WALES, AUSTRALIA

Prof. Salil Kanhere is with the School of Computer Science and Engineering at the University of New South Wales in Sydney, Australia since April 2004. Prof. Salil is a senior member of the IEEE and ACM.

Reza Parizi

KENNESAW STATE UNIVERSITY, USA

Prof. Parizi is the Director of the Decentralized Science Lab (DSL) and a consummate technologist and cybersecurity researcher at Kennesaw State University, USA. His interests are R&D in AI-assisted Cybersecurity, Federated learning, Blockchain, Smart contract programming etc.

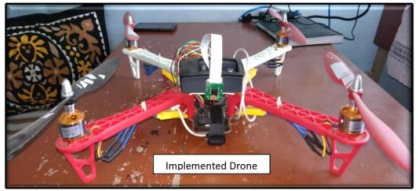
Journal Publications

Search:

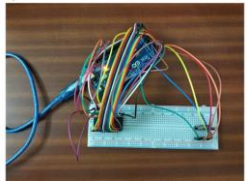
#	Paper	Impact Factor
3	**V. Chamola**, S. Patra, N. Kumar and M. Guizani, FPGA for 5G: Re-configurable Hardware for Next Generation Communication, ***IEEE Wireless Communications***, *vol. 7, iss. 3, pp. 140-147, Jun. 2020.*	11
38	**V. Chamola** and B. Sikdar, "Solar Powered Base Stations: Current Scenario, Issues and proposed Solutions," ***IEEE Communications Magazine***, vol. 54, no. 5, pp. 108-114, May 2016	10.43
6	V. Hassija, **V. Chamola**, V. Gupta, S. Jain and N. Guizani, "A Survey on Supply Chain Security: Application Areas, Security Threats, and Solution Architectures", ***IEEE IoT Journal***, June. 2020, Accepted	9.5
9	V. Hassija, **V. Chamola**, N. Dara, N. Kumar and M. Guizani, "A Secure Framework for Government Tenders using Blockchain and Collective Signing", ***IEEE IoT Journal***, June 2020	9.5
32	G. Verma, B.B Singh, N. Kumar and **V. Chamola**, "CB-CAS: Certificate-Based Efficient Signature Scheme with Compact Aggregation for Industrial Internet of Things Environment", ***IEEE IoT Journal***, vol. 7, iss. 4, pp. 2563 - 2572, Sept. 2019	9.5

Prototypes Built in different IoT domains by research group at BITS-Pilani

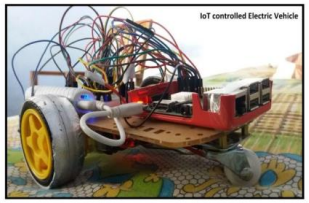
Unmanned Aerial Vehicles

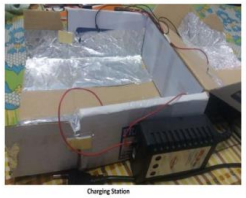


IoT security

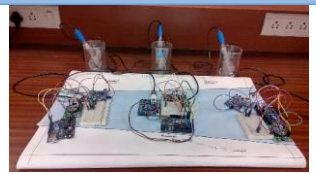


IoT enabled Vehicle to Grid networks



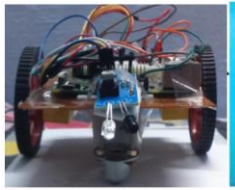


IoT based cyber physical systems



Internet of Things lab

Brain Computer Interface



And many other real-life applications….

IoT – an glimpse

Introduction to the Internet of Things & Cyber physical systems

Levels of IoT systems, Design methodology, Examples

Sensors and Actuators for IoT, MSF

Arduino labs

IoT system design

RPi labs

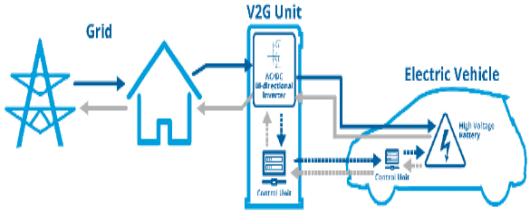
python

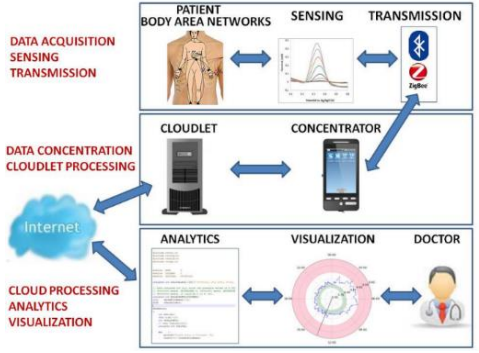
Assignment, Project

Prototyping IoT Systems

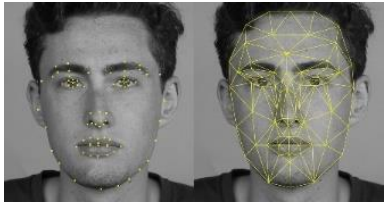
- COAP, MQTT based and other lab exercises

- Networking IoT devices (WSN, VANET, MANET etc)
- Data Analytics (sending data to Cloud and analytics)
- IoT Security / Cyber-attacks
- Smart Grid / Industrial IoT

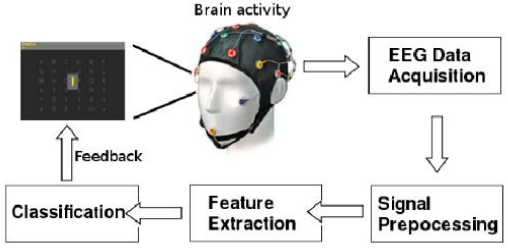

Grid
V2G Unit
AC/DC bi-directional Inverter
Control Unit
Electric Vehicle
High Voltage Battery
Control Unit

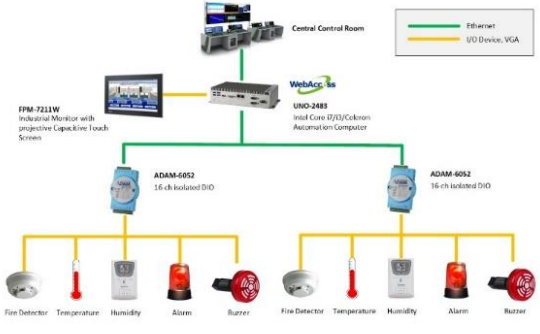

PATIENT BODY AREA NETWORKS
SENSING
TRANSMISSION
DATA ACQUISITION
SENSING
TRANSMISSION
CLOUDLET
CONCENTRATOR
DATA CONCENTRATION
CLOUDLET PROCESSING
Internet
ANALYTICS
VISUALIZATION
DOCTOR
CLOUD PROCESSING
ANALYTICS
VISUALIZATION

1 CHECK
2 DIRECTION
3 PARKING
4 PAYMENT
38 SPACES
TURN RIGHT
Smart Parking



ANDROID
APP DEVELOPMENT


Brain activity
EEG Data Acquisition
Feedback
Classification
Feature Extraction
Signal Prepocessing


Central Control Room
Ethernet
I/O Device, VGA
WebAccess
FPM-7211W
Industrial Monitor with projective Capacitive Touch Screen
UNO-2483
Intel Core i7/i3/Celeron Automation Computer
ADAM-6052
16-ch Isolated DIO
ADAM-6052
16-ch Isolated DIO
Fire Detector
Temperature
Humidity
Alarm
Buzzer
Fire Detector
Temperature
Humidity
Alarm
Buzzer

Beam Sensor
Door Sensor
PIR Sensor
Ceiling Motion Sensor
Smoke Sensor
Glass Break Sensor
Camera
Vibration Sensor
Siren Alarm
LPG Gas Sensor

Course plan

Module	Topics covered	Lectures
Module 1: Introduction to IoT	Introduction to IoT & Cyber-Physical Systems, IoT applications - an overview, Different Levels of IoT Applications : Level 1 - 6 with examples, IoT Design Methodology & Life Cycle, Introduction to IoT Physical End Points & Platforms, IoT System Design Examples (for applications like fitness tracker, smart parking etc.).	Lecture 1- Lecture 4
Module 2: Sensors and Actuators for IoT	Introduction to sensors for IoT application development, Data Acquisition, Signal Conditioning and Processing, Multi Sensor fusion for IoT, Advanced sensing techniques (e.g. BCI/HCI), Actuators and Controllers for IoT	Lecture 5 - Lecture 8
Module 3: Programming IoT end points	Introduction to Arduino microcontroller & NodeMCU for IoT applications, Programming with Arduino & NodeMCU and prototype development (e.g. for smart farming, smart city applications etc.), Introduction to Raspberry Pi, Programming Raspberry Pi (Python), Rest API based hands on.	Lecture 8- Lecture 18

Module 4: Networking for IoT	Wireless sensor networks: Introduction, Deployment, Localization, Routing, MAC, Time synchronization and Multi-sensor-fusion for WSN	Lecture 18 - Lecture 23
Module 5: Communications and networking in IoT	Ad Hoc networks (MANET, VANET, FANET), Industrial IoT Networks, Common network standards (Bluetooth, NFC, LORA) etc, COAP and MQTT (including lab/ hands-on)	Lecture 24-31
Module 6: Data management in IoT	Data Management for IoT, Advanced optimization for processing sensor data, Machine learning for IoT data analytics, Introduction to IoT Cloud Services, Case studies of Cloud services for IoT and learning how to use them.	Lecture 32-36
Module 7: Security issues in IoT	Cyber-attacks on IoT- Case study, Security solutions for IoT: hardware/software	Lecture 37 - Lecture 40

Lab:

Lab for the course would be in-class labs during the class hours when the relevant topics are covered. Labs would consist of hands on session where the students will learn how to work with microcontrollers and raspberry pi and learn building IoT applications from the scratch. Some of the suggested lab exercises are:

- Programming Arduino/ Nodemcu (esp8266) microcontrollers.
- Blinking LED using the above microcontrollers.
- Interfacing sensors to microcontrollers.
- Connecting microcontrollers to the internet and streaming sensor data to cloud.
- Actuation using microcontrollers.
- Raspberry pi programming and application development.
- Rest API based hands on.
- Lab exercise based on COAP/ MQTT.

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time
Midsem	1 hour	25	TBA
Lab Test	1 hour	20	Based on the lab exercises
Project (Prototype implementation)	Will be announced	25	Continuous Evaluation
Comprehensive Examination	120mins	30	TBA