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Areas of interest

- Machine Learning and Artificial Intelligence.
- Computer Vision and Image Processing.
- Intelligent Systems, Control and Robotics.

Educational Qualifications

Year	Degree	Institution(Board)	CPI / %
2009-Present	Dual Degree in Electrical Engineering	IIT, Kanpur	UG-9.0/10 PG-8.0/10
2009	Higher Secondary	Vijayaratna Jr.College (BIE AP)	91.8 %
2007	Secondary	Anjali High School (S.S.C)	93.3 %

Publications

- **CONFERENCE PAPER:**

  T-S Fuzzy Model Based Maximum Power Point Tracking Control of Photovoltaic System. Avanish Kumar, **Anurag Sai Vempati** & Laxmidhar Behera, accepted for publication at **22nd International Conference on Fuzzy Systems, FUZZ-IEEE'13.**
    - Built a robust controller using Maximum Power Point Tracking (MPPT) strategy for a solar power generation system by implementing Takagi-Sugeno (T-S) Fuzzy model of the power system.
    - We proposed a method to design a state feedback controller to regulate power output by controlling the duty cycle of the converter while maintaining the system Lyapunov stable.
    - Both Fixed gain and variable gain state feedback controllers are compared for the purpose of stability.
    - In addition, a tracking controller is designed which searches for Maximum Power Point (MPP) to optimize systems performance without actually calculating the MPP or measuring the solar radiation.
    - The controller is also robust to disturbances in atmospheric conditions. The proposed system is found to be extremely efficient even in rapidly changing weather conditions. The system is found to reach optimal operation point within few milliseconds.

  Presented the paper in FUZZ-IEEE'13 held at the HICC (Hyderabad International Convention Center) in July'13, which was sponsored by **IEEE**.
  Addressed an audience comprising of PhDs and professors from leading research companies and universities in the world with the talk based on the research done with Dr. Laxmidhar Behera, Electrical Engineering, IIT Kanpur.
  The paper has been published in the **IEEE Xplore journal** under conference proceedings

M.Tech Thesis

- **SURVEILLANCE QUAD ROTOR (Jan, 2013 - Present):**
    - **AIM:** Develop a fully functioning quad rotor that can navigate in an unsupervised fashion in both indoor (cluttered) and outdoor (varied) environments. Helps in detecting malicious activity and reports back to the main server in case of emergency.
    - **Current Status:**
        - Designed a quad rotor with on-board AURDINO board to control the altitude and attitude of the system.
        - Used PyGame to build a quad rotor simulator which made the task to test control strategies simpler.
        - Implemented and tested both PID and Sliding mode control techniques for stable flight.
        - Achieved human controlled flight. Moves according to instructions sent via Zig-BEE.
        - Localizes and maps the surroundings using on-board camera. Recently added a more powerful ODROID-X2 board with a Quad-core ARM Processor for achieving real-time computations.

- **Localization and Mapping of 3D interior space using Depth Camera** *(Oct – Dec, 2012)*
    - Developed a technique that can rapidly create a detailed 3D reconstruction of an indoor scene. We move a Microsoft Kinect across the scene and gather the colour and depth data.
    - This problem would basically include tracking of the camera followed by surface reconstruction. Tracking is accomplished by just using the Depth images to find the necessary transformation between the camera and the global coordinate system.
    - Once the necessary transformations are found, we then constructed an isosurface from the dense 3D point cloud. The colour images are then used to map colour to the surface.

- **Learning Visual Anticipation: A Top-Down Approach** *(Mar – May, 2013)*
    - Developed an anticipatory gaze model, in a top-down approach. In the past there have been many models that can track relevant objects from a video, making use of computer vision. But one crucial difference is that, a human eye can learn to anticipate the trajectory of an object very quickly in an "unsupervised fashion".
    - We built a computational model that could imitate the way humans learn to anticipate the trajectory of fast moving objects.
    - The dataset consists of a ball bouncing off the walls and floor as viewed from different viewpoints. The ball's speed and release direction are randomly chosen with a swing/spin components incorporated in few of the videos. Then, for each video, the ball is segmented out and all relevant data is collected.
    - The objective to learn the Transition matrix can then be framed as a Linear Regression problem. Now for a given test video, conditioned on the data collected till then, a Kalman Filter predicts the future location of the ball well in advance.

- **Learning Human Actions** *(Mar - May, 2012)*
    - *Abstract:* Designing an intelligent agent that can learn realistic actions performed by humans. Training performed on huge dataset of movie clips. The project involves the following stages:
        - Identifying Space-Time interest points (STIP) in a video and collecting cuboid prototypes around them. Transformations on the cuboids and building feature descriptors.
        - Using K-means clustering algorithm to find clusters of features found in videos sampled from the dataset and building Spatio-temporal Bag of features (BoF).
        - Using Support Vector Machine (SVM) to train the agent to classify various videos.

- **Handwritten Character Recognition** *(Aug - Present, 2013)*
    - The problem is to recognize hand printed English characters and numerals (26 upper case, 26 lower case, 10 numerals) using Machine Learning. This is basically a classification problem spanned over the range of 62 classes.
    - Images are pre-processed to remove noise, resizing the digits and deskewing.
    - 2D Convolution Neural Networks are used to learn the features that help in recognizing the digit.
    - SVM takes the feature vector generated by CNN and then classifies into one of the 62 classes.

- **128-bit AES Encryption and Decryption** *(Oct 20-Nov 10, 2011)*
    - Implemented Advanced Encryption Standard (AES) specified by FIPS (Federal Information Processing Standards)-approved cryptographic algorithm that is used to protect electronic data. It involved implementation of the following modules of AES Algorithm:
        - Implementation of Cipher module (Encryption) - Series of transformations that converts plaintext to cipher text using the cipher key.
        - Implementation of Key expansion - Used to generate a series of Round Keys from the Cipher Key.
        - Implementation of Inverse Cipher (Decryption) - Finally obtain original text from cipher text.

- **Vehicular network for incremental route planning and avoiding traffic congestion** *(Mar – May, 2013)*
    - Developed an Android app that fetches Google's traffic data and also maintains a local database with critical information regarding the location, cause and delay due to several congestions (such as, rallies, maintenance work, landslides etc.).
    - We have incorporated the flexibility to allow registered users to update the database with new areas of traffic congestion regularly.
    - Devised an efficient navigation system through the busy traffic, rerouting the current traffic so that the roads with least time of travel are chosen to reach the destination.
    - The app is designed to quickly adapt to the particular user using it and change its parameters accordingly.
    - The users can see the various route options they have and average time of travel via each of them and cause of congestion in nearby areas, if any.

- **f-MRI (Functional Magnetic resonance Imaging)**   *(May – July, 2011)*
    - MRI data obtained in Fourier Transform space is converted back into real domain to obtain brain scan images.
    - Using Fuzzy C-means clustering algorithm, blood regions and brain tissues are segmented out from these images.
    - Snake model is used to detect edges. Spline Interpolation is performed to approximate the boundary by simple splines.
    - Kalman Filter is used to "measure and predict" the parameters of spline thus tracking the regions of interest.
    - Times series of all these images constitutes the video showing the variation in blood regions and brain tissue.

Electronics Projects

- **SUMMER PROJECT (May – July, 2010):** Wireless Health Monitoring System.
    - Designed equipment which collects biometric data like heart rate, temperature, blood pressure non-invasively and send the data wirelessly to a hand held device (laptop). The data is continuously monitored and the user is alerted in case of emergency.
    - The equipment was designed such that it can be carried by the user all the day without disturbing his routine. A method called **PPG** (Poly plethysmography) has been implemented to collect the biometric data.

- **TECHKRITI '11 (FEB 17-20, 2011):** Touchpad.
    - Designed a Touchpad which senses touch using a grid of wires connected to MCU. The position of touch is sent to MCU which processes the data and sends it to the laptop through a Serial Port via UART.
    - Once the data reaches the laptop Robot class of JAVA was used to control the mouse pointer's position according to the coordinates received. Further, a special feature to detect patterns and perform tasks like Rotating an Image, Page Scroll, Zoom-in and out, Close a window etc was implemented using Image Processing in MATLAB.
    - This project has **WON 1st** prize in Embedded Design in IITK Technical Festival (Techkriti).

- **TECHKRITI' 10 (FEB 11-14, 2011):** Circuit implementation using Digital ICs.
    - Implemented Snakes and ladders just using Digital ICs for multi player. Random output generation was achieved for making Roulette.

- **TAKNEEK (September 09,10):**
    - **2010:** Made a versatile LED Display which shows scrolling text that can be entered through a user interface. The principle of Human eye perception was used since only one LED glows at an instant due to the grid framework. **WON 3rd** prize in Intra college technical fest of IITK.
    - **2009:** Made a casino slot machine using digital ICs. **SECURED 3rd** position.

Other Projects

- **Designing an OPAMP:**
    - Designed an opamp that met desired performance specifications such as Max. Power consumption, Area on chip, slew rate etc.
    - Simulated the opamp using both level-1 and BSIM3 (more realistic) models and fine-tuned the hand calculated parameters to achieve optimal performance.
    - Carried out layout in Mentor Graphics and verified if the specifications are met by the final product.

- **Communications:**
    - MATLAB implementations of Amplitude Modulation and Envelope Detection, Costas Loop, Lloyd-Max Quantizer, Bit Error Rate (BER) simulations in AWGN communication systems.
    - Simulated Repetition and Hamming coding schemes in a BPSK modulated system in MATLAB to get the BER curves over AWGN and Rayleigh channel.
    - Implemented Viterbi Encoder and Decoder and evaluated its performance over an AWGN channel.
    - Term Project on Turbo Encoder-Decoder system: Simulated the system in MATLAB and plotted the performance

- **Intelligent systems and control:**
    - Modelled and simulated neural networks to identify non-linear functions and then to implement model order reduction to model lower order functions which were close approximations of the original function.
    - With the help of neural networks, modelled several control systems using the concepts of feedback learning, real time updating, etc.

- **EE380&381 Labs:** Electronic circuits, Control systems, Micro controllers and Microprocessor, Power systems.
    - Ran simulations of various electronic circuits on MICROCAP and tested them experimentally to verify results.

- Combinatorial and Sequential circuits. Coding 8085 Microprocessor and PIC Micro controller.
- Designed controller for a given plant (PMDC Motor) using techniques like Loop shaping, Root locus, Ziegler-Nichols and implemented digitized version on a plant using MCU. Simulations were done on MATLAB.
- PMDC motor modelling, identification and speed control (using both voltage and current feedback) and Disturbance Observer are also implemented.
- Conducted various experiments on capacitor start-capacitor run and squirrel cage induction motors, synchronous generator, transformers etc. Studied core and iron losses and conducted experiments to estimate them. Did a power system analysis in MATLAB.

- **Modelling of solar cell:**
    - Explored different models (empirical, single and two-diode) of a solar cell.
    - Performed simulations of single-diode model in MATLAB to obtain I-V and P-V characteristics.

Technical Skills

Platforms: Windows, Linux (Ubuntu, Fedora), Android

Software:
- Skilled in C/C++, Python, MATLAB, Microcap, Octave, Mathematica.
- Have experience in Java, OpenGl, R, Shell scripting, Socket Programming, LATEX, Web Designing (HTML, PHP), Verilog HDL, Mentor Graphics, Spice (AIM Spice), Eagle, Xilinx ISE Design Suite, ModelSim, Code Vision AVR, AVR Studio, MySQL.

Hardware:
- Good experience in using Developer Boards (Aurdino, ODROID-X2), Microcontrollers (Atmega 16, 32, PIC), Xlilinx FPGA (VERTEX 5), 8085 Microprocessor, sensors, Communication Modules and other standard Digital ICs.
- Experience in handling CRO, Function Generator.

Relevant Courses and grades obtained:

- Computer Vision and Image Processing - A
- Machine Learning*
- Mobile Computing – B
- Data Structures and Algorithms - A
- Probability and Statistics - A
- Intelligent Systems and control - A
- Information and coding theory - A
- Introduction to Electronics(Circuit Analysis) - A
- Signals, Systems and Networks - A
- Wireless Communications - B
- Microelectronics -I – A
- Power Systems – B
- Electromagnetic Theory – A

- Artificial Intelligence Programming -B
- Natural Language Processing*
- Cognitive Sciences - A
- Fundamentals of Computing - B
- Control System Analysis - A
- Digital Electronics and Microprocessor Technology- A
- Analog/Digital VLSI - B
- Communication Systems - B
- Principles of Communication – A
- Electrical Engineering Labs (I&II) – A,A
- Microelectronics – II – B
- Introduction to Electrical Machines – C
- Power Electronics - B

* – will be completed by Dec, 2013.

Other Courses:
- Mathematics I, II and III (Real and Complex Analysis, Linear Algebra, Ordinary and Partial Differential Equations)
- Physics I and II(Mechanics, Electrodynamics, Quantum Mechanics, Relativity Theory)

Accomplishments

- Secured a rank of **508** (among top 0.12%) out of 0.4 million people who appeared for Joint Entrance Exam of IIT in 2009.
- Was selected for B. Stat (Hons) programme of **ISI** (Indian Statistical Institute) in the year 2009.
- Cleared Regional Maths Olympiad and Astronomy Olympiad.
- **Won** Embedded Design contest in **Techkriti'11**, Annual Technical and Entrepreneurial festival of IITK.
- Art work exhibited in Fine arts exhibition, **Antaragni'09**.
- District topper in belt promotion test held by Kanpur Tae-Kwan-do association, recognised by **IOA** (Indian Olympics Association).

Positions of responsibility and extracurricular activities

- Secretary, Electronics Club of IIT Kanpur.
- Mentored two teams as a part of Electronics Club Summer project, 2011.
- Link Student, Counselling Service.
- Teaching Assistant for 3rd year UG Lab (Control) in EE.
- Volunteer, Dramatics Events, **Antaragni'09**.
- Part of Fine arts team, **Galaxy** – Intra College Cultural Festival of IITK for the years 2010 and 2011.