

Anuj Agrawal

CONTACT INFORMATION

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RESEARCH INTERESTS

Bio-inspired Robotics, Flapping Wing Aerodynamics, Robot Motion Planning

EDUCATION

Indian Institute of Technology Kanpur

B.Tech-M.Tech (Dual Degree) in Mechanical Engineering (2010 – present)

- Cumulative Performance Index - M.Tech (CPI) of **8.4** (on a scale of 10)
- Cumulative Performance Index - B.Tech (CPI) of **7.8** (on a scale of 10)

Council for the Indian School Certificate Examinations, ISC India (2010)

- Scored cumulative **97.0%** marks in Senior Secondary School.

Indian Certificate of Secondary Education, ICSE India (2008)

- Scored cumulative **95.6%** marks in High School.

PUBLICATIONS

S. Shriyam, **A. Agrawal**, L. Behera, A. Saxena “Robotic Fish Design and Control based on Biomechanics”, accepted at *Third International Conference on Advances in Control and Optimization of Dynamical Systems*, 2014 [[paper](#)] (first two authors contributed equally)

AWARDS AND ACHIEVEMENTS

- Ranked in **Top 0.05%** (amongst 0.5 million students) in IIT-JEE 2010, the undergraduate entrance exam for the IITs.
- Placed in **Top 0.05%** (amongst over 1 million students) in AIEEE 2010.
- Ranked in **Top 0.15%** (amongst 0.1 million students) in ISAT-2010, the undergraduate entrance exam for Indian Institute of Space Technology.
- Awarded the **CBSE Merit Scholarship for Professional Studies - AIEEE** for undergraduate studies.
- Recipient of the **T.I.M.E. Merit Scholarship** for undergraduate studies.
- Recipient of **Boeing Robotics Scholarship** for the development of autonomous robots in the Abhyast-Phase III Programme.

INTERNSHIP

Summer Internship '13, University of Pittsburgh

“Target Tracking in Shadow Regions using Distributed Robot Search for Urban Search and Rescue Operations”

Mentored by Prof. Michael Lewis (May 2013 - July 2013)

- Sub-project of the bigger government funded project on Cognitive Compliant Command for Multirobot Teams in collaboration with Robotics Institute, Carnegie Mellon University, aimed at developing effective and efficient methods for commanding robot teams of various sizes and autonomy employed in an Urban Search and Rescue Mission either for disaster mitigation or military applications in hostage rescue missions.
- Designed an algorithmic framework for dynamically keeping track of the number of targets in various regions of a map based on target sighting information provided by the swarm of ground robots.
- Effectively reduced the physical problem into a dynamically updating Bipartite Graph that employs the Ford Fulkerson Max Flow algorithm to compute the lower and upper bounds on the number of targets in various nodes.
- An efficient system for keeping track of the bounds on the number of targets was developed to semi-autonomously prioritize the sequence of map exploration by the robot team.

Master's Thesis -

"Design and Optimization of an Efficient 6-Bar Mechanism for a Flapping Wing MAV"

Thesis Supervisor : Prof. Anupam Saxena, IIT Kanpur (July 2014 - Present)

- Manufactured a 6-bar mechanism for the wing actuation of a flapping wing MAV, currently under testing phase.
- Developed independently an alternative 3-D dual slider crank mechanism to emulate wing kinematics.
- Simultaneously working on the aerodynamic optimization of the mechanism for enhancing lift by modeling leading edge vortices and wake capture using potential flow theory.

"B.Tech Project: Design and Prototyping of a Bio-Mimetic Robotic Fish"

Project Supervisor : Prof. Laxmidhar Behera, IIT Kanpur (Aug 2013 - April 2014)

Project Sponsor : Intelligent Systems Laboratory, IIT Kanpur

- Developed a unique flexor-extensor mechanism for the tail fin actuation of a robotic fish from scratch.
- The new mechanism caused a weight reduction of over 50% for the posterior part of the fish, thus increasing the efficiency of the actuation mechanism.
- Incorporated separate controls for thrust, yaw and pitch axes movements in the design.
- Achieved a Passive roll stabilization for the fish.
- **Research publication accepted at** the Third International Conference on Advances in Control and Optimization of Dynamical Systems. 2014.

"Boeing - IIT Kanpur Autonomous Navigation System, Abhyast Phase III"

Project Supervisor : Prof. Shantanu Bhattacharya, IIT Kanpur (2012)

Project Sponsor : Boeing

- Aimed at building an autonomous obstacle avoiding robot with a unique capability to make a frog like jump in motion to overcome obstacles with low heights.
- Built an autonomous robot, equipped with a Hokuyo Laser Rangefinder, 9 DOF Inertial Measurement Unit (IMU) and a 1.2 GHz Processor PandaBoard, capable of navigating an area in any given direction avoiding obstacles and implementing real-time motion planning.
- Implemented wireless intercommunication between the robot and a laptop using Xbee Pro modules, enabling the tracking of robots position, velocity and orientation.
- Developed a real time visualization program in OpenCV that builds up a map of the environment as the robot moves and plots it for visualization.
- Studied 2-D SLAM and Kalman Filtering techniques for increasing sensor measurement accuracy.

"Path Planning for terrestrial robots using Randomly Exploring Random Trees(RRTs) "

Course Project for ME766 : Robot Motion Planning under Prof. Bhaskar Dasgupta (Sep 2013-Oct 2013)

- Implemented a path planning algorithm for a 2-D workspace based on RRTs using a complex spatial datastructure called kdTrees (k-dimensional trees).
- Developed dynamic visualization for the path planning process using 2D graphics in Python.

"Rubiks Cube Solver Robot"

Summer Project under Robotics Club, IIT Kanpur, May11-July11

The project featured in the IIT Kanpur Campus Magazine, NERD.

- Built a robot capable of recognizing any given orientation of a Rubiks cube via Image Processing using Open CV and subsequently perform the steps required to solve the cube.
- Used six high torque stepper motors for changing the state of the cube, a separate motor for rotating each of the six faces of the cube.
- Established UART communication between the laptop and AtMega based microcontroller for enabling the results of the image processing generated on the laptop to be communicated to the motor drivers.

“Internal Combustion Engine powered RC Car”

Project Sponsor : IIT Kanpur Motor Sports, Society of Automotive Engineers (SAE), Nov11-Jan-12

- Designed and fabricated a radio-controlled car complete with self-manufactured chassis, braking, steering and suspension systems.
- Powered by a mini IC engine (4.6cc), the car could reach speeds of upto 40kmph.
- Fabrication was done using Water Jet Machining and Aluminium Welding.

“Hand Gesture Controlled Robot”

Course Project for ME752 : Computer Aided Design under Prof. Anupam Saxena (March 2014-April 2014)

- Designed and fabricated a wearable glove mounted device for motion control of a ground robot based purely on hand gestures.
- Implemented algorithms for proportional control of acceleration, braking and steering with variable sensitivity.
- Developed algorithms capable of detecting movement of the human palm on the pitch and yaw axes using a 6-DOF Inertial Measurement Unit and Arduino Micro.

RELEVANT COURSES

Robotics: Introduction to Robotics, Robot Motion Planning, Robot Manipulators: Dynamics and Control, Theory of Mechanisms and Machines

Mathematics: Real Analysis, Complex Analysis and Linear Algebra, Differential Equations

Engineering Design: Engineering Design and Graphics, Computer Aided Design, Design of Machine Elements, Finite Element Methods in Engineering Mechanics

Mechanical Engineering: Fluid Mechanics, Thermodynamics, Energy System-1, Energy Systems-II (Turbomachinery), Mechanics of Solids, Advanced Mechanics of Solids, Heat and Mass Transfer, Introduction to Manufacturing Processes, Manufacturing Technology, Nature and Properties of Materials

Miscellaneous: Optimization Methods in Engineering Design, Automation and Control, Introduction to Electronics, Introduction to Electrical Engineering, Fundamentals of Computing

TEACHING EXPERIENCE

Teaching Assistant - ME399: Communication Skills (Fall 2014)

Teaching Assistant - ME752: Optimization Methods in Engineering Design (Spring 2015)

TECHNICAL SKILLS

Programming Languages - C, Java, Python, HTML, PHP, Javascript, Processing

Softwares - Autodesk Inventor, AUTOCAD, Ansys Fluent, 3dsMax, OpenCV, MATLAB, LaTeX

Platforms - Linux Distros, ROS(Robot Operating System), Windows

Hardware - 3D Laser Range Sensors, Atmel AVR, Arduino, Bluetooth Modules, XBee Wireless Modules, Inertial Measurement Units, IR sensors, DC/Servo/Stepper motors, IC Engine

POSITIONS OF RESPONSIBILITY

Coordinator, Techkriti Grand Prix, Techkriti 13 - Introduced a Radio Controlled Car Racing event for the first time in the history of Techkriti, IIT Kanpur’s annual technical festival. The event was organized and marketed as a flagship event for the 4-day long festival and saw a participation of over 150 participants across the nation. Personally supervised the design and construction of the largest off-road dirt track for any such collegiate level competition across the nation.

Assistant Coordinator, Robogames, Techkriti 2012 - Assisted in the organization and proper conduct of the biggest and the flagship event - Robogames of Techkriti 2012. Assisted in the supervision of the construction of the arenas for 4 sub-events in Robogames.

Student Guide, Counseling Service, IIT Kanpur - Took charge of 6 freshmen and helped them in getting accustomed with the new environment, providing support in various academic and non-academic matters.

Secretary, Robotics Club - Looked over the resource and inventory management aspect of the club over the entire tenure, periodically conducting introductory robotics workshops and lectures for freshmen students and mentoring many student projects for various Robotics competitions held in the institute.