Gaurav Gupta

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Optimization in Robotics and Biomechanics (ORB),
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Research Interests

Locomotion, Optimization, Motion Planning

Education

2011-2016 **Indian Institute of Technology, Kanpur**.

B.Tech – M. Tech Integrated in Mechanical Engineering

- Cumulative Performance Index - M.Tech (CPI) of **9.7**/10
- Cumulative Performance Index - B.Tech (CPI) of **7.5**/10

2011 **Central Board of Secondary Education**, *CBSE*.

- Scored cumulative **89.8%** marks in Senior Secondary School

2009 **Central Board of Secondary Education**, *CBSE*.

- Scored cumulative **94.8%** marks in High School

Publications

2016 **G. Gupta**, A. Dutta, *Trajectory Generation and Step-Planning of a 12DoF Biped Robot on Uneven Surface* under review at the Journal of Applied Soft Computing.

2013 **G. Gupta**, Pradipta K. Panigrahi, *Curve Kick Aerodynamics of a Soccer Ball* accepted at Fortieth National Conference on Fluid Mechanics and Fluid Power.

Scholastic Achievements

2011 Secured an All India Rank(AIR) of 832 (**99.82 percentile**) in Joint Entrance Examination(JEE) of IIT.

2011 Secured an AIR of 2036 (**99.82 percentile**) in the All Indian Engineering Entrance Examination.

2008 Recipient of the NTSE scholarship awarded by the **Government of India** to 1000 meritorious students.

Relevant Projects

Sep'16 - **Motion Generation using Full Kinematics and Centroidal Dynamics**, Univ. of Heidelberg.
Faculty Advisor : Prof. Katja Mombaur
Objective : To generate walking motion using limited dynamics and implement it on iCub.

- Developed a framework for motion generation using optimal control in python.
- Modeled full kinematics and centroidal dynamics along with collision, collocation and dynamic constraints.
- Use of Rigid Body Dynamics Library (RBDL) for dynamic modeling and SNOPT for optimization.
- Current state: Implementation of standing and sit-up motion accomplished.

May'15 - Jul'16 **Trajectory Generation and Step-Planning of a 12DoF Biped**, IIT- Kanpur, **M.Tech Thesis**.
Faculty Advisor : Prof. Ashish Dutta
Objective : To a develop a footstep plan on a rough terrain for a 12DOF biped robot.

- Developed the kinematic and state transition model of biped for walking and turning over uneven terrain.
- Performed the inverse dynamics using Euler-Lagrange approach.
- Energy minimization using GA for a variety of turning angles, step-lengths and slopes to generate a database.
- Use of Neural Networks for real-time pattern generation and energy estimation
- A* search to develop step-plan based on energy minimization on obstacle filled rough surface.

Aug–Nov,15 **Obstacle Avoidance using Evolutionary Robotics** , IIT- Kanpur.
Faculty Advisor : Prof. Bhaskar Dasgupta
Objective : To train the neural network of a mobile robot in a planar workspace to learn to avoid obstacles.

- Modelled the Khepera robot dynamics, control system and sensory interaction in Python.
- Evolved the parameters of the control system using Genetic Algorithm.
- Altered the fitness function to enhance the performance in the aforementioned framework.
- Performed the simulation of the evolving generations and tested various fitness functions *pygame* library.

June–Sept,15 **Simulation of Human Gait**, IIT- KANPUR.
Faculty Advisor : Prof. Ashish Dutta
Objective: Study of human gait kinematics using motion capture system.
- Walking motion in the sagittal plane was captured was using LEDs at hip, knee and ankle joints.
- Data was processed to obtain joint trajectories using *cv2* in Python..
- Inverse Kinematics was performed to obtain the joint angles for the gait cycle.
- Forward Kinematics was performed to simulate a 6DOF biped model.

Jan–Mar,14 **Democratic Consensus in Fish Swarm**, IIT- KANPUR.
Faculty Advisor : Prof. Peeyush Chandra
Objective: To study the effect of uninformed individuals on decision making in animal groups.
- Movement of animals was modelled on basic rules of flocking - separation, alignment and cohesion.
- A 2-D arena was stimulated in MATLAB having 2 targets and 3 variedly opinionated groups - a minority, a majority and an indifferent group for the study.
- Based on the study, it was concluded that presence of uninformed individuals in a group prevents movement towards strongly opinionated minority groups and thus help in maintaining democratic balance

Oct,14-May,15 **Investigating the Self-Sensing Capabilities of Piezopatch in a Composite Laminate**, IIT- KANPUR.
Faculty Advisor : Prof. Bishakh Bhattacharya
Objective : To analyze the sensing-actuation properties of a piezo-patch in a composite system and to investigate its use for damage detection purposes.
- Laminate Composite Theory was used to mathematically formulate a composite in MATLAB.
- Voltage output of the self-sensing piezo patch was calculated using numerical simulations.
- Effect of piezopatch position in various configurations of Composite Laminate was analysed using voltage signal.

May–Sep,13 **Curve Kick Aerodynamics of Soccer Ball**, IIT- KANPUR.
Faculty Advisor : Prof. Pradipta K. Panigrahi
Initiated the project on the analysis and simulation of the curling free-kicks observed in association football. The aim was to determine the feasibility of a proposed trajectory and to determine the initial values if it were.
- Devised a theoretical model to determine the governing laws of motion for a spinning ball, right from the moment of impact to the inflight dynamics covering the aspects of solid mechanics as well as fluid mechanics.
- The effects of the foot velocity prior to impact, the point of impact and the ambient conditions on the trajectory of the ball were studied.

Jan–Apr,15 **Genetic Algorithm for Combinatorial Optimization of Weight of a Composite Plate**, IIT- KANPUR.
Faculty Advisor : Prof. Bhaskar Dasgupta
Objective : Weight minimization of a composite structure constrained by allowable displacement for any given load.
- Multi-constraint combinatorial optimization methodology for the design of laminated composite materials used.
- The stacking sequence of layers and the thickness of the structure were optimized for a pre-assigned geometry of the structure, constituent materials and loading condition.
- Genetic algorithm was used for the optimization process and convergence was proved using simulation.

Technical Skills

Programming PYTHON, MATLAB, C, C++, JAVASCRIPT
OS Linux, Microsoft Windows
Others AutoCAD, Autodesk Inventor, Git

Relevant Courses

- **Robotics**: Advanced Topics in Robotics, Robot Manipulators: Dynamics and Control, Introduction to Robotics, Basics of Modern Control Systems, Theory of Mechanisms and Machines, Neural Networks, Machine Learning, Aerial Robotics, Computational Motion PLanning
- **Mathematics**: Linear Algebra, Mathematical Modeling, Real and Complex Analysis, Differential Equations
- **Miscellaneous**: Optimization Methods in Engineering, Dynamics, Composite Materials, Finite Element Methods in Engineering, Advanced Mechanics of Solids, Flight Dynamics, Vibration and Control

Positions of Responsibility

Jan-May, 2016 **Teaching Assistant**, ME766A *Engineering Design and Graphics*, IIT Kanpur.
Jul-Dec, 2015 **Teaching Assistant**, ME361A, *Manufacturing Systems*, IIT Kanpur.
Jul-Nov, 2012 **Secretary**, HOSPITALITY CELL, Antaragni'12, IIT Kanpur.
- Invited over **400 colleges** to the most coveted event; registered a footfall of over **5,000**.
- Ensured smooth stay of the teams by establishing a **24x7 redressal mechanism**.