Siddharth Tanwar

Senior Undergraduate

Contact information

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Areas of Interest

- **Intelligent Systems, Control and Robotics**
- **Computer Vision and Machine Learning**

Education

Indian Institute of Technology Kanpur, India *(July 2013 - Present)*
Bachelor of Technology, Electrical Engineering

- **Major CPI/CGPA** : 9.0/10 (List of Courses)
- **Minor degree** : Artificial Intelligence in Dept. of Computer Science and Engineering

Industrial Internship

Project Trainee, Texas Instruments, India
Guide: Supreet Joshi *(May 2016 - July 2016)*

Functional Test Fault Grading and Verification of Digital System
Fault testing and verification are important aspects of IC designing and fabrication. Efficient methods that speed up this process and increase coverage in complex circuits are necessary. My work aimed at devising and validating a functional test fault grading strategy on a live project.

- Analyzed Stuck-at Faults in a very large circuit using functional vectors only
- Generated and improved testcases written in Verilog for the circuit to determine the fault coverage of the various testcases and subsequently the circuit
- Using Cadence Simvision verified and analyzed gate level simulations further processed in Cadence Encounter Test environment

Research Internship

Intelligent Systems Lab, Indian Institute of Technology Kanpur
Guide: Prof. Laxmidhar Behera, EE, IITK *(May 2015 - July 2015)*

Sensory fusion, pose estimation and controller design on Quadrotors
The project aimed at autonomous indoor and outdoor navigation of an Asctec Pelican quadrotor equipped with GPS, IMU and visual and ultrasonic sensors.

- Implemented SLAM based algorithm SVO (Semi-direct Monocular Visual Odometry) using ROS framework and OpenCV on Asctec Pelican quadrotor to estimate pose in an outdoor environment
- Fused data obtained from GPS, monocular bottom facing camera and IMU using Extended Kalman Filter to refine results
- Simulated a cascade PID position controller of the Quadrotor on Matlab-Simulink

Technical Projects

Visual Odometry and Obstacle Detection for Ground Vehicles
Guide: Prof. Gaurav Pandey, EE, IITK *(Sept 2015 - Dec 2015)*

The project aimed at estimating the pose of a vehicle by means of an on-board forward facing camera and obstacle detection and avoidance using LIDAR sensors. This was a sub-part to a larger problem statement-"Mahindra Rise Challenge" to build an autonomous car. *(Report here).*

- Implemented a basic pipeline for monocular visual odometry tackling the problem of scale estimation by using Extended Kalman Filter to fuse data from an IMU, testing the setup on Ford Campus Vision and Lidar dataset
- Collected data from a Velodyne VLP-16 LIDAR mounted on a car and tuned an algorithm to detect and classify obstacles from point cloud data only

Wind Propelled Navigation and Pole Climbing Robots, ABU Robocon, 2016
Guide: Dr. Anjali Kulkarni & Prof. Bhaskar Dasgupta, ME, IITK (Sept 2015 - March 2016)

The objective of the pan-Asia contest was to design and manufacture an autonomous robot (Eco robot) and a semi-autonomous robot (Hybrid robot) capable of working in coordination to complete a particular set of tasks, where Eco robot equipped with only a single actuator for steering was guided by driving force (wind energy) obtained from Hybrid robot. We secured 3^{rd} position among 108 participants at Nationals and were felicitated by SnT council, IIT Kanpur.

- Led a 25 member team, overseeing the design and fabrication of the two robots
- Developed a mechanism using PMDC motors and Pneumatic pistons to make Hybrid robot weighing 25kg, climb a fixed pole of 2.5m
- Innovated by introducing balsa fabrication techniques to reduce the weight of Eco robot (50 cm x 50 cm x 50 cm) to under 400 gms, thereby increasing mobility and speed of the robot
- Designed a closed loop control system to control an arm on Hybrid robot, providing wind energy to the Eco robot

Badminton Playing Robots, ABU Robocon, 2015
Guide: Dr. Anjali Kulkarni & Prof. Bhaskar Dasgupta, ME, IITK (Sept 2014 - March 2015)

The objective of the project was to design and fabricate and automate two manually controlled robots capable of playing Badminton in a Standard size Badminton court.

- Involved in design and manufacturing of the robots, fabricating the chassis and brainstorming on possible mechanisms for the task
- Built a shuttle serving mechanism capable of accurately landing shuttle at distances upto 8 metres
- Developed with the team a mechanism replicating arm movement using pneumatic linear actuators for hitting the shuttle in quick successions

Pick n' Place Robots, ABU Robocon, 2014
Guide : Dr. Anjali Kulkarni & Prof. Bhaskar Dasgupta, ME, IITK (Sept 2013 - March 2014)

The contest aimed at accomplishing certain pick and place tasks on an arena using two robots (1 autonomous and 1 manual). As a 3-tier team of 30, we received Most Innovative Design award and finished 6^{th} among 89 participating teams at national level.

- Designed and fabricated, along with the team, Autonomous child robot(50x50x50cm) and Manual Parent robot (100x100x100cm) using softwares - Autodesk Inventor and AutoCAD
- Made the child robot capable of detecting nearby objects using Ultrasonic Sensors and gripping poles at specific distances from each other and parent robot

Intelligent Ground Vehicle Competition (IGVC), 2017
Guide: Prof. Gaurav Pandey, EE, IITK & Prof. Mangal Kothari, AE, IITK (Nov 2016 - Present)

The goal here is to create a fully autonomous unmanned ground robotic vehicle that negotiates around an outdoor obstacle course under a prescribed time while staying within the 5 mph speed limit, and avoids the obstacles on a grassy terrain. With our institute participating for the first time in the competition, I am leading the team of 20 along with five others and working on localization and SLAM for the robot.

Course Projects

Obstacle Detection using Cascade Classifiers in Self Driving Car Application
Mentor: Prof. Vinay P. Namboodiri, CSE, IITK (Jan 2016 - April 2015)

- Trained Cascade Classifiers on features (HOG, Haar and LBP) to detect cars in images
- Worked with the KITTI Vision Benchmark Suite - Object Detection Evaluation 2012 dataset
- Partitioned Point Cloud data to identify obstacles using Velodyne Height Map algorithm
- Processed LIDAR scan data using graph based technique to identify ROIs (Regions of Interest)

(Project Report here and Poster here)

Real-time Object Detection using CNNs
Instructor: Prof. Gaurav Sharma, CSE, IITK *(Jan 2016 - April 2015)*

- Followed CVPR'16 paper "You only look once: Unified, real-time object detection" by Joseph Redmon et al., training and testing YOLO and tiny-YOLO CNN models on PASCAL VOC 2012 Object Detection Dataset
- Trained and obtained detection results on the object detection benchmark KITTI by using a YOLO network pre-trained on ImageNet
- Did an extensive parameter study on YOLO, studying the changes observed on increasing/decreasing the grid resolution and increasing number of bounding boxes per grid cell
- Our trained Tiny-YOLO model runs at around 50-70 fps on NVIDIA GeForce GTX 760 GPU with mAP 44.65% on PASCAL VOC 2012 validation dataset

(Project Report here and Presentation here)

Disparate Image Matching using Duality Descriptor
Instructor: Prof. Tanaya Guha, EE, IITK *(Jan 2016 - April 2015)*

- Followed ICIP'16 paper "DUDE (duality descriptor): A robust descriptor for disparate images using line segment duality" by Youngwook P Kwon et al. to implement from ground-up the author's novel descriptor and detector algorithm in MATLAB
- Obtained comparable results on repeatability and mAP as obtained by the author
- Used other existing feature descriptors - SIFT, SURF, MSER, SYM-I and SYM-G to compare against our implementation of DUDE

(Project Report here and Presentation here)

Marker based Localization of a Quadrotor
Instructor: Prof. Gaurav Pandey, EE, IITK *(Jan 2016 - April 2015)*

- Followed ICRA'15 paper "Precise quadrotor autonomous landing with SRUKF vision perception" by S. Yang et al. to implement a high level control pipeline on a quadrotor
- Used Aruco Markers and library in ROS framework to estimate pose from images and experimented by fusing this with onboard IMU and Sonar sensor data using Extended Kalman Filter (EKF), Unscented Kalman Filter (UKF) and Square-Root Unscented Kalman Filter (SRUKF)
- Our team of two won the Best Presentation Award for the project

(Project Report here and Presentation here)

Mixing Mechanism
Manufacturing Lab-2, ME, IITK *(Jan 2015 - May 2015)*

- Designed and manufactured a manually operated single input mixing mechanism using Whitworth Quick Return Mechanism and 4-R Linkage mechanism capable of mixing manure in soil
- Simulated the motion of the mixing arm in Matlab and optimized path trajectory by choosing appropriate dimensions

Auto-playing Xylophone
Manufacturing Lab-1, MSE, IITK *(Aug 2014 - Nov 2014)*

- Designed and built xylophone capable of playing fixed notes using cam shaft mechanism
- Designed and analyzed the model on Autodesk Inventor and used casting, welding, brazing techniques for fabrication

Achievements and Awards

Competitive Exams and Scholarships

- Secured All India Rank-310 in the JEE Advanced 2013 among 75,000 students
- Secured All India Rank-327 in the JEE Mains 2013 among 10, 00,000 students
- Recipient of National Talent Search Examination (NTSE) Scholarship since 2009 by NCERT

Competitions

- Secured 3^{rd} position at national level in ABU Robocon 2016 representing the institute
- Received Most Innovative Design award and finished 6^{th} at nationals in ABU Robocon 2014
- Secured 1^{st} position for building a Rope Traversing Robot *(Aug'14)* in a competition organized by Robotics Club, IITK

Positions of Responsibility

Coordinator, Team Robocon IITK
Centre for Mechatronics, ME, IITK *(Sept 2015 - March 2016)*

- Coordinated a team of 28 undergrads from varying engineering disciplines and years of study
- Conducted recruitment test and interview for selecting new team members for Robocon 2016
- Tutored New Members on Modeling and Assembly designing in Autodesk Inventor, Solidworks
- Introduced Balsa Fabrication, Computer vision applications to the team and secured funding of INR 700,000 for the project

Executive, Tinkering Lab, IIT Kanpur
Tinkering Lab, ME, IITK *(April 2015 - March 2016)*

- Supervised and aided in smooth functioning of the Lab and introduced software such as Autodesk Inventor, Solidworks and AutoCAD to the lab workers
- Recommended new machines - Pipe Notching Machine, Abrasive Waterjet Cutting Machine to expand and develop the lab
- Organized an institute level competition on CAD designing during Intra-college Technical Fest

Relevant Coursework

Systems, Controls and Robotics
Probabilistic Mobile Robotics, Robot Manipulators: Dynamics and Control, Digital Control, Control Systems Analysis, Signals, Systems & Networks

Computer Vision, Image Processing and Artificial Intelligence
Recent Advances in Computer Vision, Image Processing, Artificial Intelligence Programming, Data Structures and Algorithm, Fundamentals of Computing

Mathematics, Signal Processing and Electronics
Probability and Statistics, Partial Differential Equations, Linear Algebra, Complex Variables, Principles of Communication, Digital Signal Processing, Introduction to Electronics, Digital Electronics, Electrical Engineering Laboratory I & II

Technical Skills

Programming	C, C++, Python, Bash, MATLAB, VHDL, Perl, HTML, LaTeX
Software	ROS/Gazebo, OpenCV, Matlab & Simulink, AutoCAD, Autodesk Inventor, Solidworks, SPICE Simulator, CVAVR, AVRStudio
Embedded Platform	Arduino, Odroid, RaspberryPi

Voluntary Work

Student Guide, Counseling Service, IITK *(July 2014 - May 2015)*

Assisted a group of 5 freshman students in adapting to the campus environment and resolving any kind of difficulty faced by them

Academic Mentor, Counseling Service, IITK *(July 2014 - May 2015)*

Helped academically weak students and students facing problems in the course *Engineering Graphics(TA101)* by taking remedial lectures and handing out self-made assignments

Other Interests

Apart from my academic interests, I like travelling & driving, playing badminton and reading novels. I enjoy dramatics and have taken part in a stage play and a street play in college. Music is an integral part of my day and I am a big fan of Adele, Sia and Coldplay.

References

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