Avi Singh

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Research Interests

Computer Vision, Machine Learning for Artificial Intelligince, AI for Robotics

Education

Indian Institute of Technology Kanpur
2012-Present

Bachelor of Technology (expected July 2016)
Major: Electrical Engineering • Minor: Computer Science(Artificial Intelligence)
GPA: **9.4/10** (after five semesters)

DAV Public School, Kota
2010-2012

CBSE Class XII
Subjects: Maths, Physics, Chemistry, English
Percentage: 86%

IRA International School
2005-2010

CBSE Class X
Subjects: Science, Maths, English, Social Science
GPA: 10/10

Scholastic Achievements and Awards

2014	Awarded an **A* grade**, for exceptional performance in **Undergraduate Project - 1**
2012-2013	**Academic Excellence Award**, IIT Kanpur (Awarded to 60 students out of 840).
May 2012	Secured All India rank **387** in Joint Entrance Exam (JEE) out of **500K** candidates
Jan 2012	**Top 1%** in National Physics Olympiad

Research Experience

Stereo Visual Odometry for Ground Vehicles — Ongoing since August 2014

Computer Vision Lab, IIT Kanpur,under Prof.KS Venkatesh

Two appraoches were implemented and evaluated on KITTI odometry benchmark:

1. Jiang2014: Model Based ICP: 3D points triangulated from stereo data, inliers detected via the use Iterative Closest Point Algorithm that uses a 1-DOF motion model for initial estimate. Efficient PnP Algorithm is then used on the selected inliers to obtain the final rotation and translation.
2. Howard2008: Inlier detection using an assumption of scene rigidity. Problem reduced to finding the maximum clique in a graph, solved using a heuristic. Levenberg-Marquardt used for minimizing the reprojection error on the selected inliers.

Work is ongoing to improve the accuracy and speed of computation of the above exisiting methods.

Estimation of Range Flow from RGBD data — May 2014 - July 2014

Computer Vision Lab, IIT Kanpur,under Prof.KS Venkatesh

- Designed and implemented two approaches for estimation of Range Flow from RGB-D data, one using 'Total Least Squares Solution', the other utilizing 'Global Minimum Energy Solution'.
- A third approach, Physical RGBD Flow, attempting to capture the physical flow (instead of apparent flow) was also implemented.
- The Physical RGBD Flow approach was evaluated against data generated using a highly accurate 6-DOF tracking device, the Personal Space Tracker (PST-110).
- Captured RGBD Data from a Microsoft Kinect using OpenNI and OpenCV libraries, and did all the processing using C/C++.

Selected Projects

Landmark-based Robotic Localisation from RGBD data — December 2013

under Mr. Arjun Bhasin, Research Associate at Mechatronics Lab, IIT-Kanpur

- Geometric Triangulation was used to determine the pose (modelled as a set of random variables with Gaussian Distribution) of a robot, from information obtained from noisy landmarks.
- A Microsoft **Kinect** was used to identify the landmarks (using color histogram based models), **CAMshift** algorithm was used to track these landmarks, and bearing measurements were calculated using the depth data.
- An error model for the data obtained from a Kinect was used along with the Error Propagation Law to arrive at the uncertainty in the final pose computed using the Geometric Localisation Algorithm.

Hilbert Transform on FPGA/Verilog — March 2014

For Techkriti 2014 [Github]

- Implemented a 32-point Discrete Hilbert Transform in **Verilog**, making use of the **Fast Fourier Transform** in the intermdeiate stages.
- Won **2nd position** in FPGA Design, Techkriti 2014.

DAAnT - Dental Automated Analysis Tool (Computer Vision for intraoral cameras) — January 2015

MIT RedX Camp,under Dr.Hyunsung Park, Postdoc at Camera Culture, MIT Media Lab

We devloped Computer Vision algorithms for diagnosis of dental diseased from images obtained from an intraoral camera. My contribution in the eight-member team was primarily in the following areas:

- Stitching Images: Used Affine SIFT to overcome the difficulties in feature matching due to changes in perspective, and then computed Homography with RANSAC to stitch the images.
- Segmenting Every tooth: Marker-controlled watershed transform was used to segment every tooth from the image. Both semi-automated and automated approaches were implemented and compared.

Kaggle	**Titanic: Learning from Disaster**	Used Random forest to achieve an accuracy of 72% (for the predicition of survival).
	Classifying MNIST digits	Used random forest with 100 estimators to achieve an accuracy of 96.6%.

Hardware Hacks @ Electronics Club	**Cashless Campus**:	Developed an **arduino-based** point-of-sale device, with **biometeric (fingerprint) authentication** . An Arduino Mega was interfaced with an ethernet shield (with Wiznet51000 chip for UDC/TCP stacks), an LCD, a touchscreen, a thermal printer, and an SD card via **SPI and UART**.[Github]
	SNAKE64:	Implemented the classic 'Snakes' game on a self-fabricated LED matrix of size 8x8, and wrote an original C code for ATmega8 to drive the matrix.
	Laser Tag:	An infrared-based gun was implemented using IR leds and 38KHz modulated wave was generated on an ATmega32. The receiving unit employed a TSOP to detect bursts of infrared sent from the gun.

Relevant Courses Completed and Ongoing(*)

Mathematics	Electrical Enginering and Computer Science	Other
Probability and Statistics	Machine Learning for Computer Vision*	Engineering Graphics
Linear Algebra	Digital Signal Processing*	Applied Game Theory
Multivariate Calculus	Data Structures and Algorithms	Intro to Psychology
Ordinary/Partial Differential Equations	Communication/Information Theory*	Art of Video Making

Technical Skills

Programming Languages	**C, C++,** MATLAB, Python	**Microcontrollers**	Atmel ATmega, dsPIC, Arduino
Software Packages	**OpenCV**, ROS, Point Cloud Library (PCL)	**Imaging Systems**	Microsoft Kinect, PST-110
Operating Systems	GNU/Linux (Ubuntu), Microsoft Windows	**Other Hardware**	Raspberry Pi, Beagleboard, Servos, IMUs
Other	Git, LaTeX		

Positions of Responsibility

Electronics Club Coordinator, Science and Technology Council — 2014- Present

- Floated, mentored and ensured the completion of **nine summer projects** including a **3D Laser Scanner**, **A Video Surveillance Robot**, Conway's Game of Life simulation using FPGAs, Fast Fourier Transform on FPGA, An accelerometer based fitness and sleep tracker with accompanying Android App, a Surveillance system with **face recognition**, and a Laser Tag system.
- Leading a team of **16 secretaries** and handling a budget of **Rs.76,000** to organize lectures, workshops, competitions, and another **Rs.4,74,000** for funding projects and for participation in external events.
- Lectures attended by 400+ people, workshops attended by 200+ people, and participation of 100+ people in Takneek (intra-IIT Kanpur technical festival) Electronics competitions.

Coordinator, ECDC, Techkriti 2014 — 2013 - 2014

Designed and verified the problem statement for the event Electromania. Prepared sample codes and tutorials for the participants.

Secretary, Electronics Club — 2013 - 2014

Assisted in organisation of lectures, workshops, tutorials, and maintenance of club.

Student Guide, Counselling Service — 2013 - Present

Assisted in the organisation of various counselling service activities such as the Orientation Program and helped a group of six freshers in settling in the new college environment.