Shantanu Sinha

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Education

B.Tech. Mechanical Engineering — GPA 8.03/10.00　　　　　　　　*May 2014 (expected)*
Indian Institute of Technology Bombay, Mumbai, India

Indian School Certificate (Intermediate) — 91.80%　　　　　　　　*May 2009*

Indian Certificate of Secondary Education (Matriculation) — 93.71%　　　　*May 2007*

Research Interests

My primary interests lie in the fields of **Computer Vision**, **Computer Graphics** and **Machine Learning**. More specifically, I am interested in vision-centric human computer interaction, geometric and learning-based vision, virtual and augmented reality.

Publications

Shantanu S. Sinha, R.K. Satzoda, S. Suchitra, T. Srikanthan, "Additive Hough Transform on Embedded Computing Platforms", at the *56th IEEE International Midwest Symposium on Circuits and Systems (MWSCAS)*. Columbus, Ohio, USA. 2013.

Research Experience

Face Identification using Neuromorphic Feature Descriptors　　　　*May 2013 - Present*
Guide: Prof. David D. Cox
Center for Brain Sciences, Harvard University, Cambridge, USA

- Achieved state-of-the-art results on NIST's "The Good, The Bad and The Ugly" face identification challenge dataset using features derived from a large-scale random search in parameter space of a biologically-inspired multi-layer convolutional network.

- Enhanced verification rates using attribute classifiers for detecting facial characteristics such as presence of glasses, difference in expression etc. and then fused scores from different facial regions based on the difference in attribute scores between the two images.

- Currently working on using hyper-parameter optimization techniques to determine the feature set that best describes the challenge problem.

- Future work includes extending the face identification framework to face matching in video sequences, such as in the YouTube Faces Dataset.

Fast Lane-Detection Algorithms for Embedded Platforms　　　　*Jan - April 2012*
Guide: Prof. Thambipillai Srikanthan
Center for High Performance Embedded Systems, NTU, Singapore

- Implemented a block-based parallel version of the linear Hough Transform called the Additive Hough Transform (AHT) on a variety of computing platforms.

- Quantitatively evaluated the performance benefits offered by AHT on multicore processors, GPUs and reconfigurable hardware.

- Achieved significantly lower execution times than regular Hough Transform implementations in both serial and parallel configurations on each of the aforementioned platforms.

- Developed hardware and application-specific variants of AHT to ensure optimal performance on all systems. Suggested methods to reduce the computational complexity of AHT on systems lacking hardware multipliers.

Pseudo-Real-Time 3D Reconstruction of Animatable Humanoids *Jan - August 2013*
Guide: Prof. Parag Chaudhuri
Vision and Graphics Laboratory, IIT Bombay

- Designed and implemented a system for pseudo-real-time registration and meshing of dense 3D point clouds of human subjects. The system is capable of operating on low-end commodity hardware available to the end-user, unlike most commercial implementations.

- Point clouds are captured in real-time using a depth camera such as the Microsoft Kinect. During capture, the camera pose is estimated automatically using a purely vision-based camera tracker and is used to provide rough real-time feedback to the user.

- This camera pose is then further refined using gradient descent techniques for fine-adjustment to asynchronously generate a complete 3D model of the subject.

Design of a Unified Co-Processor for Image/Signal Processing Applications *May - July 2012*
Guide: Prof. Thambipillai Srikanthan
Center for High Performance Embedded Systems, NTU, Singapore

- Optimized various standard image and signal processing routines for the Infineon TriCore at the assembly level for application in Advanced Driver Assistance Systems (ADAS) in automobiles.

- Coupled the TriCore with a hardware accelerator (Xilinx Spartan 6 FPGA) to shift inherently parallel routines off the TriCore and onto the FPGA to speed up time-intensive computations.

- Successfully demonstrated the performance gain theorized by the inclusion of a hardware accelerator for computation of the Hough Transform for line detection. Since the regular Hough Transform is not optimized for parallel systems, Additive Hough Transform was implemented instead, which produces the same final Hough space but supports block and angle-level parallelism.

Template-based 3D Reconstruction of Human Subjects using the Kinect *Sept - Nov 2013*
Guide: Prof. Parag Chaudhuri
Vision and Graphics Laboratory, IIT Bombay

- Applied Laplacian mesh deformation to a database comprising 3D scans of human subjects in different postures as opposed to directly deciphering body structure from the depth image, thereby confining the final model to the space of human subjects.

- Reformulated the ICP optimization problem using sparsity-inducing norms to make the system more robust in the presence of outliers and holes, as is expected in noisy real-world data.

Portable, Affordable Technology for Imaging the Anterior Segment of the Eye *Jan 2014 - present*
Guides: Everett Lawson and Nick Savidis, MIT Media Lab
        Dr. Jim Patalano, Harvard Medical School

- The challenge in imaging the eye, today, is not the availability of technology, but access to this technology. Ocular imaging is a specialized procedure involving million-dollar instruments and highly-trained ophthalmologists, possible only in major hospitals in big cities.

- We plan to change this by employing advanced computer vision techniques, clever illumination and simplified optics to build an affordable, portable, user-friendly device that can easily be carried to patients in rural areas and operated by lesser-trained nurses for preventive diagnosis of many major illnesses.

Application of Pattern Recognition Techniques to Kikuchi Diffraction Patterns *Aug - Dec 2012*
Guide: Prof. Asim Tewari
Microstructural Mechanics Laboratory, IIT Bombay

- Applied image segmentation and pattern recognition techniques to Kikuchi diffraction patterns generated by a scanning electron microscope in order to extract properties of individual grains.

- Modified existing algorithms for use in a highly parallel environment in order to speed up time-intensive computations

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Simultaneous Egomotion Estimation and Mapping in a Stereo Camera Setup *Feb - April 2013*
Guide: Prof. Subhasis Chaudhuri, IIT Bombay

- Developed an RGB-D based camera tracker similar to the commonly used Parallel Tracking and Mapping (PTAM) camera tracker.
- Implementation comprises two threads that run asynchronously in parallel - one generating a map of the environment and the other estimating camera pose. The depth map is generated using a stereo camera setup.

Classification of Handwritten Numerical Digits using Learning Techniques *Feb - April 2013*
Guide: Prof. G. Nagaraja, IIT Bombay

- Implemented various pattern classification algorithms like support vector machines, Ho-Kashyap linear classifier, Bayesian classifier and unsupervised learning techniques like k-means clustering to determine the best possible classifier for the given data.
- Successfully classified training and test data with overall accuracy of 98.3% across 5620 instances using a modified Ho-Kashyap linear classifier for pairwise classification of digits.

3D Modelling, Rendering and Animation in OpenGL *Sept - Nov 2013*
Guide: Prof. Parag Chaudhuri, IIT Bombay

- Modelled and textured a 3D room, complete with tables, chairs, OpenGL lights, a bed, paintings, flooring, a mirror and a music box with a man inside.
- Functionality included a camera fly-through, brought about by plotting Bezier splines through points clicked by the user. Animated the music box employing interpolation techniques between key frames.

Interactive 2D OpenGL-based Application for Plotting Vector Shapes *August 2013*
Guide: Prof. Parag Chaudhuri, IIT Bombay

- Developed a simple 2D drawing program capable of drawing points, lines, polygons and freeform shapes on a 2D canvas. The program also supported filling of closed shapes using the flood fill algorithm. File I/O routines were implemented to load and store drawings.
- The entire program was constructed with limited use of OpenGL functionality, with the objective of developing a firm grasp on the algorithmic underpinnings of OpenGL routines.

Pre-Placed Laser Cladding of Hydroxyapatite on a Titanium Substrate *Sept - Nov 2012*
Guide: Prof. Ramesh Singh, IIT Bombay

- Modelled temperature distributions across the substrate during the pre-placed laser cladding of Hydroxyapatite on Ti-6Al-4V using the finite element modelling package Abaqus.
- Determined the optimal laser power and cladding speed to achieve the desired interfacial bond strength while minimizing size of the heat affected zone.

Design of Secondary Mass Balancer System for Four Cylinder Inline IC Engines *Oct - Nov 2013*
Guides: Profs. Tanmay Bhandakkar and Parag Tandaiya, IIT Bombay

- Modelled a balancer shaft rotating at twice the engine speed, to neutralize secondary vibrations from the engine caused by the rotation of heavy components – one of the primary sources of NVH (Noise, Vibration and Harshness) in automobiles.
- Coupled the balancer shaft with an idler shaft, rotating at the same speed as the balancer shaft but in the opposite direction, to nullify the moment created between the balancer and crank shafts.

Mathematical Modelling of a MacPherson Strut-based Suspension System   *Mar - April 2013*
Guides: Profs. Abhishek Gupta and V. Kartik, IIT Bombay

- Theoretically determined the impulse absorbed by each shock absorber as a function of point of impact in a four-point MacPherson strut-based suspension system.
- Developed a simplistic model of the entire system using accelerometers for experimental validation. Performed Fourier analysis to determine the natural frequencies of vibration of the system.

Self-Motivated Projects

Sensors and Navigation Modules of a Library Book-Retrieval Robot   *Jan - April 2011*

- Part of a team designing a robot for autonomous book retrieval in a large library. Used ultrasonic sensors for rough positioning, further refined using TSOP1738 infrared receivers. Developed a modified version of the A* heuristic search for route planning.

Autonomous Target Detection, Tracking and Motor Actuation   *Sept - Nov 2011*

- Built a system that autonomously identified objects of a particular colour and shape and tracked them over time. Additionally, the system could convert the image coordinates into 3D world coordinates using a perspective projection model and was interfaced with an Arduino for motor actuation.

Organizational Activities

Core Team, Web and Coding Club, IIT Bombay

- Organized and conducted workshops, lecture sessions and coding competitions at the institute level.
- Promoted programming as a hobby and provided opportunities to enthusiastic club members to further explore their interests by organizing mentorship for institute-sponsored summer projects.

Online Treasure Hunt for Mood Indigo 2011

- Organized and developed content for an online treasure hunt for Mood Indigo, Asia's largest college cultural festival.
- Challenges were designed to test users' general knowledge as well as their skill at handling web interfaces, requiring clever use of search queries and deciphering of clues hidden in the source code.

Other Activities

- Secured an ***All-India Rank of 129*** (99.97 percentile) in the Indian Institutes of Technology Joint Entrance Examination (IIT-JEE) 2010, given by more than 450,000 students.
- Secured an ***All-India Rank of 86*** (99.99 percentile) in the All India Engineering Entrance Examination (AIEEE) 2010, given by more than 1.1 million students.
- Recipient of the ***CBSE Merit Scholarship for Professional Studies*** for three consecutive years (2011-2013).
- Student member of the IEEE.

Relevant Courses

Computer Vision, Computer Graphics, Pattern Recognition, Artificial Intelligence, High Performance Scientific Computing, Optimization Models, Data Structures, Operating Systems

Skills

Programming Languages - C/C++, Python, CUDA, MATLAB/Simulink, Java, VHDL, Assembly
Libraries - OpenCV, OpenGL, OpenNI, OpenMP, Point Cloud Library
Web Design - HTML, CSS, JavaScript, PHP
Packages - gcc/g++, Microsoft Visual Studio, Blender, Xilinx ISE, LaTeX

Experienced in programming Infineon TriCore, Freescale XEP100 and Atmega series microcontrollers.

Extra-Curricular Activities

- Certified PADI Advanced Open Water Diver.
- Participated in a Swimathon at IIT Bombay requiring six hours of continuous swimming.
- Actively participated in institute-level technical competitions and projects.
- Have represented my school in multiple inter-school table tennis competitions.

References

Prof. David D. Cox
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Center for Brain Sciences
Harvard University
Email: davidcox@fas.harvard.edu

Prof. Thambipillai Srikanthan
Professor, Department Chair
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