Shashank Sharma

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Education

Udacity, School of Autonomous Systems Online
Robotics Software Engineer Nanodegree Program Apr 2021 – Apr 2022
- **Relevant Areas:** ROS, Gazebo, Localization, Mapping, SLAM, Navigation, and Path Planning

State University of New York, State University at Stony Brook Stony Brook, NY
Ph.D. + M.S., Mechanical Engineering, GPA 3.95 Aug 2015 – Aug 2020
- **Concentration:** Design and Robotics, **Minor:** Applied Mathematics
- **Relevant Courses:** Robotics, Advanced Dynamics, Vibration and Control, Kinematic Analysis and Synthesis, Applied Stress Analysis, Product Design Optimization, Geometric Modeling, Analysis of Algorithms

Udacity, School of Autonomous Systems Online
Self Driving Car Engineer Nanodegree Mar 2019 – Mar 2020
- **Relevant Areas:** Computer Vision, Deep Learning, Sensor Fusion, Localization, Planning, Control, System Integration

Indian Institute of Information Technology Jabalpur, India
B.Tech., Mechanical Engineering Aug 2009 – Aug 2013
- **Relevant Areas:** Mechanical Design and Manufacturing, Computer Aided Design

Publications

Ph.D. Dissertation
- Analytical and Machine Learning Based Frameworks for Synthesis of Planar, Spherical and Spatial Mechanisms

Journal Articles
- Sharma S., Purwar A.; **A Machine Learning Approach to Solve the Alt–Burmester Problem for Synthesis of Defect-Free Spatial Mechanisms**, ASME Journal of Computing and Information Science in Engineering 2022; doi:10.1115/1.4051913
- Sharma S., Purwar A.; **Using a Point-Line-Plane Representation for Unified Simulation of Planar and Spherical Mechanisms**, ASME Journal of Computing and Information Science in Engineering 2020; doi:10.1115/1.4046817
- Sharma S., Purwar A., Ge Q.J.; **A Motion Synthesis Approach to Solving Alt-Burmester Problem by Exploiting Fourier Descriptor Relationship Between Path and Orientation.**, ASME Journal of Mechanisms and Robotics 2019; doi:10.1115/1.4042054
- Sharma S., Purwar A., Ge Q.J.; **An Optimal Parametrization Scheme for Path Generation Using Fourier Descriptors for Four-Bar Mechanism Synthesis.**, ASME Journal of Computing and Information Science in Engineering 2019; doi:10.1115/1.4041566

Conference Papers
- Sharma S., Purwar A.; **Path Synthesis of Defect-Free Spatial 5-SS Mechanisms Using Machine Learning.**, ASME 2020 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference; doi:10.1115/DETC2020-22731
- Sharma S., Purwar A.; **Unified Motion Synthesis of Spatial Seven-Bar Platform Mechanisms and Planar-Four Bar Mechanisms.**, ASME 2020 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference; doi:10.1115/DETC2020-22718
- Sharma S., Purwar A.; **Using a Point-Line-Plane Representation for Unified Simulation of Planar and Spherical Mechanisms**, ASME 2019 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference; doi:10.1115/DETC2019-98194
- Sharma S., Purwar A., Ge Q.J.; **A Motion Synthesis Approach to Solving Alt-Burmester Problems by Exploiting Fourier Descriptor Relationship Between Path and Orientation Data**, ASME 2018 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference; doi:10.1115/DETC2018-85567
- Sharma S., Purwar A., Ge Q.J.; **Optimal Non-Uniform Parametrization for Fourier Descriptor Based Path Synthesis of Four Bar Mechanism**, ASME 2018 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference; doi:10.1115/DETC2018-85568

Awards

- Invited by ASME (American Society of Mechanical Engineers) multiple times to review journal publications of peers.
- Received the Resource Access Project Travel Grant Fall 2019 by Graduate Student Organization, Stony Brook to present research findings at IDETC 2019 in Anaheim, California.
- Received the Resource Access Project Travel Grant Fall 2018 by Graduate Student Organization, Stony Brook to present research findings at IDETC 2018 in Quebec City, Canada.

Experience

Lucid Motors Newark, CA
Senior Software Engineer *Nov 2023 – Present*
- Working on Advanced driver-assistance system (ADAS) and Autonomous Driving (AD) software for Lucid vehicles.
- Developing navigation pipeline using data from GNSS and IMU sensors.
- Developing sd-map and hd-map pipelines to improve ADAS features like Highway Assist.
- Supporting software validation, for Lucid Air Sedan and Gravity SUV, using hardware-in-loop and prototype vehicle testing.

Dematic Holland, MI
Machine Learning Engineer *Sept 2020 – Oct 2023*
- Developed on-board software for autonomous vehicles(AGVs) in warehouse environments.
- Improved accuracy and robustness of the reflector extraction algorithm leading to sub-centimeter accuracy.
- Developed a Gazebo-based virtual testing pipeline to improve line extraction algorithm using hyperparameter tuning.
- Improved speed of feature-based association algorithm by 50%, leading to a 30% faster localization pipeline. Analyzed real-time CPU utilization of SLAM processes and threads using Valgrind, LTTng, and perf.
- Standardized the pallet pick/drop testing at physical warehouses. The accuracy-repeatability analysis was done using an external laser tracking system by Faro. Also, a procedure to calibrate the lidar, steering encoder, and traction encoder was created.
- Developed a Python-based tool to visualize recorded mapping logs, and automated their offline performance analysis.
- Tackled technical debt in the mapping codebase by reducing complexity, simplifying API, and decoupling tightly connected units. Improved mapping API calls latency by creating caching threads.
- Created a commissioning workflow to first map a small warehouse and then localize using the generated map.
- Implemented and integrated obstacle detection(human/ forklift) and pallet detection algorithms using 3D camera data.
- Certified SAFe (Scaled Agile Framework) Practitioner and trained to use Scrum, Kanban, and XP in an Agile environment.

Stony Brook University Stony Brook, NY
Research Assistant *May 2017 – Aug 2020*
- Developed a Computational Framework for Data-Driven Mechanism Design Innovation supported by a $450K NSF grant.
- Designed machine learning and algebraic algorithms for simulation and synthesis of Planar, Spherical, and Spatial single-degree-of-freedom Robotic systems resulting in multiple publications in journals by the American Society of Mechanical Engineers.
- Created MotionGen, a web-based mechanism design framework. Uses MEAN (MongoDB, Express.js, Angular.js, Node.js) stack to create a RESTful web service based on MVC architecture. iOS and Android apps created using Apache Cordova framework.
- In-charge of Computer-Aided Design and Innovation Lab and collaborating with a research group of 10+ graduate students.

Teaching Assistant *Aug 2016 – Apr 2017*
- Developed SnappyXO, a laser-cut design-driven robotics platform that enables designing mechanisms, structures, and robots. It has successfully raised $16K+ on Indiegogo for a crowdfunding campaign.
- Advised 250+ students in MEC101-Freshman Design Innovation, MEC 102-Engineering Computing, and Vertically Integrated Projects(VIP) Program. The Robot Design projects gained recognition from the Office of President at university.

Leviathan Energy Stony Brook, NY
Strategic Partnership for Industrial Resurgence (SPIR) Intern *Feb 2016 – May 2016*
- Designed and manufactured Hydro-kinetic turbines with improved airfoil design which produces 50% more power in collaboration with Leviathan Energy.
- Created engineering models using Solidworks and Autodesk Inventor and fabricated parts by FDM based 3D printing.

Indian Institute of Information Technology Jabalpur, India
Junior Research Fellow *May 2014 – May 2015*
- Led a $70k+ research project funded by the Science and Engineering Research Board titled "Development of Additive-Subtractive Integrated Rapid Prototyping System for Improved Part Quality".
- Spearheaded design and manufacturing teams to create a new hybrid 3D printing process using Pellet based Screw Extruder with CNC machines. Created Toolpath Planning strategies to manufacture CAD models using Hybrid Manufacturing techniques.

Sara Sae Private Limited Dehradun, India
Design Intern *May 2013 – Aug 2013*
- Involved with product development of Hydraulic Tongs used in the oil and gas industry.
- Carried out Kinematic and Dynamic analysis to find the most probable failure regions.

Altair Jabalpur, India
Engineering Intern *Sept 2012 – Dec 2012*
- Solved practical engineering problems by Topology, Topography, Size and Shape Optimization using OptiStruct.
- Achieved 44th rank in Altair All India Optimization Contest 2012.

Vehicle Factory Jabalpur Jabalpur, India
Manufacturing Intern *July 2011 – July 2011*
- Worked with the Production Line and Maintenance Teams for Mine Protected Vehicle and Stallion Mark-I trucks.

Central Institute of Hand Tools Jalandhar, India
Computer Aided Design Intern *June 2010 – June 2010*
- Carried out Computer-aided Design using Pro/ENGINEER, Mold Modelling and Mold-flow analysis.

Technical Proficiency

- **Robotics hardware :** Nvidia Jetson (Nano and Xavier NX), 2D and 3D Lidar (Sick, Ouster, and Velodyne), RGBD camera (Intel Realsense D455), steering and traction encoder, IMU, Raspberry Pi, Arduino
- **Robotics software :** Keras, Tensorflow, PyTorch, ROS, Gazebo, Rviz, Anaconda, Jupyter, OpenCV, Scikit, Pandas
- **Programming Languages :** C++, Python, Javascript, Matlab, Mathematica, Delphi
- **Tools :** Git, Virtual box, LTTng, Perf, Valgrind
- **CAD softwares :** Solidworks, Autodesk Inventor, PTC Creo, CATIA, Ansys (CFD and Mechanical), Autodesk AutoCAD, Autodesk Moldflow, FeatureCAM , MSC-Adams, ZWCAD, Altair HyperMesh, Altair OptiStruct, Materialize Magics, Materialize Mimics, CNC G-M Code

Projects

Autonomous Robot Navigation
Udacity
C++, Python, ROS, Gazebo, AMCL, gmapping, RTABMap
Apr 2021 – Apr 2022

- Simulated Automated Guided vehicles (AGVs) and Autonomous Mobile Robots (AMRs) in a warehouse environment.
- Mapped a virtual environment, by manually moving an AGV and creating an occupancy grid map. The AGV only had a 2D lidar sensor on it. Localized an AMR using the same map while controlling it manually or autonomously using path planning. Simulated a complete pick-and-drop operation. ROS packages like gmapping, AMCL, and move_base were used.
- Used SLAM to manually move an AMR through a virtual environment and create a loop-closed 3D graph map using RTAB-Map. The AMR used a 3D camera and a 2D lidar sensor to create the map for localization.
- Programmed an AMR to autonomously follow a moving reflective ball target using a 2D camera.
- Used A-star path planning to move a payload through a 2D maze using a KUKA industrial robotic arm as part of KUKA Robotics Challenge.

Self Driving Car subsystem design and integration
Udacity
Python, Jupyter, OpenCV, TensorFlow, Keras, C++, ROS
May 2019 – Aug 2019

- Created a robust image processing pipeline to detect highway lanes in dashcam live-feed. The car's position within lane and lane curvature was calculated using bird's eye view (BEV) and polynomial fitting. LeNet-inspired convolution neural network was also developed to detect and classify 40+ kinds of traffic signs.
- Used a 2D particle filter with GPS, sensor data, and landmark map for sparse localization. Also localized using an extended Kalman filter which fused LIDAR and RADAR sensor data.
- Autonomously drove on a virtual highway with other cars using a Finite State Machine based trajectory planner.
- Implemented a PID controller to maneuver a vehicle around a virtual track using steering, throttle, and brake.
- Used Robot Operation System (ROS) framework to robustly integrate Perception, Localization, Planning, and Control.

Master's projects
Aug 2015 – May 2017
Machine Learning approach to Path Synthesis of crank-rocker mechanisms

- Path tracing mechanisms with optimum transmission angle are synthesized using Artificial Neural Network.
- Input features are calculated using Wavelet transformation to capture the temporal path information.

Motion Systhesis of Planar Four-bar Mechanisms

- Solving Five pose Burmester Motion Synthesis Problem using Kinematic Mapping in an interactive OpenGL based environment implementation in C++.

Motion Planning for a Robot with Two Anthropomorphic 6-DOF Arms

- Inverse Kinematics and Dual Quaternion interpolation based optimal trajectory planning to pick and place objects considering individual arm's workspace and dexterity.

Fracture test analysis for compact tension specimen

- Finite element analysis of a fracture specimen to predict and validate deformations at the crack tip.

Quality Improvement of Aircraft Wing Assembly

- Identifying and correcting the root cause for high rejection rate of final assembly using Pareto Charts, Cause and Effect Diagrams, Control Charts, and Histograms.

Conceptual Design

- Conceptual design of an Ergonomic Nutcracker and Stone Crusher.
- Formulation of product design specification and criteria and generation of the best possible product concept.

Bachelor's projects
Aug 2009 – May 2013
Tessellation Algorithms

- Reviewed algorithms used for the tessellation of Voronoi Diagrams and Delaunay Triangulation and implemented tessellation on a sample set.
- Coding and simulation were done on MATLAB.

Mold Design and Manufacturing

- Designed and manufactured molds for irrigation industry products for Injection Molding Process.
- Flow Analysis results were used to optimize the design and a Pricing Strategy was developed for industry partners.

Deformation Analysis and Validation of Cycle Frame
- Modeled frame elements and calculated the deformations for the model on MATLAB.
- Analyzed the model on ANSYS to validate the results.

Automatic Bartender
- Developed a concept of a sensor-based automatic multiple liquid mixing mechanism and simulated it using PLC (Programmable Logic Control).
- Used Solidworks, PLC ladder logic and Labview.

Remote Controlled Hovercraft
- Designed, analyzed and fabricated a Remote Controlled Hovercraft.
- Modeled the design, performed the lift and thrust calculations and did CFD analysis.
- Used ANSYS CFX, Solidworks, PTC Creo, and Labview.

Computer Aided Manufacturing Projects
- Solved a simplified 2-D Stock Cutting Problem and implemented it through GUI using MATLAB.
- Modeled, Assembled and Simulated the Treadle Sewing Machine using PTC Creo.

Computer Aided Design Projects
- Developed interactive GUI for 3D Transformation of Geometrical Shapes on MATLAB.
- Implemented Hermite Curve, Bezier Curve and B-Splines in 3D on MATLAB.
- Implemented Bilinear Surfaces, Ruled Surfaces, Coons Bicubic Surface Patch, Bezier Surfaces and B-Spline Surfaces in 3D on MATLAB.

Computer Aided Optimization Projects
- Topography optimization of a pressure tank to minimize wall displacement.
- Topology optimization of an automotive control arm to minimize deformation and volume of the component.
- Topology optimization of a clutch pedal to minimize the weight of the part.
- Free size optimization of an aircraft wing rib to minimize weight and maximize stiffness.
- Used Altair Hyperworks, HyperMesh, and OptiStruct.

Human Powered Energy Device
- Designed and Fabricated a Product Concept that harnessed human power.
- Two attachments were designed: Portable Fan and Electric Generator.
- Modeled and Assembled using PTC Creo.

Landing Gear Mechanism
- Analysed and Fabricated Airplane Landing Gear Mechanism. Analysis was done using MSC Adams.