Guru Koushik S

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Research Interests

Autonomous Vehicle Systems, Deep Reinforcement Learning for End to End Learning, Hardware in Loop Vehicle Testing, Autonomous Driver Assistance Systems, Transfer Learning

Education

Indian Institute of Technology Madras, Tamil Nadu, India
B.Tech & M.Tech, Engineering Design — *Jul' 14 - May' 19 (Expected)*
Minor Stream: Operations Research
GPA: 8.66/10 (Overall)

Maharishi Vidya Mandir, Chennai, Tamil Nadu, India
Class XII, Central Board of Secondary Education — *May' 12 - May' 14*
Percentage: 96.6% , Marks: 483/500

JSS International School, Ooty, Tamil Nadu, India
Class X, Central Board of Secondary Education — *May' 10 - May' 12*
GPA: 10/10

Awards & Achievements

Awarded the **Merit cum Means Scholarship** for undergraduate study at **IIT Madras**
Secured an **All-India-Rank of 5973** in JEE Advanced 2014 amongst 150,000 candidates
Secured an **All-India-Rank of 897** in JEE Mains 2014 amongst 15,00,000 candidates
Awarded **INSPIRE Scholarship of 4 lakhs** for securing top 1% in **CBSE SSCE 2014**
Placed in top 10% of the **National Standard Exam in Physics** conducted by IAPT in 2013
Awarded the **Best Outgoing Student** by JSSIS for academic and co-curricular excellence

Professional Experience

Bosch Limited, Diesel Systems - Engineering of Advanced Tech — *Dec '17 - May '18*
Mr. Jeemon PK — *Research Intern*

- Developed a powertrain analysis methodology and evaluated eight hybrid electric powertrain topologies based on fuel efficiency, reduction in emissions, cost and feasibility
- Designed a hybrid powertrain with 40% reduction in fuel consumption for a 3-wheeler vehicle
- Developed Fuzzy Logic, Dynamic Optimization and Rule Based Energy Management Strategies for the powertrain to obtain the maximum possible fuel consumption reduction

Department of Engineering Design, IIT Madras — *Jun '18 - Present*
Prof. Shankar Ram — *Graduate Teaching Assistant*

- Working as a teaching assistant to Prof. Shankar Ram for the course 'ED5160 - Fundamentals of Automotive Systems' which is an entry level graduate course in Engineering Design
- Assisting the Professor in grading and reviewing assignment materials and submissions

Research Projects

Autonomous Lane Keeping Assist Hardware in Loop Simulation — *Jul '18 - Present*
Thesis Advisor : Prof. Shankar Ram — *Master's Thesis*

- Working on setting up multiple sensors based simulation pipeline with IPG Carmaker and the Hardware in Loop (HiL) system to build autonomous driving models
- Future work includes testing of Reinforcement Learning algorithms for Autonomous Driving

Obstacle Avoidance Motion Planning for Autonomous Vehicles *May '17 - Jul '17*
Project Advisor : Prof. Shankar Ram *Research Intern*

- Implemented a modified Hybrid A* grid search algorithm to plan a path which circumvents obstacles and reaches the goal position given the local map and vehicle constraints
- Simulated the 46 possible Reeds Shepp optimal paths between a starting and a goal pose with forward and reverse motion capabilities

Academic Projects

Vehicle Parameter Identification using DoE *Jul '17 - Nov '17*
Advisor : Prof. R Krishna Kumar *Course : Vehicle Dynamics Lab*

- Simulated vehicle handling tests in IPG Carmaker to study the effect of handling parameters
- Designed experiments using Taguchi's DoE method to simulate minimum number of tests and get maximum inference about the extent of influence of the parameters studied

Feedback Controller Design for Vehicle Subsystems *Jul '17 - Nov '17*
Advisor : Prof. Shankar Ram *Course : Control of Automotive Systems*

- Devised a control law for active suspension system to minimise vehicle roll using LQR
- Explored the efficacy of PID and LQR controllers for the vehicle steering system to track a given trajectory with minimum lateral and orientation errors

Microfluidic Touch Sensors Based on Mimosa Pudica *Jan '17 - May '17*
Advisor : Prof. Savio Sebastian *Course : Biomimetic Design*

- Conceived a novel idea for a touch sensor based on microfluidics inspired from Mimosa Pudica
- Ideated a mechanical sensor system with serpentine fluid channels that can sense a loss of pressure and hence locate an input similar to the plant's mechanosensory response to touch

Leapfrog Algorithm for Optimal Control of a Mobile Robot *Jan '17 - May '17*
Advisor : Prof. Arun Mahindrakar *Course : Optimal Control Theory*

- Formulated an energy optimal control problem for a non-holonomic differential drive robot
- Performed numerical integration using Leapfrog Algorithm to solve the boundary value problem and obtain the trajectory with the least control energy

Emergency Stair Mechanism for Electric Railway Coaches *Jan '17 - May '17*
Advisor : Prof. Sandipan Bandyopadhyay *Course : Product Design Lab II*

- Designed and prototyped a retractable emergency stair mechanism with a four bar linkage in collaboration with the design team of ICF (Integral Coach Factory)
- Analysed the kinematics of the four bar linkage which has a straight line as a coupler curve and performed stress and strain analysis on the CAD model

Ergonomic Lumbar Support Design for Driver Seats *Jul '16 - Nov '16*
Advisor : Prof. Venkatesh Balasubramaniam *Course : Human Factors in Design*

- Conducted a small scale consumer survey and identified the effects of prolonged driving on musculoskeletal and thoracolumbar disorders
- Designed a modular lumbar support cushion for driver seats which accounts for the curvature of the spinal cord

Model Predictive Control and State Estimation *Jul '16 - Nov '16*
Advisor : Prof. Raghunathan Rengaswamy *Course : Modern Control Theory*

- Implemented Model Predictive Control and Extended Kalman Filter to perform state estimation and control of the non-linear model of Fluidized Catalytic Cracker (FCC)
- Investigated the effect of hyper parameters like cost coefficients, initial state, process and noise co-variance on the performance of Model Predictive Controller for FCC system

Arduino Controlled Path Tracking and Memorization *Jan '16 - May '16*
Advisor : Prof. Ganapathy K *Course : Microprocessors & Microcontrollers*

- Built a robot that follows a line using an array of IR sensors and memorises the path traced and retraces the same path on a drawing sheet with a pen
- The robot was built using an Arduino Uno, servo motors and a 3D-printed chassis

Skills

Programming: MATLAB, Python, Mathematica, C++, LaTeX, Simulink, Arduino
Softwares: Autodesk Inventor, Solidworks, IPG CarMaker, ABAQUS, Adobe PhotoShop
Languages: English (Proficient), Tamil (Proficient), Hindi (Limited), German (Limited)

Coursework

Adaptive & Optimal Control, Reinforcement Learning, Modern Control Theory, Vehicle Dynamics, Automotive Structures Control of Automotive Systems, FEM for Design, Biomimetic Design, Machine Learning for Science, Advanced Operations Research, Computer Simulation, Field & Service Robotics, Product Design Lab, Controls Lab, Mechatronics Lab

Positions of Responsibility

Coordinator, **Institute Placement Team, IIT Madras** *May '16 - May '17*
Strategist, **Extra Mural Lectures, IIT Madras** *Jun '15 - May '17*
Graphic Design Coordinator, **Saarang 2016** *Jun '15 - May '16*

Extra Curricular Activities

- Secured 2nd place in Manual Robotics and 3rd place in Aquatic Robotics in TechSoc (Inter Hostel Technical Competition of IIT Madras) and contributed to attaining overall 2nd position
- Basketball - Member of NSO, IITM Chapter
- Won 1st place in the district level art and collage competitions held in Niligiris, Tamil Nadu
- Plectrum Guitar Grade 2 Trainee, Trinity College, London, Passed with Distinction