

Dr. Vilas K. Chitrakaran, Ph.D., C.Eng. (MIET)

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About

I engineer robots and autonomous systems for manufacturing, nuclear, aerospace, defense and consumer electronics applications. I lead engineers working on the edge of chaos and ambiguity.

Areas of Expertise

- **Product development:** Full lifecycle from concept (TRL1) to product (TRL8).
- **Leadership:** Technology strategy, fundraising, people operations.
- **Robotics:** Distributed real-time control architectures for large industrial robotic fleets; kinematic and dynamic modeling of articulated arms, legged robots and wheeled robots; algorithms for localisation and navigation of autonomous vehicles; design of command and control systems, human-machine interfaces; immersive 3D visualization and simulation systems; machine vision.
- **Tools and Technologies:** Multi-paradigm software design - C++23, Python, Rust; distributed systems - Zenoh, DDS; algorithm prototyping - MATLAB, ROS, OpenCV, PCL; graphical system design - Vulkan, Qt; OS/RTOS kernel programming - Linux, QNX Neutrino; code compliance - MISRA, JSF AV Rules; safety - ISO26262, ISO13482, ANSI/ITSDF B56.5.

Professional Experience

- **Principal Roboticist, Software Team Lead** *Sep. 2023 - present*
All3, London, United Kingdom
- **Principal Roboticist, Software Team Lead** *Aug. 2018 - Sep. 2023*
Arrival, London, United Kingdom
 - Conceived the software architecture for Arrival's industrial mobile robot fleet, a distributed system of hundreds of robotic agents working as one to deliver a vision of flexible (software-defined) manufacturing.
 - Nurtured a diverse, globally distributed, high-performing software team that built the above.
 - Formulated standards and procedures that enabled us to deliver fortnightly into the production environment.
 - Provided consultancy services to successfully transfer above technology to one of the largest automotive companies on Earth.
- **Senior Systems Engineer** *Apr. 2017 - Jul. 2018*
Intelligent Robots Limited, London, United Kingdom
 - Directed concept research and systems engineering towards “the world’s simplest conveyor robots” for intra-logistics.
 - Won a competitive funding grant from Innovate-UK to develop a prototype for commercial validation.
 - My team delivered. However, the company did not succeed. Hardware is hard!

- **Senior Robotic Algorithms Engineer**
- **Robotic Algorithms Engineer - Advanced**
- **Robotic Systems Engineer**

Aug. 2015 - Mar. 2017

Jan. 2015 – Jul. 2015

Sep. 2013 – Dec. 2014

Dyson, Malmesbury, United Kingdom

- Member of the team that delivered the Dyson 360 Eye robot, their first commercial robotic vacuum cleaner. Improved robustness of its visual navigation system in the areas of camera calibration, high dynamic range omni-directional imaging, illumination system, localisation and mapping system. Product improvements were data-driven, based on extensive user trials and lab tests.
- Delivered a high precision embedded visual-inertial odometry system for next-generation floor-care robots.
- Delivered a motion tracking lab, from requirements specification to commissioning.
- Brought mature academic research into commercial products.
- Influenced large vendors to align their product development with the needs of our business.
- Represented the business at trade shows and external events.

- **Senior Software Engineer**

Sep. 2012 – Sep. 2013

Guidance Navigation Limited, Leicester, United Kingdom

- Affiliated with Guidance's Innovation Center, I worked closely with leading researchers at Oxford University's Robotics Institute to transfer their natural feature navigation technology to Guidance, an activity of strategic importance to the company.
- Developed design specifications for a driverless control system for a manual fork-lift truck. BS-EN 1525:1998 standard (Safety of Industrial Trucks. Driverless Trucks and Systems) provided the basis for this work, given the requirement for safe operation of the vehicle in human environments.
- Modified mathematical formulation of autonomous navigation algorithms to deliver by performance improvements.
- Visited strategically important customers for on-site product testing and validation.

- **Senior Engineer**

Sep. 2011 – Sep. 2012

Blue Bear Systems Research, Bedford, United Kingdom

- Developed control and payload subsystems of unmanned aerial vehicles for urban ISTAR (Intelligence, Surveillance, Target acquisition and Reconnaissance) operations.
- Collaborated with academic partners to find commercial applications for their research.
- Worked with prime vendors in the defense sector on government-funded projects, one of which was the development of software-based simulators for verification and validation of subsystems on the Long Endurance Multi-Intelligence Vehicle (LEMV).
- Participated in flight trials. Improved efficiency and safety of flight ops by applying my experience as a qualified private pilot.
- Represented the company at air shows and public events to demonstrate our products and capabilities.

- **Senior Systems Engineer**

Oct. 2006 – Sep. 2011

OC Robotics, Bristol, United Kingdom

- As a vision systems specialist, I delivered a variety of tools such as 3D cameras (using the emerging technology of LCoS pico-projectors) and stereo vision systems for surface inspection, localisation and object identification. I specified hardware components such as imagers, optics, video processors, and lighting, and delivered software for image analysis, machine vision and metrology.
- Applied my math-intensive academic background to extend Linear Programming concepts to design a novel model-based gravity compensation algorithm that enhanced the controllability of slender Snake-arm robots operating in highly confined environments.
- As one of only two software engineers in the company at the time, I delivered several human-machine interfaces (HMIs) for customers from a variety of industrial sectors (aerospace, nuclear and defense), each with unique functional and performance requirements. In designing such systems, I applied state-of-the-art research and best practices in Human Factors (e.g. Apple's OSX Human Interface Guidelines, or industry specific standards) to meet specifications for ergonomics, productivity, user-friendliness, and resistance to human errors.
- Snake-arm robots offer capabilities very different from typical industrial robots. I led a team of 3 engineers to deliver *Snake Arm Simulator*, a software-based professional simulation and analysis suite that demonstrated the unique capabilities of Snake-arm robots. My work included the development of requirements specifications for various versions of the product, concept design and design guidance documents for the development team.
- Proposed, designed and delivered a high-value software-based simulator platform for SAFIRE, a bespoke Snake-arm robot to conduct inspections within the Upper Feeder Cabinets of CANDU nuclear reactors. The simulator was used to train inspection engineers, and for mission planning during reactor inspection outages.
- Led a team of engineers and managed the development of a commercial proposal (valued at GBP 6 million) for a novel robotic inspection system for pressure vessels in an 'upstream' natural gas processing plant operated by one of the global oil and gas supermajors. I defined the scope of the project, worked with senior management on risk assessments and costings, directed a junior engineer in generating design options, and presented a comprehensive set of solutions to the customer. This included a proposal for an innovative software product for spatial and temporal geo-tagging of 3D environment models with visual inspection data (images, lidar scans, PDF reports, etc) to capture and archive inspection reports over time.
- Advocated the use of documentation tools, industry standard software development guidelines (JSF AV rules, MISRA C++) and code reviews to ensure high quality standards. The team was audited routinely by external agents for quality and always met ISO/IEC 90003:2004 requirements.

- **Graduate Research Assistant, Mechatronics Laboratory**

Aug. 2000 – Aug. 2006

Clemson University, SC, USA

- Member of the technical team funded under DARPA's *Biodynotics* program to research the application of soft robotic manipulators. As part of a multi-disciplinary team dispersed across multiple universities, I led the electronics and control systems integration for the Clemson Octor bio-mimetic continuum robot. Crucially, I solved the challenge of shape measurement in continuum robots by an innovative application of cable-extension transducers (also called string potentiometers) used in automotive, aerospace and civil engineering industries. (<http://cvilas.github.io/clemson-archive/projects/octor>)
- Key developer of the *Robotic Platform*, an open research and development platform for hard real-time robotic applications. The system integrated multiple robotic functionalities such as closed loop control, trajectory generation, an advanced numerical computation library and 3D visualization

into a single homogeneous platform – a significant achievement at a time when such complex systems were typically implemented in a distributed fashion. (<http://cvilas.github.io/clemson-archive/projects/rp>)

- Extended techniques familiar to the computer vision community towards theoretical development of new types of non-linear controllers and signal estimators using Lyapunov design methods. Applications included vision-based control of micro air vehicles, rigid body motion estimation, and structure-from-motion.
 - <http://cvilas.github.io/clemson-archive/projects/sfm>
 - <http://cvilas.github.io/clemson-archive/projects/landing>
 - <http://cvilas.github.io/clemson-archive/projects/follower>

Education

- **Self Driving Car Engineer Nanodegree** 2018
Udacity
- **Ph.D., Electrical Engineering (Focus: Robotics and Nonlinear Control)** 2006
Clemson University, USA
GPA 3.8/4.0
- **M.S., Electrical Engineering (Focus: Robotics and Nonlinear Control)** 2003
Clemson University, USA
GPA 3.78/4.0
- **B.Eng., Electrical and Electronics Engineering** 1999
University of Madras, India
GPA 85.6/100 (University Silver Medallist)

Additional Qualifications

- Chartered Engineer (CEng), awarded by the Engineering Council, UK, Feb 2016.
- Senior Member, Institute of Electrical and Electronics Engineers (IEEE).
- Flight Crew Licence (expired): JAR-FCL PPL(A) SEP (Land), UK Civil Aviation Authority, June 2010.

Voluntary Service

Co-host, London.Robotics (2019 - 2021): Co-organised a London-based ‘Meetup’ intended as a forum for roboticists working in and around the city to encourage collaboration and learning. See <https://www.meetup.com/london-robotics/>

Executive Team Member, IET Robotics and Mechatronics Network (2015 - 2019): I contributed to, and sometimes led, activities and events for the network, such as public lectures and conferences.

Reviewer (2002 - 2016): I serve (or have served in the past) as a reviewer for many academic publications relevant to my areas of expertise. These include:

- IEEE/ASME Transactions on Mechatronics
- IEEE Transactions on Systems, Man and Cybernetics
- IEEE Transactions on Control Systems Technology
- IEEE Transactions on Robotics
- The International Journal of Robotics Research

Publications

- **Book Chapters:**

- D. Lee, T. C. Burg, V. Chitrakaran, E. Tatlicioglu, and C. Natraj, "Model-based 3D Position and Angle Trajectory-Tracking Control of Underactuated Unmanned Aerial Vehicle," *Numerical Simulation*, Academy Publishing, 2013.

- **Selected Journal Papers:**

- J. Chen, V. K. Chitrakaran, and D. M. Dawson, "Range Identification of Features on an Object Using a Single Camera," *Automatica*, Vol. 47, No. 1, pp. 201 – 206, January 2011.
- V. K. Chitrakaran, D. M. Dawson, W. E. Dixon, and J. Chen, "Identification of a Moving Object's Velocity with a Fixed Camera," *Automatica*, Vol. 41, No. 3, pp. 553 – 562, March 2005.
- M. S. Loffler, V. K. Chitrakaran, and D. M. Dawson, "Design and Implementation of the Robotic Platform," *Journal of Intelligent and Robotic Systems*, Vol. 39, No. 1, pp. 105 – 129, January 2004.

- **Theses:**

- Vilas K. Chitrakaran, "Lyapunov-Based Nonlinear Estimation and Control Using Vision in the Loop," *Ph.D. Thesis*, Dept. of Electrical and Computer Engineering, Clemson University, August 2006.
- Vilas K. Chitrakaran, "The Robotic Platform – Implementation of the Manipulator Classes and the Math Library," *Master's Thesis*, Dept. of Electrical and Computer Engineering, Clemson University, December 2002.

- **Selected Conference Papers:**

- V. K. Chitrakaran, and D. M. Dawson, "A Lyapunov-Based Method for Estimation of Euclidean Position of Static Features Using a Single Camera", *Proc. of the 26th American Control Conference*, pp. 1988-1993, July 2007.
- H. Kannan, V. K. Chitrakaran, D. M. Dawson, and T. Burg, "Vision-Based Leader/Follower Tracking for Nonholonomic Mobile Robots," *Proc. of the 26th American Control Conference*, pp. 2159-2164, 2007.
- V. K. Chitrakaran, D. M. Dawson, H. Kannan, and M. Feemster, "Vision Assisted Autonomous Path Following for Unmanned Aerial Vehicles," *Proc. of the 45th IEEE Conference on Decision and Control*, pp. 63-68, Dec. 2006.
- V. K. Chitrakaran, D. M. Dawson, J. Chen, and H. Kannan, "Velocity and Structure Estimation of a Moving Object Using a Moving Monocular Camera," *Proc. of the 25th American Control Conference*, pp. 5159-5164, June 2006.
- W. McMahan, M. Pritts, V. Chitrakaran, D. Dienno, B. Jones, M. Grissom, M. Csencsits, V. Iyengar, I. Walker, C. Rahn, and D. Dawson, "Field Trials and Testing of the Octarm Continuum Manipulator," *2006 IEEE International Conference on Robotics and Automation*, pp. 2336-2341, May 2006.
- V. K. Chitrakaran, D. M. Dawson, J. Chen, and M. Feemster, "Vision Assisted Autonomous Landing of an Unmanned Aerial Vehicle," *Proc. of the 44th IEEE Conference on Decision and Control*, pp. 1465-1470, Dec. 2005.
- V. K. Chitrakaran, D. M. Dawson, J. Chen, and W. E. Dixon, "Euclidean Position Estimation of Features on a Moving Object Using a Single Camera: A Lyapunov-Based Approach," *Proc. of the 24th American Control Conference*, pp. 4601-4606, June 2005.