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Summary

18+ years of experience building algorithms that control & optimize economics for the systems ranging from virtual power plants, home batteries, wind turbines, hybrid vehicles and trains with electric propulsion. Proven track record of disruptive innovation, nurturing ideas from inception to production and technical leadership. 13 patents with 9 currently active. Passionate about impact, sustainable energy, tapping/growing early-stage ideas and a firm believer in first principles approach. Strong background in optimization, modelling, software design, model based control algorithms.

Launched & operated the very first virtual power plant of thousands of homes in Texas energy markets. Contributed to the production code in Python or Simulink that is running on the fleet of GE wind turbines, Tesla Powerwalls and on cloud services such as Autobidder, Lifespan. and invented smart algorithms such as *WindBoost*, control for twist, extreme-event-controls, pitch bearing health prognostics, fatigue aware controls which directly reduced the cost of wind energy. Wrote custom-built non-convex optimizers which reduced the pay-back period for home-owners with solar & storage.

Industry Experience

Since *2022:* **Tesla Energy**, *Palo Alto, CA* as a staff algorithms engineer.

- As a part of Tesla Autobidder team, launched and operated the very first pathbreaking virtual power plant (VPP) in Texas that aggregates solar & battery energy from thousands of homes & and bids them into day-ahead and real-time energy markets, and is dispatched via SCED commands. This unlocked energy market revenues for home solar, similar to large generators, and allowed Tesla customers to become their own utility, save up to $1100 per home per year and zero out their energy bills as they helped the grid during times of scarcity and high prices during hot Texas summer.
- One of two engineers, who built all energy trading algorithms that support this VPP 24/7. These are based on the opportunity cost concept and ensure the least cost dispatch of customer assets. Built in-house custom non-convex dyn-programming based solver, developed from scratch, to deliver heuristic-free optimization that directly minimizes the cost to serve despite price & load uncertainty.

2017:2022 **GE Renewable Energy**, *Schenectady, NY* as a senior control systems engineer.

- Led a new technology product and team to develop on-turbine accurate odometers for fatigue-critical components. Developed apps at the windfarm edge to use such odometers for more energy/life/revenue with less variation, shear estimation, prognostics and feedback for wind turbine design.
- Led a new technology project to recover up to 2% energy loss, or approximately 200k$ revenue loss per turbine, due to blade twisting as it causes deviation from the optimal angle of attack near tip. Managed the whole lifecycle from an idea to eventual integration into blade, aero, controls design, implementation and validation of this technology into five new turbine platforms, including 5MW Cypress turbine, the largest onshore turbine launched in 2019.
- Proposed a correction for a decades old error in Kalman filter implementation within all commercial control design softwares. This correction was accepted and implemented in Matlab control systems toolbox in 2015, and can dramatically improve bandwidth of unknown input estimation for systems with direct feed-through. Applied it to improve thrust estimation in wind turbines and published the same in IEEE control systems magazine.
- Invented an analytic and created a data product to sense degradation of pitch bearings using Tableau. Pitch bearings are critical to the reliability and project economics as they are costly to

[1] security-constrained-economic-dispatch

replace. Led a team to scale it up for fleetwide coverage on more than 40k wind turbines. This enabled early detection, root cause analysis, severity based prioritization and timely actions which extend the bearing life. Saved business $5MM each year in cost of quality by avoiding unscheduled crane hire and unnecessary bearing exchanges. Worked directly with site managers, technicians and engineers to continuously refine the analytic.

- Faced with the lack of critical diagnostic data, proposed and led a project and created a data product to measure integrity of data pipeline across whole of GE fleet and ensure timely feedback and correction. This closed a longstanding gap in quality assurance by generating expected channel list through text mining of control software. Created similar dashboards to measure quality metrics for operability engineering to analyze faults from fleet and use it for feedback & continuous improvement.

2012-2016 **GE Global Research**, *Niskayuna, NY* as a lead control systems engineer.

- Designed key algorithms within *extreme event controls* software update for GE wind turbines, which optimized turbine operation at constraint boundaries. Algorithm for overspeed constraint reduced overspeed driven shutdowns by more than 90%. Algorithm for tower loads constraint reduced tower loads by more than 10%, which directly helped lower the cost of energy for new designs.
- Worked on wind turbine control design using advanced Lidar sensors, blade sensors and multiple actuators per blade. This helped quantify entitlement from these technologies as well as optimize configuration such as sensor locations and beam count. Applied dynamic programming to design power-optimal yaw control algorithms, as well as state-of-charge optimization for integration of wind and storage.
- Developed a coupled linear parameter varying model from the first principles of aerodynamics and mechanics, that can improve fidelity of wind turbine estimation. Showed that such model could be used to estimate blade effective wind speed, localized gusts and complex sheared inflow, previously thought to be impossible.
- Worked with GE Healthcare on the stability proof of a fuzzy logic anesthesia control system. This led to a FDA approval, needed for an eventual product launch in USA.
- Worked with GE Oil and Gas on control design for magnetic bearings for offshore gas compressor. Developed novel grey-box identification techniques and proved the feasibility of stable operation at speed higher than the first natural bending mode of shaft on a small scale prototype.

2009-2012: **Clipper Windpower Inc.**, *Carpinteria, CA* as a senior control systems engineer.

- Led a lean team of engineers and consultants to continuously improve control algorithms running on 700+ fleet of 2.5MW wind turbines. These improved stability, energy capture, loads reduction and grid compliance. Created one of the first fleet-level data mining tools to generate site specific turbine health reports for various anomaly vectors based on hypotheses testing. Created an efficient and scalable process to get such reports in hands of site supervisors and enable corrective actions at source.
- Designed windfarm controller, a new product for Clipper. Improved power set-point tracking bandwidth by 5x. Redesigned the response during heavily yawing winds to decrease number of shutdown and unavailable time by more than 90%. Field validated the improved yaw control algorithm which decreased yaw activity by more than 80%. Developed adaptive coherence detection schemes from Lidar data to identify and mitigate extreme gusts. This IP was later acquired and filed by GE.

2002-2004: **GE Global Research**, *Bangalore* as a *Edison* engineering leadership program candidate

- Designed an intelligent power uprate algorithm for wind turbines to boost power beneign winds. This was commercialized as the successful *WindBoost* product offering. Built several stochastic spectral models to generate realistic wind for the load testing. Authored the user manual for Flex5, a wind turbine load testing software.
- Designed algorithms to maximize the traction on a train engine, and validated them on a track. Designed and built a 2 disk adhesion test rig for empirically determine wheel-rail traction vs. slip curve including the unstable backside.

Summer Internships

2008: **Ford Research***, Dearborn, MI*; "Implementation of energy management controller based on the shortest path stochastic dynamic programming, on a parallel hybrid electric vehicle"

2006: **GE Global Research***, Niskayuna, NY*; "Hardware in the loop prototyping for a novel tactile actuator for a medical ventilator using Labview-RT"

Education

Ph.D., M.S., Mechanical and Aerospace Engineering, Dec 2009, University of California at San Diego,
Thesis: Developed semidefinite programming based pruning algorithms for a novel curse-of-dimensionality-free method of solving HJB PDE. This made solving high dimensional dynamic programming based optimization feasible for the first time. Analyzed the error incurred due to approximations in this method, and obtained rigorous error bounds for same. As a special case of above PDE, discovered analytical fundamental solution for the time-varying differential Riccati equation, based on max-plus algebra. This unified all previously known solution methods and improved convergence rate.

B.Tech., Mechanical Engineering, May 2002 Indian Institute of Technology, Mumbai, India.

Honors

- *Technical Achievement awards* for design of extreme event controls within GE, pitch bearing health sensing and data integrity assurance.
- *Outstanding commitment award* for driving control design excellence within Clipper windpower.
- Within top 30 candidates in Indian National Math Olympiad in 1997 and 1998.

Publications

Journal Papers

A.S. Deshpande. Bridging a gap in applied Kalman filtering: Estimating outputs when measurements are correlated with the process noise [focus on education]. *IEEE Control Systems*, 37(3):87–93, June 2017.

A.S. Deshpande. Max-plus representation for the fundamental solution of the time-varying differential Riccati equation. *Automatica*, 47(8):1667 – 1676, August 2011.

W.M. McEneaney and A.S. Deshpande. Payoff suboptimality and errors in value induced by approximation of the Hamiltonian. *SIAM Journal on Control and Optimization*, 51(5):3993–4015, Oct 2013.

Conference Papers

A.S. Deshpande and R.R. Peters. Wind turbine controller design considerations for improved wind farm level curtailment tracking. In *Power and Energy Society General Meeting, 2012 IEEE*, pages 1 –6, July 2012.

W.M. McEneaney, A.S. Deshpande, and S. Gaubert. Curse-of-complexity attenuation in the curse-of-dimensionality-free method for HJB PDEs. In *American Control Conference (ACC)*, pages 4684–4690, June 2008.

W.M. McEneaney and A.S. Deshpande. Payoff suboptimality and errors in value induced by approximation of the Hamiltonian. In *IEEE Conference on Decision and Control (CDC)*, pages 3175–3180, Dec 2008.

W.M. McEneaney and A.S. Deshpande. Payoff suboptimality in controls generated by approximation of the Hamiltonian in the HJB PDE. In *International Symposium on Mathematical Theory of Networks and Systems, (MTNS).*, July 2008.

Patents

9 granted & active, 1 pending, 3 abandoned.

- *Methods and systems to operate a wind turbine system using a non-linear damping model.* #US9587629B2, led to the tower loads reduction within extreme event controls.
- *System and method for operating a wind farm under high wind.* #US8649911B2, this started the *GE WindBoost* service.
- *Methods and systems to operate a wind turbine system.* #US10100812B2, led to dramatic reduction in overspeed trips fleetwide.
- *Method to estimate wind coherence online and control algorithm for reacting to large damaging coherent wind structures*, #US9926912B2.
- *Method to estimate spatial windfield variation on wind turbines*, #US10047722B2.
- *High bandwidth tower deflection and stress estimator for wind turbines.* #US10774810B2, a first in industry to enable tower loads monitoring without strain gauges.
- *Method of controlling a torsionally flexible blade for maximum power*, #US10808681B2.
- *Odometer based control of a wind turbine power system*, #US11661919B2.
- *System of operating a wind turbine using cumulative load histograms based on actual operation*, #US11635060B2.
- *Use of pitch motor signals for bearing anomaly detection*, #US20230003192A1.
- *Load Mitigation During Extreme Yaw Error on a Wind Turbine*,#US20120009062A1.
- *Temporary uprating of wind turbines to maximize power output*, #US20140288855A1.
- *Methods and systems for feedforward control of wind turbines*, #US20180003154A1.