Chethan Ramakrishna Reddy

Mechatronics Engineer

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Education

- **Michigan Technological University** — Houghton, MI, USA
  PhD in Mechanical Engineering — *2016 - Present*
- **National Institute of Technology Karnataka** — Surathkal, India
  MTech (MS equivalent) in Mechatronics Engineering — *2011 - 2013*
- **Visvesvaraya Technological University** — Belgaum, India
  BE (BS equivalent) in Mechanical Engineering — *2007 - 2011*

Educational Details

1. PhD at Michigan Technological University – Transcript
   - **CGPA (so far) – 3.77/4.00**
   - **Expected to graduate in Dec 2021**
   - Co-advised by **Dr. Mahdi Shahbakhti** and **Dr. Rush D. Robinett III**
   - Research focus –
     Model Predictive Control of Energy Systems for Heat and Power Applications
   - Key courses:
     - Fall 2016
       * Introduction to Propulsion Systems for Hybrid Electric Vehicles – GPA 4/4
       * Internal Combustion Engines II – GPA 3.5/4
         Project: Effect of External Supercharging in a CI Diesel Engine with Swirl Combustion Chamber – Validation of experimental result in simulation (Tool GT-Suite).
       * Principles of Energy Conversion – GPA 4/4
         Project: Efficacy of PV Solar Energy in Houghton, MI – Study on technical and economic feasibility (break even time).
     - Spring 2017
       * Advanced Propulsion Systems for Hybrid Electric Vehicles – GPA 4/4
         Project: Fuel Consumption Reduction Technologies and Hybrid design – A study on the impact of engine downsizing, aerodynamic drag reduction, tire rolling resistance reduction, start-stop technology, and a rule-based parallel hybrid strategy on fuel consumption using a simulation model parameterized to a production vehicle in Matlab/Simulink.
       * Engineering Research Communications – GPA 4/4

    * Distributed Embedded Controls – GPA 3.5/4
      Project: Control-System for a Hybrid ECU (MotoTron ECU) – Control system built for a parallel HEV using model-based embedded control system design approach. (Tools: Matlab/Simulink and MotoHawk tool-chain).
  - Fall 2017
    * Linear Systems Theory & Design – GPA 3.5/4
    * Decentralized Control of Large-Scale Systems – GPA 4/4
      Project: Decentralized Model Predictive Control (MPC) for Thermal Control of Buildings – A study to showcase the advantages and disadvantages of decentralized MPC over centralized MPC for thermal control of an office building at Michigan Technological University.
  - Spring 2018
    * Optimization I – GPA 4/4
      Project: Optimal Control of Wave Energy Converters – Converting an optimal predictive control problem of a typical wave energy converter to a linear parameter varying (LPV) problem and getting the optimal input predictions.
    * Non-linear systems analysis and control – GPA 3.5/4
  - Fall 2018
    * Research only mode.
  - Spring 2019
    * Internship/co-op at Halla Mechatronics.
  - Fall 2019
    * Research only mode.
  - Spring 2020
    * Research only mode.
  - Fall 2020
    * Research credits.
  - Spring 2021
    * Research only mode.
  - Fall 2021
    * Research only mode.

2. MTech at National Institute of Technology Karnataka – Transcript

   - **CGPA: 8.37 / 10, US equivalent CGPA: 4.00 / 4.00**
   - Laboratory overview (Apr 2013)
     - Three day laboratory (Automotive Electronics lab, sponsored by RBEI) overview to fellow graduate students
   - Mini Project: Rotary Encoder using an 8051 Micro-Controller
     - Aim of the project was to reduce the cost of available rotary encoders
     - An incremental rotary encoder was designed and built using a stepper motor
     - Every step by the stepper motor gives a pulse, which was amplified and fed into the micro controller
     - The micro controller was programmed to show the angle turned by the stepper motor by an LED and an LCD display

- MTech project/thesis:
  Development of Automotive Thermoelectric Generator (ATEG) – Thesis
  - Aim of the project was to recover waste heat energy from the exhaust of an Internal Combustion (IC) engine driven automobile and convert a part of it to electricity (useful form of energy) by the thermoelectric or Seebeck effect.
  - Project involved a detailed simulation model built in MATLAB/Simulink environment and an overview on the control strategy to realize ATEG. Model validation was done by giving the model inputs from the engine test bench data (measurements).
  - Future activities involved the demonstration of Waste Heat Recovery by thermoelectric generator on a test vehicle.

3. BE at Visvesvaraya Technological University – Transcript
   - **Grade – 73.18%, US equivalent CGPA: 3.73 / 4.00**
   - Head of the Print media team for Mechanical Engineering Department (2009-2011)
     - Responsible for writing columns related to events in the department and send to print media.
   - Final semester project: **Design and Fabrication of Boundary Layer Turbine as a Potential Automotive engine (Compressed Air as Fuel)** –
     Report
     - Based on invention by Nikola Tesla in early 20th century
     - The project involved design and analysis of a rotary boundary layer turbine to drive an automobile
     - This was a low torque engine which could rotate at speeds towards the fluid inlet velocity
     - Compressed air was used (upwards of 10 bar) and the engine output was tested at each input fluid pressure
     - The problem of low torque was tackled by inletting compressed air at a high velocity so that the shaft output speed was high (rpm), the engine shaft was then geared down at the wheels to maintain sufficiently high torque
     - Storage of compressed air fuel required a very large tank to obtain a reasonable range
     - The solution proposed was to have an on-board compressor which kicked in at a threshold rpm (when the engine has enough power to drive the compressor and the automobile), thus increasing the range for smaller storage tanks.

Work Experience

1. **Research Assistant – Michigan Technological University** Houghton, MI, USA
   Energy Mechatronics Laboratory *May 2017 - Present*
2. **Teaching Assistant – Michigan Technological University** Houghton, MI, USA
   Mechanical Engineering – Engineering Mechanics Department *Aug 2019 - May 2020*
3. **Automotive Controls Intern – Halla Mechatronics** Bay City, MI, USA
   Modeling & Simulation in the Motor Controls Group *Jan 2019 - May 2019*
4. **Teaching Assistant – Michigan Technological University** Houghton, MI, USA
   Mechanical Engineering – Engineering Mechanics Department *Aug 2017 - Dec 2018*

5. **Senior Engineer – Robert Bosch India** Bangalore, India
Simulation Expert in the System Engg. Group (Hybrid Systems and E-Mobility) *Oct 2015 - Aug 2016*
6. **Engineer – Robert Bosch India** Bangalore, India
Modeling & System Simulation Group *Aug 2013 - Sep 2013*
7. **Intern – Robert Bosch India** Bangalore, India
Plant Modeling Support & My Masters Thesis *Jun 2012 - Mar 2013*
8. **Teaching Assistant – National Institute of Technology Karnataka** Surathkal, India
Mechanical Engineering Department *Jan 2012 - May 2012*

Work Details

1. Research Assistant at Michigan Technological University
   - Research in the Energy Mechatronics Laboratory at Mechanical Engineering - Engineering Mechanics department.
   - Research on **Model Predictive Control of (i) Building HVAC System with Solar Energy Integration, and (ii) Internal Combustion Engine with Waste Heat Recovery.**
2. Teaching Assistant at Michigan Technological University
   - Lab instructor for two courses handling a total of about 45 students (3 Laboratory sessions) in Fall 2019 & Spring 2020 terms. The first course focuses on dynamics and control of mechanical systems, the second course focuses on introductory manufacturing processes. Both courses consist mostly of senior undergraduate students in Mechanical engineering.
   - Student reviews of 3.71/5 for Fall 2019.
3. Automotive Controls Intern at Halla Mechatronics
   - Internship task was to model, validate and simulate a vehicle with electrically assisted power steering (EPS) system developed by Halla Mechatronics.
   - The vehicle dynamics was modeled in CarSim. The proprietary EPS system along with the EPS controller of Halla Mechatronics was modeled in Matlab and Simulink.
   - The objective was to co-simulate the plant model with the controller model in order to simulate test cases to understand the controller and vehicle behaviour.
4. Teaching Assistant at Michigan Technological University
   - Lab instructor for about 45 students (3 Laboratory sessions) in Fall 2017, Spring 2018, and Fall 2018 terms. The course focuses on dynamics and control of mechanical systems, and consists mostly of senior undergraduate students in Mechanical engineering.
   - Student reviews of 3.97/5, 4/5, and 3.98/5 for Fall 2017, Spring 2018 and Fall 2018, respectively.
5. Senior Engineer at Robert Bosch India – Service letter

- Active Noise Cancellation and Enhancement – The aim was to develop a product for automobiles (two wheelers, passenger cars, off road vehicles etc.) capable of cancelling or enhancing sound at the exhaust of the vehicle. This is achieved actively. We cancel sound if the vehicle exhaust is too loud or enhance it to make a passenger car sound like a F1 car (for ex). I was responsible fully on the technical implementation of the project (from vehicle noise measurement, mechanical setup of sensor and actuator to electronic control unit development). I was successfully able to develop two demonstrators on test vehicle (a two-wheeler). One with a pure static analog hardwired solution for active noise cancellation and an adaptive software solution for cancellation/enhancement both (a switch to opt either of the two). The software tools I used for this project are MATLAB/Simulink and DSPACE MicroAutoBox 2 (rapid prototyping electronic control unit (ECU)).
- Bosch Boost Recuperation System (BRS) Simulation – BRS is an advance system for mild hybrid and CO2 reduction by Bosch, one step ahead of conventional start/stop systems. It provides start/stop, coasting, brake recovery and also boosting using a controller and an electrical machine (acts as a motor and also generator) coupled to the Engine. BRS is typically a 48 Volt system (i.e. consisting of a 48 Volt electrical machine) in developed markets like the Europe and America but for emerging markets such as India, a 12 Volt BRS (i.e. consisting of a 12 Volt electrical machine) is more appropriate due to cost and smaller Engines. So, my task was to develop both the control (mainly because control strategies for European and Indian market will be markedly different) and plant model to analyze the advantages of a 12 Volt BRS and 48 Volt BRS for Indian market and the different vehicle segments of the Indian market. One more important task in this project was to validate the pros and cons of using a Supercapacitor/Ultracapacitor/Hybrid-Supercapacitor as an alternate ESS (Energy Storage System) to the Li-Ion Battery for Indian Market. This work was done partly in GT-Suite and partly in MATLAB/Simulink.
- Automobile Waste Heat Recovery using Thermoelectric Generators This is mainly a self-initiation project. In addition to the work I had done during my internship at Bosch, I have further built competency, interacted with thermoelectric generator manufacturers, studied use cases in the Automotive domain, and demonstrated a use case on a two-wheeler.

6. Engineer at Robert Bosch India

   - HIL Plant Model Development – A Hardware in Loop setup (HIL) contains a control model (to be tested in its target hardware) and a plant model. My role was in developing, calibrating, and generate code of the plant model (in this case an Automobile) in MATLAB/Simulink.
   - Model-Based Testing – The aim of this project was to develop control model in a simulation environment (MATLAB/Simulink) and then generate code out of it. Testing and validation (of the control logic) is done, by Model in Loop testing (MIL - integrating the control model with plant model and testing by feeding the model with standard test cases) and Software in Loop testing (SIL - generating code out of the control model and integrating it with the same plant model and feed the co-simulation model with standard test inputs), in the development phase itself thus saving time and resources. I was responsible for all the technical implementation for this pilot project.
   - Model-Based Design & Calibration – There are two aims with this project, they are
     - Built highly accurate plant models and use it to pre-calibrate the Maps/Tables in an Electronic Control Unit (ECU)
     - Built highly accurate plant models and use it to make design decisions (for ex: how big a component is required? How best to connect it? etc.)

     The outcome of this project is lesser dependency on Test Bench, faster time to market; leading to cost savings. The project is carried out in GT-Suite and MATLAB/Simulink.

- Virtual Hardware – The aim of this project is to be able to model/simulate the whole embedded system in a PC environment. That includes an accurate microcontroller model (purchased for microcontroller manufacturers), ASIC models (usually the electrical drivers), control model (software inside the microcontroller) and plant model (to give various sensor and receive actuator signals from the control model). The use case of this pilot project will benefit the organization in time, money and resources. My role was to completely develop and validate the plant model. This included calibrating the model to the use case, develop missing models and validate the same with integrating with the rest of the system. MATLAB/Simulink was used to develop, calibrate and generate code out of the model.

7. Intern at Robert Bosch India – Certificate

    - Practical Training – Report
        - Built a Stepper Motor interface model (MATLAB/Simulink environment) as an Idle Air Control Actuator for a Fuel Injected Gasoline I.C. Engine
        - Modeled and simulated a complete Air Intake system (including cylinder breathing dynamics) considering a Gasoline 2-cylinder Engine – in MATLAB/Simulink environment.
    - MTech project/thesis – Please see education details

8. Teaching Assistant at National Institute of Technology Karnataka

    - Lab instructor for about 60 students (3 Laboratory sessions) in Fall 2012 term. The course focuses on computer aided engineering drawing of mechanical systems, and consists mostly of junior undergraduate students in Mechanical engineering.

Publications

- **C. R. Reddy**, V. B. Vinhaes, R. D. Robinett III, J. D. Naber, M. Shahbakhti, **'Model Predictive Control of a Waste Heat Recovery System Integrated with a Dual Fuel Natural Gas-Diesel Engine'**, in 2021 IEEE American Control Conference. Link
- M. Toub, **C. R. Reddy**, R. D. Robinett III, M. Shahbakhti, **"Integration and Optimal Control of MicroCSP with Building HVAC Systems: Review and Future Directions"**, in Energies, Volume 14(3), pp.730, 2021. Link
- **C. R. Reddy**, M. Shahbakhti, R. D. Robinett, and M. Razmara, **"Exergy-wise predictive control framework for optimal performance of MicroCSP systems for HVAC applications in buildings"**, in Energy Conversion and Management, Volume 210, pp.112711, 2020. Link
- M. Toub, **C. R. Reddy**, M. Razmara, M. Shahbakhti, R. D. Robinett III, G. Aniba, **"Model-based predictive control for optimal MicroCSP operation integrated with building HVAC systems"**, in Energy Conversion and Management, Volume 199, pp.111924, 2019. Link
- **C. R. Reddy**, M. Shahbakhti, M. Razmara, R. D. Robinett III, **"Optimal Exergy-wise Predictive Control for a Combined MicroCSP and HVAC System in a Building"**, in 2019 IEEE American Control Conference. Link

- **C. R. Reddy**, M. Toub, M. Razmara, M. Shahbakhti, R. D. Robinett, G. Aniba, **"Modeling and Optimal Control of Micro-CSP and a Building HVAC System to Minimize Electricity Cost"**, in 2018 ASME Dynamic Systems and Control Conference. Link

- M. Toub, **C. R. Reddy**, M. Razmara, M. Shahbakhti, R. D. Robinett, G. Aniba, **"Model Predictive Control for MicroCSP Integration into a Building HVAC System"**, in 2018 IEEE International Conference on Control and Automation. Link

- **C. R. Reddy**, S. S. Rao, V. Desai, K. Ramachandran, **"Modeling of an Automotive Thermo-Electric Generator (ATEG)"**, International Journal of Science and Research (IJSR), India Online ISSN, pp.2319-7064, 2013. Link

Technical Skills

- Model-based engineering.
- Closed-loop modeling, control, & co-simulation between plant & control model.
- Energy systems, energy storage systems (thermal energy storage, battery energy storage) modeling, control & simulation.
- Modeling of thermal, mechanical, hydraulic, pneumatic, electronic and electric sub-systems.
- Linear and non-linear control theory.
- Model-based predictive control.
- Modeling, simulation, data analysis, code generation in Matlab/Simulink.
- 0D, 1D and 3D Modeling Techniques.
- Optimization techniques.
- Automotive system simulation in GT-Suite, AVL, AMESim, & CarSim.
- Using model-based embedded software development tool chains of ETAS, DSPACE, & MotoHawk.
- Model in loop (MiL), software in loop (SiL), and hardware in loop (HiL) development and testing.
- Computer aided mechanical design (CAD) in Solidedge, & Solidworks.

Certification Courses

- Completed "Evaluating Writing Training Program" as a Graduate Teaching Assistant in the Department of Mechanical Engineering – Engineering Mechanics, Michigan Technological University, Houghton, Michigan, USA. Certificate
  Highlights:

  - Was a five week course focussing on writing evaluations of students as a GTA
  - Each week, we focussed on a topic (like the importance of communication in engineering, having a "GRADING RUBRIC" for faster and fair evaluation, student accommodations, fairness to student of diverse backgrounds etc) concerning evaluating students writing

- Completed a practical and hands on course in Automobile Servicing and Maintenance in G.D. Naidu Charities, Coimbatore, Tamil Nadu, India. Certificate
  Highlights:

  - Was a three week course on Automobile servicing and Maintenance
  - We were given all the typical Automobile parts (Engine, Clutch, Gear Box, Differential, Suspension, Steering, etc.).
  - These were stripped to most basic level and we learnt to service (clean) and re-assemble them
  - Was a course designed to understand the parts of a typical Automobile, realize their physical implementation and appreciate their performance

- Completed a familiarization course in H.A.L. Aircraft division, Bangalore, Karnataka, India. Certificate
  Highlights:

  - Was a month long Training/Familiarization course in the H.A.L. Aircraft division plant
  - Each day we were assigned a department/shop to get to know and familiarize ourselves with what they are doing, which component of which Aircraft they are producing, number of employees etc
  - In the final week, we were assigned to Aircraft service bay and final assembly plants, where I got a chance to sit inside and explore Sukhoi, LCA (Light Combat Aircraft), Surya Kiran, Hawk (the then training and combat Aircrafts used by the Indian Air Force)

Achievements

- Doctoral Finishing Fellowship for Fall 2021
- Outstanding Graduate Teaching Assistant Award based on Fall 2017 student reviews
- Demonstrated ANCE (Active Noise Cancellation and Enhancement) project on a two-wheeler and was appreciated by many top-level management/technical leads of our organization including the president of our organization (Robert Bosch India). Our project ANCE was covered by various media organizations (Link 1, Link 2, Link 3)
- Took an active part in College fests at both Pre-University and Undergraduate level
- Was the school captain in Class X

International Work Experience

- In Germany for a two week business visit in Feb 2014 to BEG (Bosch Engineering Group), a sister organization to Robert Bosch India, to learn/discuss about ANCE (Active Noise Cancellation and Enhancement) project.

Review Panels

- Project Continuation Review Panel for Senior Design Projects at Mechanical Engineering - Engineering Mechanics Department at Michigan Technological University
  - "DCCV Housing Process Improvement" in Fall 2017
  - "Aftertreatment Body Joint Design" in Spring 2018
  - "Exhaust Aftertreatment Substrate Heater Design" in Spring 2018
  - "Sand Point Tower and Boardwalk" in Fall 2019

Other Short Term Work Experience

- Was part of the Kingfisher promotion store for IPL 2010 (Apr 2010 – May 2010) in M. Chinnaswamy stadium, Bangalore, India

Computer Literacy

- Languages – embedded C (Auto code generation)
- OS – Windows, MAC OS, and Android
- MS Office tools (powerpoint, excel, word, etc.)

Languages

- English – Business fluent English (Read, write & speak).

- Indian Languages known – Telugu (mother tongue), Kannada, & Hindi.
- German (Basic Conversation skills) – 1A qualified.

Personal Details

- Date of Birth: 14 December 1989
- Sex: Male
- Marital Status: Married
- Citizenship: India
- US VISA Class: F1