**Research Area**

Experience Mapping based Predictive Controller (EMPC) Design for DC Motor based Position Control Applications

Drawing inspiration from Human Motor Control (HMC), the EMPC is developed for various precision position control systems, including special applications involving under-damped, unstable or non-minimum phase conditions. Comparison with existing control techniques, such as PD, MRAC, LQR, and LQG, in both simulation, as well as practice, proves superior performance of EMPC.

**Personal Interests**

- Puzzle Solving
- Video Gaming
- Travel
- Swimming
- Basketball

**Tools Expertise**

- SolidWorks
- KEIL Tools by ARM
- Altium Designer

**Random Trivia**

- Taught part of Mechatronics Course as a Teaching Assistant
- Conducted workshops on Basics of: Robotics, App Design, Image Processing
- Helps out under-privileged children frequently with education and science projects

**A.CADEMIC PROJECTS**

- **Mechatronics**
  - Real-Time Interactive Robo-Puppet® Theatre System Design
  - Control Design for XY Plotter System
  - DC and Stepper Motor Control Boxes for Laboratory Course

- **Electronics Design and Development**
  - for Medical Applications
  - Compliance Monitoring of Club Foot Brace (PadmaPada®)
  - Drug Delivery Systems
  - Self (Joystick) and Remote Controlled Wheelchair System
  - Automated Ilizarov Apparatus
  - Motorized Intelligent Spastic/Geriatric Walker
  - for Environmental Applications
  - Remote Water Level Sensing for Lakes
  - Remote Automatic Weather Monitoring System

- **Robotics**

**Industry Projects**

- **Internet of Things**
  - Wireless IoT-Enabled Jars and Grocery System
  - Wireless Home Automation Solutions
  - Wi-Fi Enabled Colour LED Lighting System
  - Networked Water Metering System
  - Networked Motion Detection Systems

- **Security**
  - Wearable Personal Protection Device
  - Secure Lock with Geo-Fence
  - RFID-based Vehicular Entry/Exit Logging System
  - RFID-based Real-Time User Tracking System

- **Miscellaneous**
  - Point-of-Care 5-in-1 Medical Diagnostic System
  - Coin Sorter Control Mechanism System
  - Current Sensing and ELR Meter Electronic System
  - 3D Printer System Design

**Publications**

- **Journals** 2
- **Conferences** 4
- **Patents** 1

**Professional Interests**

- Literature Survey
- Problem Solving
- Circuit Design
- PCB Design
- Mechanical Design
- UI Design

**Transferable Skills**

- Leadership
- Communication
- Technical Writing

**Technical Skills**

- Control Engineering
- Embedded Systems
- Circuit Design
- PCB Design
- Mechanical Design
- UI Design

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A controller was developed inspired by the concepts of Human Motor Control for applications requiring position control. The developed controller termed EMPC, uses concepts of iterative action and learns by experience to apply the correct control action for a given system. The controller was simulated for a generic under-damped Type-1 system. The concepts were further implemented on practical setup of a DC motor test bench for precise position control and shown to outperform other controllers like PD, MRAC, LQR and LQG. It was further applied to an inverted pendulum system which is an example for unstable systems. The results showed that EMPC is a very easy to implement adaptive control that can effectively handle under-damped and unstable systems.
**RESEARCH WORK**

Experience Mapping based Predictive Controller (EMPC) Design for DC Motor based Position Control Applications

EMPC was implemented practically using an ARM processor. The practical system consisted of high non-linearities like actuator saturation, static and dynamic friction and varying inertia and spring constant. The practical results matched the performance of the simulated results.
Journals:

Conferences:

Patents:
A fully automated interactive theatre capable of supporting simultaneous operation of 6 marionette puppets was designed.

Each robot manipulator has an 18 axes pulley driven servo-based actuation for controlling various limbs of a puppet. The puppet motion can be pre-recorded or played live, using Microsoft Kinect's body motion digitization technique. Appropriate algorithms were developed to bring about a more fluidic motion effect on the puppets. Motion library modules were also developed for use as plug-and-play during live interactions.

The manipulators are controlled by a master controller (Linux PC) via Wi-Fi and synced to an audio-visual in real-time, which was displayed on a screen behind the puppet. The user interface designed provides for an easy and efficient way for the puppeteer to record the motion in sync with the audio-visuals and provides a platform for automation of stage lighting and curtains.

Each manipulator is also designed to work in battery-powered stand-alone mode, either with a support stand or to be held by hand, so that the artist holding the puppet can add extra effects to the motions of the puppet.

The entire system is patented as Robo Puppet under the Indian Patent No. 219215.

ACADEMIC PROJECTS – MECHATRONICS

DC and Stepper Motor Control Boxes for Laboratory Course

⇒ Based on an ARM cortex M4 processor with USB interface to the PC
⇒ 3 versions:
  = 50W DC Motor Control Toolbox
  = 250W DC Motor Control Toolbox
  = 50W 1/32 Micro-Step Stepper Motor Control Toolbox
⇒ Interface for two motors with quadrature encoder feedback
⇒ Designed to work with 2S/3S LiPo batteries.
⇒ GUI developed on DotNet platform to enter control parameters and plot results for – Step response and Tracking response
⇒ Used for other mechatronics course laboratory experiments like:
  = Magnetic levitation
  = Line Follower Robot
  = Inverted Pendulum

Line Follower  
Magnetic Levitation  
Inverted Pendulum
This National Research Development Corporation (NRDC) award winning innovative clubfoot brace was developed by Mechatronics Lab at IISc jointly in collaboration with CMC Vellore. The brace is a low cost, light weight and easily manufacturable medical product that has garnered wide acceptance from both the medical and the patient community. It allows more degrees of freedom than the commercially available counterparts. The brace shoes are embedded with capacitive sensing technology for compliance monitoring. Consolidated results can be viewed by the doctors via user-friendly graphical interface after a follow up period of up to 6 months. The aesthetics of the brace has been designed to facilitate the child to easily roll over and crawl, which was previously not possible in other available braces. In the clinical trials, it was observed that the patients had no recurrence of the deformity.

This product is patented with Patent No. T.0 (04) TIFA/2013.

My contributions towards this project are:

⇒ Production level design (PCB design and embedded coding) of foot pressure sensor for tracking and monitoring various pressure points on the foot using multiple capacitive sensors.

⇒ Windows UI development

### Contribution towards Other Academic Projects

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<th>Embedded Coding</th>
<th>Circuit Design</th>
<th>PCB Design</th>
<th>UI Design</th>
<th>Mechanical Design</th>
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<th>Enclosure Design</th>
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Contribution towards Other Academic Projects

- Autonomous Wheelchair
- Motorized Intelligent Spastic/Geriatric Walker
- Automated Ilizarov Apparatus
- Drug Delivery System
- XY Plotter