# Balancing Control & Path Planning of a Ballbot

Project Summary

Controlling a ballbot from a **digital twin** design remains challenging. The project aims to integrate an equivalent nonlinear system embedding, e.g., **linear parameter varying (LPV)** along with **nonlinear control strategies** to enable **real-time balancing and motion** planning through **complex safety-aware environments**.

Project Types

- **BA** thesis – 3 months
- **MA** thesis – 6 months
- **Praktikum** – (3->6) months
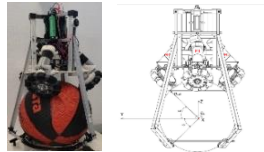
Digital twin of a ballbot

Project Potential Objectives concerning time/level and will

- **Studying** the fundamentals of control strategies
- **Investigating** the dynamics of such a challenging system
- **Data-driven model discovery** and system identification
- **Online optimization** tools for **real-time** implementation
- **Theoretical analysis** on **stability & recursive feasibility**

Required Qualifications

- Basic courses in automatic control
- Programming skills, e.g., Matlab/Python/C++
- Motivation for using Infineon/Raspberry Pi hardware

Contact

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Detailed Description

A ball balancing robot, also known as a ballbot, is a dynamically-stable mobile robot designed to balance on a single spherical wheel (e.g., a ball). Through its single contact point with the ground, a **ballbot is omnidirectional and thus exceptionally agile, maneuverable**, and **organic in motion** compared to other ground vehicles. **Its dynamic stability improves navigability in narrow, crowded, and busy environments.**
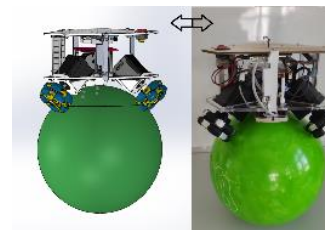
The new IME ballbot
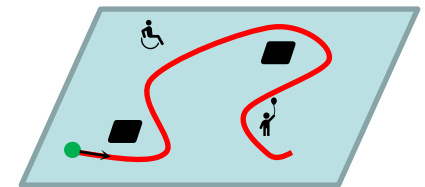
Balancing & motion
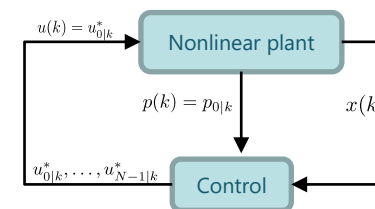
Modeling & Control

Selected References

- M. Studt, I. Zhavzharov and H. S. Abbas, "Parameter Identification and LQR/MPC Balancing Control of a Ballbot," 2022 European Control Conference (ECC), London, United Kingdom, 2022, pp. 1315-1321, doi: 10.23919/ECC55457.2022.9837996.

- T. Fischer, I. Zhavzharov, D. S. Karachalios, and H. S. Abbas, " In preparation "