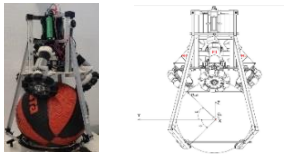
Balancing & Tracking Control of a Ballbot

Project Summary

A ballbot is a mobile robot designed to **balance on a single spherical wheel.** It is **omnidirectional** and thus exceptionally **agile** and **manoeuvrable** compared to wheeled robots, which improves **navigability** in narrow and crowded environments. Controlling a ballbot from **a digital twin** design remains challenging. This project aims to use **advanced control strategies** to enable **real-time complex manoeuvring** due to specific reference paths.

Project Types

- **BA** thesis – 3 months
- **MA** thesis – 6 months
- **Praktikum** – (3->6) months



Digital twin of a ballbot

Objectives concerning time/level

- **Studying** the ballbot dynamics and basic control strategies
- **Familiarity** with the setup and data acquisition and analysis
- **Data-driven modelling** and system identification
- **Investigating** advanced H_∞/H_2 control approaches in simulation
- **Real-time** implementation

Required Qualifications

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

Contact

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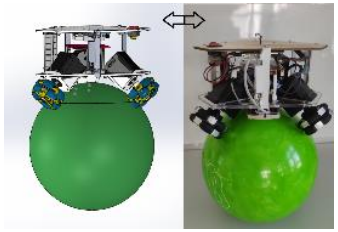
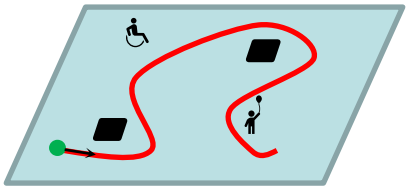
Detailed Description

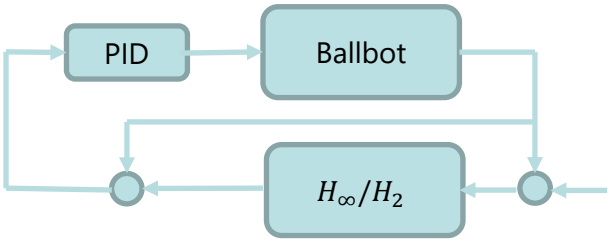
A two-loop approach will be investigated to control the robot where the internal loop is a PID controller to maintain the balancing while the outer loop is an advanced H_∞/H_2 controller to allow the robot to track efficiently complex reference paths. The loop shaping and generalized plant concepts associated with H_∞/H_2 control will allow to compromise different control objectives in terms of reference tracking and suppressing high frequency disturbances.



IME ballbot



Balancing & motion



Modeling & Control

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 "