

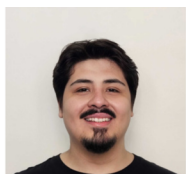
Catchy 2.0

Technical improvement of the ball catching system "Catchy"

Graduate



Andrin Kälin



Marco Rouge

Ausgangslage: The "Catchy" is a system developed by the Interdisciplinary Center for Artificial Intelligence designed to catch ping pong balls using a movable cup. The system employs cameras, computer vision, and real-time trajectory estimation to predict the flight path of incoming objects. Based on this prediction, motion planning algorithms generate trajectories for the cup, while an XY-drive mechanism positions it precisely for successful interception. The project combines image processing, trajectory planning, and actuator control into an integrated autonomously working system.

Ziel der Arbeit: Previous development primarily focused on the AI-based image processing components of the system. This thesis addresses the control engineering aspects, with particular emphasis on state-space methods for estimation, trajectory planning, and control.

The work includes the analysis of the existing hardware and software architecture, the revision of the current control pipeline, and the implementation and evaluation of a suitable control approach.

Ergebnis: Software optimization increased the processing rate from 20 to 60 measurements per second, drastically reducing the time required for accurate trajectory prediction.

A dynamic S-curve motion planning algorithm was implemented to generate smooth and time-efficient robot trajectories. In addition, a separate linear-programming-based peak jerk minimization algorithm was developed to reduce mechanical stress and improve motion smoothness. Together with improved motor control and a more rigid mechanical setup, these enhancements enabled significantly smoother system operation.

Further tuning of the Kalman filter and prediction pipeline, as well as improvements to the control architecture and time-fixed motion planning implementation, increased the overall catch rate by 38 percentage points.

Benchmarking:

Base system catch rate: 48%

Catchy 2.0 catch rate: 86%

Advisor

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Co-Examiner

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Subject Area

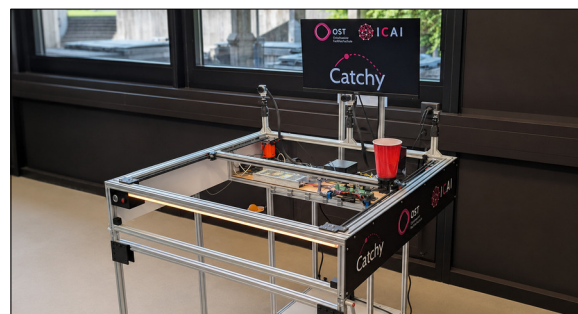
Regelungstechnik /
Control Theory

Project Partner

ICOM Institute for
Communication
Systems, OST -
Ostschweizer
Fachhochschule,
Rapperswil, SG

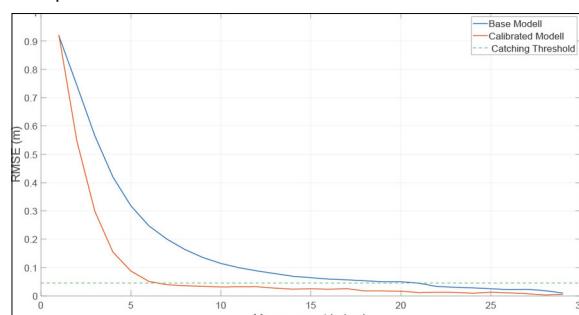
The Catchy

Own presentation



RMSE comparison of predicted versus actual landing points for the original and improved predictor pipelines

Own presentation



S-curve vs. trapezoidal motion planning: jerk (derivative of acceleration) is limited instead of infinite

Own presentation

