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Real time Adaptive Estimation

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Problem

Prior knowledge of the system dynamics

Difficulty to accurately model dynamics of complex systems

Adaptability to system changes

Proposal

Temporal Predictive Coding (tPC)

- Learns system dynamics and perform state estimation.
- Similar performance to Kalman filter.

Hypothesis

- Will adapt to changes in system dynamics

Actuation

Motor Control

Set point - E

Control

LQR or PID

PWM

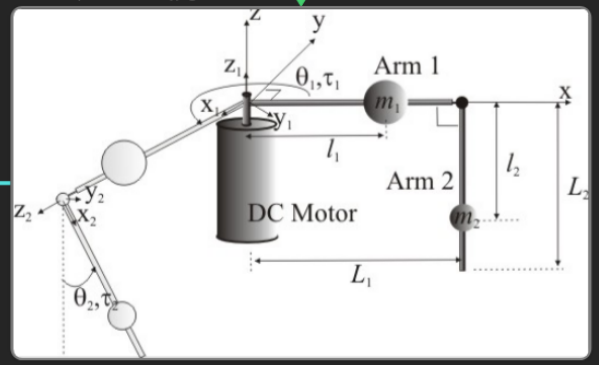
$X = \{x, \theta, \dot{x}, \dot{\theta}\}$

State Estimation

Sensor measurement

$\{\theta_1, \theta_2\}$

Furuta_pendulum.jpg



Goals

- To implement a tPC based adaptive estimator
- Deploy the system in Simulator and Real world hardware

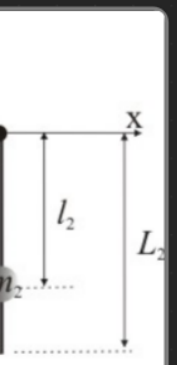
Objectives

Phase 1 : Simulation

- Set up simulator in NVIDIA IsaacSIM #Sasa
- Replicate state estimation results of the paper.
  - KL as the baseline #Sasa
  - tPC #Nick
- Off the shelf control. PID, LQR etc. #Sasa , #Nick
- Evaluate systems adaptability with #Sasa , #Nick
  - Changes in the physical parameters (e.g. gravity).
  - Changes in the system dynamics (mass of pendulum).
  - Unseen external disturbances.
  - Novel sensing methods.

Phase 2 : Real world

- Construct the physical device #Sasa , #Nick
- Evaluate the adaptability to sim2real gap for both KF and tPC. #Sasa , #Nick



August 20 September 2024
October 2024
November 2024
December 2024
January 2025
February 2025
Milestone 6
Fri, Sep 13 - Mon, Jan 27 2025
1 Meeting with Iman #23
2 Meetings with mentors #24
3 Project plan review 1 #1
4 Project plan review 2 #2
5 Final seminar preparations #3
6 Final Demo #4
Add item
Presentation 6
Wed, Oct 2 - Sun, Jan 26 2025
7 Return presentation to moodle #25
8 Check canvas2pdf plugin #7
9 Review 1 presentation preperation #21
10 Review 2 Presentation preperation #22
11 Final Presentation Preparation #19
12 Planning for the Video #20
Add item
Plan 3
Mon, Sep 23 - Sun, Sep 29
13 Create GANTT chart and add to slides #5
14 Make a project document for Gökhan #6
15 [Risk MGT] Evaluation of the existing hardw... #8
Add item
Implementation - SIM 7
Mon, Sep 30 - Sat, Dec 21
16 Set up Isaac Sim #9
17 Structure tPC code to interface with Isaac #10
18 Replicate KL results of the paper #12
19 Set up LQR control #16
20 Replicate tPC results of the paper #13
21 Evaluate systems adaptability #11
22 Fine tune / debug the system in simulation #18
Add item
Implementation - Hardware 3
Sat, Oct 26 - Thu, Jan 16 2025
23 Set up physical device #15
24 Evaluate the adaptability to sim2real gap #14
25 [Opt] Novel Sensing methods (Evt. Camera) #17

SWOT

Strengths

- Technical know-how
  - Electronics and hardware design
  - Robotics
  - Real time control system design
  - Learning based system expertise

Weaknesses

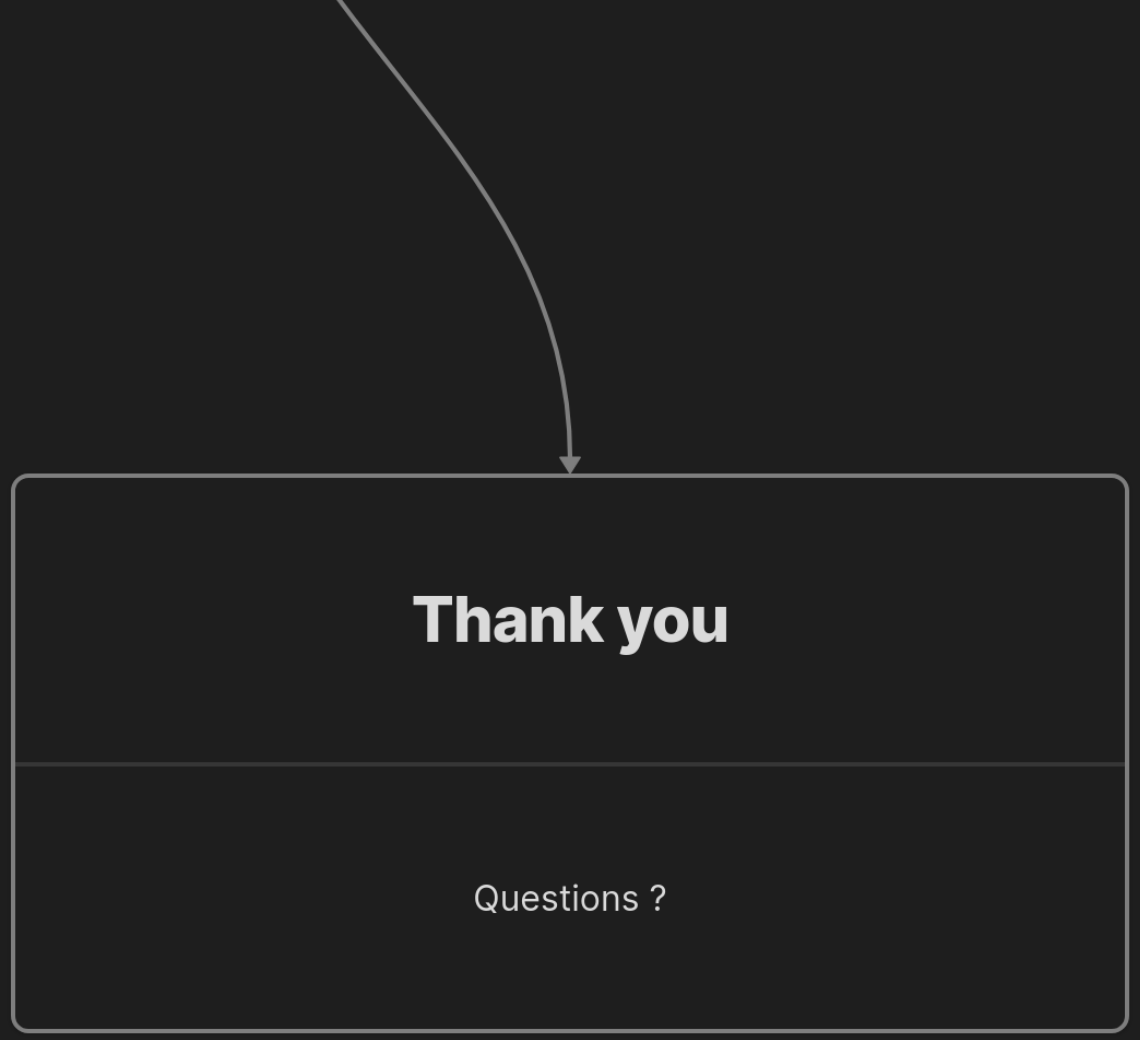
- tPC is a cutting edge learning based method which is yet to be established
- Time management

Opportunities

- Enables learning dynamics of complex systems
- Enables a plug and play estimation algorithms with minor/self tuning

Threats

- Sim-to-real gap
- Uncertainty of scaling to bigger systems


Thank you
Questions ?