WP1.2 MPC

WP Leader: Lieve Helsen

Expert Meeting Paris
October 1-2, 2018

IBPSA Project 1

WP1.2 Goals and Work Plan

THE GOALS

Using Modelica,

an equation-based object-oriented modelling language

1. To develop an open-source **Library for MPC**
2. To develop a **framework** to test and assess MPC performance
3. To compare and **benchmark** different **MPC formulations**

THE WORK PLAN

WP1.2 Model Predictive Control (MPC)

Task 1.2.1:
Develop a framework to test and assess MPC performance

Task 1.2.2:
Compare and benchmark MPC algorithms

Task 1.2.3:
Develop a Modelica library for MPC

ACTION PLAN DEFINED IN BERLIN

Focus points defined for the period between Berlin and Paris

1. Selection emulator models
2. Prototype BOP-TEST
3. MPC description template to allow formulating guidelines for best practices
4. Selection and quantification of performance indicators

WP1.2 Contributors

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Affiliation	Team members
KU Leuven (WP Leader)	Lieve Helsen, Filip Jorissen, Damien Picard, Iago Cupeiro, Javier Arroyo, Jan Drgona
LBNL	David Blum, Michael Wetter
PNNL	Draguna Vrabie, Sen Huang, Yan Chen
NREL	Kyle Benne
SDU	Krzysztof Arendt, Christian Veje (→ WP3)
ENGIE Lab	Valentin Gavan
ENGIE-Axima	Lisa Rivalin (now at LBNL)
3E	Roel De Coninck
Ingersoll Rand	Kaustubh Phalak

WP1.2 Status work

STATUS WORK

Coordination Meetings since Berlin Meeting

- March 23: selection of emulators, start up BOP-TEST Toolchain Working Group
- April 11: BOP-TEST Toolchain WG
  Handling local loop and supervisory control
- May 9: BOP-TEST Toolchain WG
  Signal override block, prototype test case implementation into Docker container
- June 12: BOP-TEST Toolchain WG
  Synergistic Alfalfa project, data requirements, updates on software architecture
- August 30: Follow-up plan made in Berlin, important topics for break-out sessions in Paris, abstract BS2019
- September 18: Agenda Break-out sessions Paris meeting finalized

STATUS WORK

Task 2.1: Development of a framework to test and assess MPC performance BOP-TEST

Virtual test bed

- Architecture which allows control by MPC
  - ✓Prototype ready
  - ✓To be tested and documented (user guide): ongoing
- Detailed emulator models
  - ✓Emulators selected
  - ✓Peer review process (checklists and tests): first proposal ready

STATUS WORK

- Detailed emulator models
  - ✓Selected

	Residential	Commercial
Single zone	BESTEST as building envelope and we add the energy system: - KU Leuven → hydronic system - LBNL → air system	- David's VAV based building → air system - Krzysztof's building → hydronic system
Multi zone	Valentin's 8-zones building with: - Only heating → hydronic (boiler + radiators) - Heating and cooling → hydronic (boiler + radiators) and air based (split air-to-air HP) Remark: Multi-zone with all-air system is lacking!	- David's 5-zones VAV based office building → air based less complex - Iago's INFRAX office building → hybrid less complex - Filip's SolarWind office building → hybrid more complex - Draguna's prototype building → air based more complex

STATUS WORK

Task 1.2.2: Comparison and benchmarking MPC algorithms

Virtual test bed developed in Task 1.2.1 is used to **test MPC formulations and solvers** on common emulators, which allows benchmarking the MPC algorithms using selected performance indicators

- MPC description template: first proposal ready
- KPI selection and quantification: first proposal ready
- Modelica template for standardizing KPIs and input/output communication: first proposal ready

THE WORK PLAN

Task 1.2.3: Development of a Modelica library for MPC

Library of models that can be used to efficiently solve optimal control problems for building and district energy systems (& that can be combined with parameter and state estimation algorithms)

→All physical equations need to be at least twice continuously differentiable with bounded derivatives on compact sets

Not yet started.

STATUS WORK

Focus points defined for the period between Berlin and Paris

- ✓Selection emulator models
- ✓Prototype BOP-TEST
- ✓MPC description template to allow formulating guidelines for best practices
- ✓Selection and quantification of performance indicators

STATUS WORK

Publications

- Abstract BS2019 submitted

Prototyping a framework for simulation-based testing of advanced control strategies in buildings

David Blum, Filip Jorissen, Sen Huang, Yan Chen, Kyle Benne, Lisa Rivalin, Draguna Vrabie, Michael Wetter, Marina Sofos

STATUS WORK

Publications

➢Journal paper in preparation

ALL YOU NEED TO KNOW TO START WITH MODEL PREDICTIVE CONTROL FOR BUILDINGS: MODELING, PROBLEM CLASSES, SOLUTION TECHNIQUES AND SOFTWARE TOOLS

Ján Drgona[a], Enric Perarnau Olléa, Iago Cupeiro Figueroa[a,b], Javier Arroyo[a,b], Donghun Kim[c], David Blum[e], Juraj Orave[c,d], Lieve Helsen[a,b]

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WP1.2: Plan for break out sessions

THE PLAN FOR BREAK OUT SESSIONS – DAY 1

BS 1-1	KPI		50 min	day 1 - session 1
	Discussion KPI matrix	Javier Arroyo	30 min	
		Draguna Vrabie		
	Modelica template for standardizing KPIs and inputs/outputs communication	David Blum	20 min	
BS 1-2	Emulators		60 min	day 1 - session 2
	Peer review of emulators	Filip Jorissen	40 min	
	checklists			
	tests			
	action plan emulator development	Lieve Helsen	20 min	

THE PLAN FOR BREAK OUT SESSIONS – DAY 2

BS 2-1	BOP-TEST		65 min	day 2 - session 1
	Introduction	David Blum	5 min	
	Example of User Needs	Draguna Vrabie	20 min	
	Current Status of Prototype	David Blum	20 min	
	Future Development	Kyle Benne	20 min	
BS 2-2	BOP-TEST		75 min	day 2 - session 2
	Discussion	David Blum	45 min	
	Documenting - user guide	David Blum	15 min	
	Action plan BOP-TEST	David Blum	15 min	
BS 2-3	MPC		75 min	day 2 - session 3
	Discussion MPC description template	Jan Drgona	45 min	
	Modelica Library for MPC: how to start up?	Filip Jorissen	30 min	
BS 2-4	Wrap-up and discussion		55 min	day 2 - session 4
	Prioritization of next steps, target timeline	Lieve Helsen	20 min	
	Action plan joint publications	Lieve Helsen	10 min	
	Keep open to discuss open issues	All	25 min	

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