Asian Modelica Conference 2024

December 12-13

International Convention Center Jeju

Modelica

Scan for Registration

CONTENTS

WELCOME TO ASIAN MODELICA CONFERENCE 2024

Welcome to the Asian Modelica Conference 2024 here in Jeju. It is a great honor to have you all join us for what promises to be an enlightening and inspiring event.

The concept of Modelica is revolutionizing industries, from manufacturing to healthcare, urban planning to energy management. Today, we gather to delve into the latest advancements, share innovative ideas, and explore the vast potential of digital twin technology.

This conference brings together a diverse group of experts, innovators, and enthusiasts from around the world. Each of you plays a crucial role in shaping the future of digital twins, and your presence here is a testament to the importance and impact of this technology.

Over the next 2 days, we will have the opportunity to engage in thought-provoking discussions, attend insightful presentations, and participate in hands-on workshops. These sessions are designed not only to educate but also to inspire, challenge, and drive forward our collective vision for the future of digital twins.

I would like to extend my heartfelt gratitude to our distinguished speakers, sponsors, and organizers. Your dedication and hard work have made this event possible, and we are deeply appreciative of your contributions.

As we embark on this journey together, I encourage each of you to take full advantage of the opportunities to connect, collaborate, and learn. Let's make this conference a catalyst for innovation and a platform for forging lasting partnerships.

Thank you, and once again, welcome to the Asian Modelica Conference 2024. Let's create a truly remarkable and impactful event.

Yongha Han
Conference Chair

Daeoh Kang
Program Chair

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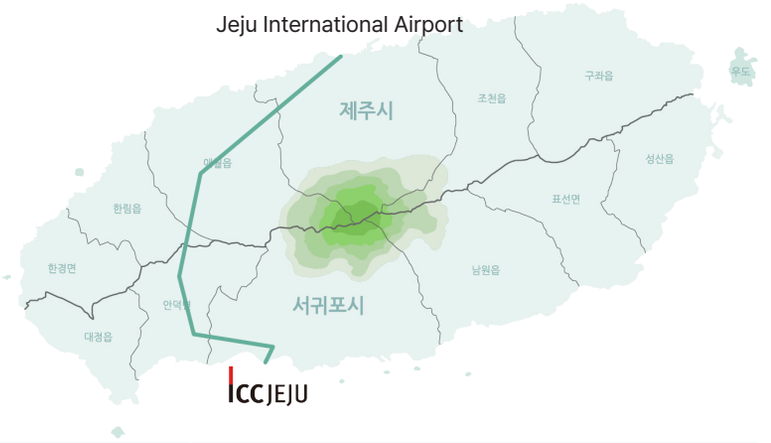
CONFERENCE VENUE



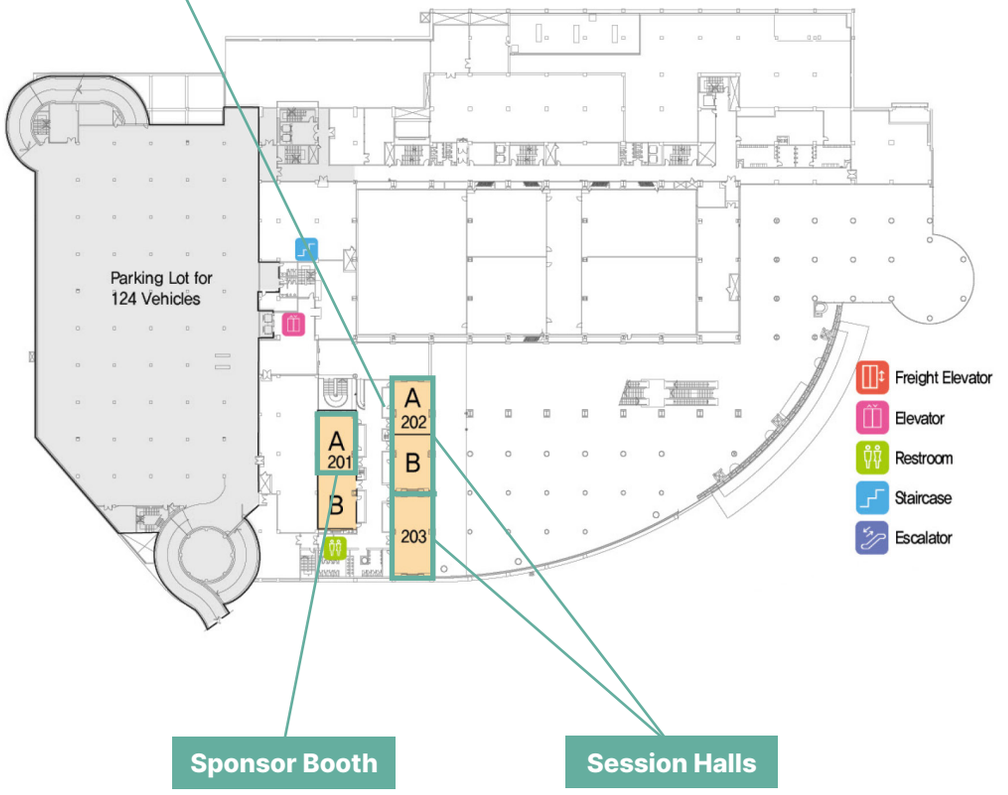
Address	224, Jungmungwangwang-ro, Seogwipo-si, Jeju-do, Republic of Korea
Transportations	**Airport Limousine Bus No.600(06:30 ~ 21:40)** • Airport → Jeju Sun Hotel → Jungmun Tourist Complex → Hotels (Grand Josun Jeju, Parnas Hotel, Shilla Hotel, Suite Hotel, Bloom Hotel, Lotte Hotel, Kensington Resort, CS Hotel) → ICC JEJU → Jeju World Cup Stadium → Paradise Hotel → Seogwipo Kal Hotel **By car** • Route 1135 Pyeonghwa-ro - Takes 50minutes
Parking Information	**Parking Charges** • Free for the first hour after entry. • 1,000 KRW for every additional 30 minutes. • Maximum daily charge : 5,000 KRW (10,000 KRW for large vehicles). **Discount** • JTO Duty-Free Store Purchase Customers • Barcode Verification of Receipt
WiFi	Jeju Free WiFi

Accomodations near ICC JEJU	■ Jeju Booyoung Hotel & Resort(next to ICC) ■ Kensington Jeju Hotel(2.3km) ■ Jeju Shilla Hotel(2.5km) ■ Lotte Hotel Jeju(2.2km) ■ Suites Hotel Jeju(2.5km)
Sightseeing neer ICC JEJU	■ Botanic Garden Yeomiji ■ Teddy Bear Museum ■ Cheonjeyeon Waterfalls(Seayeongyo Bridge) ■ Jusangjeolli Cliff ■ Jungmun Saekdal Beach

Jeju Special Self-Governing Provincial Tourism Association

MAP OF THE VENUE

2F



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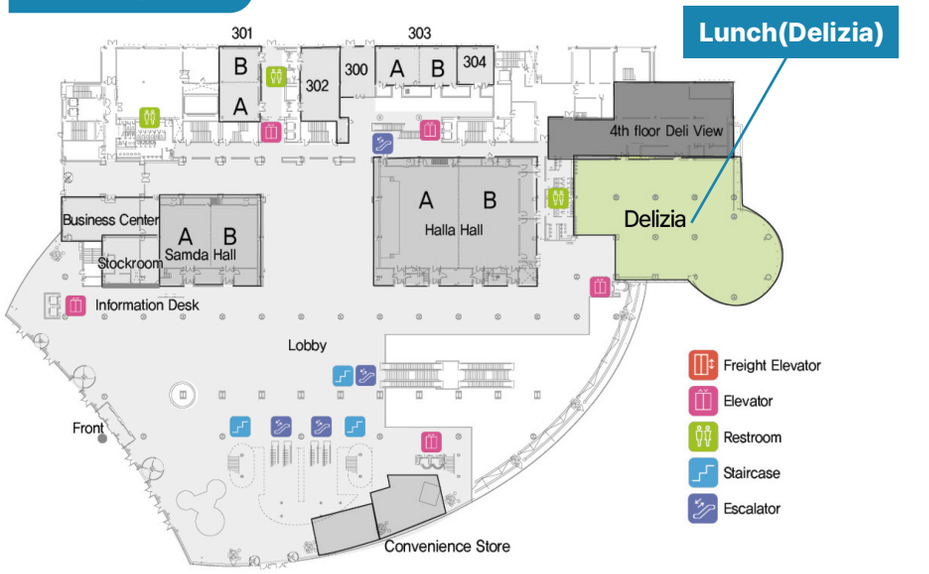

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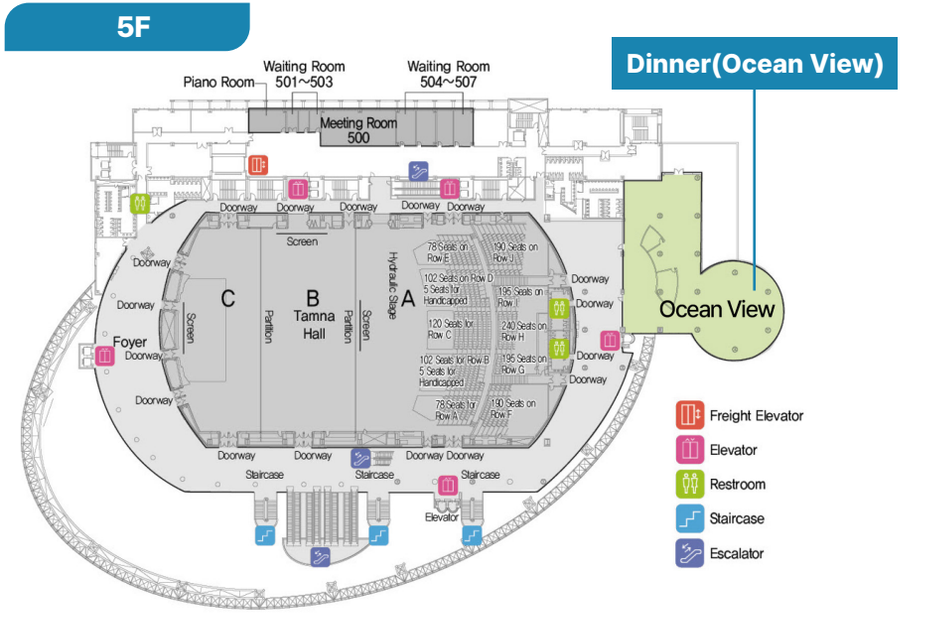

SCOPE OF ASIAN MODELICA CONFERENCE 2024

Modelica is a freely available, equation-based, object-oriented language for convenient and efficient modeling of complex, multi-domain cyber-physical systems described by ordinary differential, difference and algebraic equations. The Modelica language and the companion Modelica Standard Library have been utilized in a variety of demanding industrial applications, including full vehicle dynamics, power systems, robotics, buildings and district energy systems, hardware-in-the-loop simulations and embedded control systems. The Functional Mock-up Interface (FMI) is an open standard for the tool-independent exchange of models and for co-simulation. It is supported by many Modelica and non-Modelica tools and is the key to utilizing Modelica models in non-Modelica environments. **Development in the Modelica Association is organized in Modelica Association Projects:**

LANG	Modelica Language
LIB	Modelica Libraries
FMI	Functional Mock-up Interface
eFMI	Functional Mock-up Interface for embedded systems
SSP	System Structure and Parameterization of Components for Virtual System Design
DCP	Distributed Co-Simulation Protocol

These projects collaborate to design and maintain a set of coordinated standards for modeling and simulation of complex physical systems.The Modelica conference will bring together people using Modelica and/or other Modelica Association standards for modeling, simulation, and control applications, such as Modelica language designers, tool vendors and library developers. The Modelica Conference provides Modelica users with the opportunity to stay informed about the latest language, library, and tool developments, and to get in touch with people working on similar modeling problems. **The conference will cover topics such as the following:**

- Multi-engineering modeling and simulation with free and commercial Modelica libraries (mechanics, electrical, hydraulics, thermal, fluid, media, chemical, building, automotive, aircraft, ...)
- Automotive applications
- Thermodynamic and energy systems applications
- Mechatronics and robotics applications
- Medicine and biology applications
- Other industrial applications, such as electric drives, power systems, aerospace, etc.
- Large-scale system modeling
- Real-time and hardware-in-the-loop simulation
- Simulation and code generation for embedded control systems
- Simulation acceleration by use of many CPU cores or GPU cores
- Applications of Modelica for optimization and optimal control
- Modelica modeling, simulation and design tools
- Symbolic algorithms and numerical methods for model transformation and simulation

PROGRAM OVERVIEW

Thursday, 12 / Dec / 2024

Time	Room 202	Room 203
09:00 ~ 10:30	-	Tutorial Session 1-A : Modelica Language Basic
10:30 ~ 11:00	Welcome Ceremony	Tutorial Session 1-B : Modelica Language Basic
11:00 ~ 11:30	Welcome Speech | Mr. Yongha Han(HMC), Dr. Dirk(DLR)	-
11:30 ~ 13:00	**Lunch**	**-3F Delizia-**
13:00 ~ 13:30	Keynote Speech 1 | Mr. Yongha Han(HMC)	-
13:30 ~ 14:00	Session 1-A : Combining Equation-based and Multibody Models	Session 2-A : A Study on the Methodology to Develop Virtual Drive Environment for Autonomous Driving Evaluation
14:00 ~ 14:30	Session 1-B : The DLR Cables Library	Session 2-B : Community Updates to the DLR ThermoFluid Stream Library
14:30 ~ 15:00	Session 1-C : Validating the DLR Cables Library with Experiments and Parameter Optimization	Session 2-C : An Integrated Optimization and Orchestration Toolchain for Adaptive Optimal Control in Modelica Simulations
15:00 ~ 15:30	**Coffee**	**Break**
15:30 ~ 16:00	Session 3-A : Modeling FCEV for performance prediction and optimal component selection	Session 4-A : Study on Determining Optimal Design Parameters of Solar Heating and Cooling System
16:00 ~ 16:30	Session 3-B : Vehicle Health Monitoring for Driving Safety using Co-simulation between Dymola and Simulink	Session 4-B : Study on nuclear and renewable hybrid energy system performance prediction by using Modelica
16:30 ~ 17:00	Session 3-C : A Virtual Testing Environment for SDV Development : Towards CI/CD Integration	Session 4-C : Digital Twin for District Heating Substations : A Cyber-Physical Modeling Approach
18:00 ~ 21:00	**Dinner & Networking**	**& Sponsor Speech(DASSAULT SYSTEMES) -5F Ocean View-**

PROGRAM OVERVIEW

Friday, 13 / Dec / 2024

Time	Room 202	Room 203
09:00 ~ 09:15	Sponsor Session 1 : KOROAD | Taekyung Kim	-
09:15 ~ 09:30	Sponsor Session 2 : DASSAULT SYSTEMES | Nuri Kang / LG Electronics Inc	-
09:30 ~ 09:45	Sponsor Session 3 : Modelon | Emily Hirai	-
09:45 ~ 10:15	Keynote Speech 2 : Modelon | Dr.Moritz Hübel	-
10:15 ~ 10:30	**Coffee**	**Break**
10:30 ~ 11:00	Session 5-A : Testing Large Scale System Simulation using Linear Implicit Equilibrium Dynamics	Session 6-A : Multi-Physical Modeling and Analysis of AWD Electric Vehicles with Disconnector Actuator System and Regenerative Braking Control Using Modelica and FMI
11:00 ~ 11:30	Session 5-B : Requirements-based, early-stage Architecture Performance Validation on a Brake System Use Case	Session 6-B : A Study on Model-Based Thermal Management Systems Architecture Modeling and Energy Efficiency Prediction of Fuel Cell Electric Vehicles
11:30 ~ 12:00	Session 5-C: Development of a Modelica-based Multi-fidelity Simulation Framework for Semiconductor Infrastructure Digital Twin	Session 6-C : Digital Human Body Model for Occupant Monitoring System
12:00 ~ 13:30	**Lunch**	**-3F Delizia-**
13:30 ~ 14:00	Session 7-A : Modeling a Rotary Compressor	Session 8-A : Object Oriented Modeling of Single and Multi-Bed Pressure Swing Adsorption Processes using OpenModelica
14:00 ~ 14:30	Session 7-B : Process modeling and simulation of a batch reverse osmosis process using modelica	Session 8-B : Improving Automatic Parallelization for Equation Based Mathematical Modeling and Simulation using Metaheuristic Optimization
14:30 ~ 16:20	Tutorial session 2 : Modeling complex thermal architectures using the DLR ThermoFluid Stream Library	Tutorial session 3 : FMI Beginner's tutorial
16:20 ~ 16:40	**Coffee**	**Break**
16:40 ~ 17:00	**Ending Ceremony | Mr. Yongha Han(HMC), Dr Dirk(DLR)**	-

[KEYNOTE SPEAKERS] Speech 1

Yongha Han

Research Fellow
Hyundai Motor Group

Speaker Bio

YongHa Han is Research Fellow at Hyundai Motor Group. He joined Hyundai Motor Group in 1996 in Korea. He has been working in the areas of crash safety performance development and virtual technology development. He was appointed as a research fellow in charge of future core technologies in 2020 and is in charge of the Virtual Technology Innovation Research Lab.
(Hyundai Motor Group has been operating a research fellow system since 2009, and has been supporting top R&D experts to focus on their original research work, free from the burden of management.)

Recent research has mainly focused on three areas: ① Development of safety and NVH performance improvement solutions for electric vehicles based on virtual models of batteries and motors ② Development of high-accuracy models simulating new manufacturing processes such as giga casting, and development of solutions to map manufacturing effect on performance analysis model ③ Development of Innovative body and chassis mechanism solution and NVH active vibration control technology to increase the completeness of future mobility.

Abstract

How can we stay competitive continuously?
Virtual vehicle development strategy and use cases

Recently, three trends are buffeting R&D in the automotive industry :
① The transition from the combustion engine to electric vehicle technology
② Software-defined vehicles with increased customer centricity
③ Automated vehicles and the emergence of generative AI (gen AI).
Under these circumstances, the increasing complexity of development requires exponentially increasing costs and time, and it is essential to respond effectively through virtual development. Virtual vehicle development refers to all activities of developing a vehicle using a virtual model in the entire process from planning to sales. Recently, as a virtual vehicle development strategy, Model Based System Engineering (MBSE) has become a hot topic, and MBSE has the advantage of expressing system processes and characteristics as models, enabling smooth communication between stakeholders, and easily analyzing the overall system.

Hyundai Motor Group defines a practical MBSE from the perspective of vehicle development, which is to structure and systematize tasks using a descriptive model and efficiently implement (V-type) development using an executable model. In this presentation, the process, application cases, and issues related to the integration and operation of the virtual model, as well as several use cases related to virtual vehicle development with a focus on concept engineering and virtual reality verification will be given.

[KEYNOTE SPEAKERS] Speech 2

Moritz Hübel

Industry Director for Energy & Process
Modelon

Speaker Bio

Moritz Hübel is Industry Director for Energy & Process at Modelon. He joined Modelon in 2019 in Hamburg, Germany and has been working with providing modelling and simulation solutions for customers from the Energy & Power industries and managing Modelon's global team of energy experts. Prior to joining Modelon, he has been working with customer and research projects for the Center of Combustion Engines and Thermodynamics (FVTR GmbH), managing the energy system simulation team. Moritz received his PhD in Thermodynamics & Power engineering from Rostock University in 2016. His PhD project was focused on flexibility optimization of large-scale thermal power plants using Modelica solutions for thermodynamic system simulation. He also holds a degree in mechanical engineering with a focus on energy systems and thermodynamics.

Abstract

Finding the right balance

What technologies can complement renewable energy to achieve true sustainability?

The global situation of energy supply today is dominated by uncertainties: existing energy systems need to be converted from conventional, mostly fossil generation towards more sustainable, low carbon-emission solutions. Energy resource supply chains on a global scale introduce political dependencies and complexities. Industries and societies opt for cost efficient solutions. Emerging technologies for renewable energy generation, storage and distribution are being developed with largely unknown future cost structure and scalability. In that context, investment decisions need to be made, especially in the energy industry usually require large investments and long payback periods. Engineers working with Modelica know how to tackle this challenge on a fundamental basis: the large set of unknowns needs to be addressed with an equally large number of equations.

The problem needs to be balanced with knowledge. While system simulation cannot give a single universally applicable answer to such problems, its usage helps to remove the unknows: energy balances are not negotiable and neither is the selection of cost competitive supply options under given legal, social and reliability constraints. The complexity of the problem can be reduced and broken down in a system model. Some uncertainties can be captured with empirical correlations or learning of data. In combination with the ability to quantify remaining uncertainty, e.g. future price data, robust technology decisions can be identified that are truly sustainable. In this presentation an overview of how Modelica can help make such choices will be given.

PAPER ABSTRACT

Session 1-A, 13:30 ~ 14:00, Room 202
Combining Equation-based and Multibody Models
| Andrea Neumayr and Martin Otter

This article highlights the combination of equation based modeling with multibody models. In other words, it combines the equation-based modeling lan guage Modia and the multibody module Modia3D. The multibody system is defined in an object-oriented way and parts of it are defined by equations. Alge braic loops are treated that appear due to the connection of multibody and equation-based components. A new approach to variable structure systems are so called predefined acausal components which consist of pre-compiled causal parts and acausal equations. To generalize the concepts for variable structure sys tems, the multibody module is defined as a prede f ined acausal component. As a result, the number of degrees of freedom of the multibody system can vary during simulation. This is demonstrated with a non-trivial example of a walking space robot from the MOSAR space project.

Keyword Modia / Modia3D / Modelica / Julia / multibody / variable structure systems / segmented simulation

Session 1-B, 14:00 ~ 14:30, Room 202
The DLR Cables Library
| Tobias Bellmann, Andreas Seefried and Thomas Bernhofer

The DLR Cables Library can be used to simulate steel cables with nonlinear stiffness such as steel wire cables with and without non-metal core or coatings. The cable itself is simulated as discrete element component, and can easily be connected to Modelica Multibody components. Additional components like winches and pulleys are included in the library. With those, complex cable systems with multiple interconnected pulleys become possible in Modelica. Two applications of the library are demonstrated, a construction crane and a cable robot used to compensate gravitation in a space robotic application.

Keyword Modelica / Cables / Pulleys / Winches / Ropes

PAPER ABSTRACT

Session 1-C, 14:30 ~ 15:00, Room 202

Validating the DLR Cables Library with Experiments and Parameter Optimization

| Andreas Seefried and Tobias Bellmann

The advantages of modelling and simulation are widely known: Optimizing systems before production, generating alternatives in a few clicks, reducing costs, monitoring, digital twin, etc. The quality of the simulation depends heavily on the quality of the modeling, making it an essential task. The DLR Cables library, which we presented in another work, allows the simulation of steel cables, focusing on use cases where their dynamic behavior is of interest, such as cranes and elevators, but also special motion systems using cables and amusement rides. There, the numerical approach based on finite elements is explained in detail and it is also shown that some simplifications are accepted in order to improve the computational effort.

This paper presents the crucial tasks of validation and parameterization of the model, specifically focusing on the material properties of bending stiffness and bending damping. To achieve this, a series of experiments were carried out on four different cables. Optical systems are used to record the cables and to compare them with the simulation. For some of the experiments, we were able to show a good match between reality and simulation, but it also became clear that a linear approach may not be sufficient depending on the application.

Keyword Modelica / Steel Cables / Validation

Session 2-A, 13:30 ~ 14:00, Room 203

A Study on the Methodology to Develop Virtual Drive Environment for Autonomous Driving Evaluation

| Wonyul Kang, Jongho Park and Daeoh Kang

It takes many hours and restrictions once AD(Autonomous Driving) evaluation based on real tests. This paper presents a methodology for development of virtual driving environment that can replace the real vehicle test. When developing a virtual driving environment, it is important to develop the same virtual element model (Road, Vehicle model, etc.) as the real world. So the high-occupancy BRT (Bus Rapid Transit) bus route in Cheongna zone was modelled using the MMS(Mobile Mapping System) as the openDRIVE format which is the ASAM(Association for Standardization of Automation and Measuring Systems) road standard.

In addition, we develop a vehicle model that simulates the dynamic performance of BRT based on Modelica language. Finally, we develop an interface module that integrates the virtual environment, the vehicle model, and the driver model. In conclusion, this paper present virtual test drive platform for AD Evaluation.

Keyword Autonomous / BRT / Vehicle Model / AWS

PAPER ABSTRACT

Session 2-B, 14:00 ~ 14:30, Room 203
Community Updates to the DLR ThermoFluid Stream Library
| Raphael Gebhart, Philipp Jordan, Peter Stein, Peter Junglas, Niels Weber, Peter Eschenbacher and Dirk Zimmer

Since its inception in 2021, the user base of the DLR ThermoFluid Stream Library has steadily grown. This growth was accompanied by improved or refined models, new additions such as models for static head pressure and also new examples, especially for teaching. This paper summarizes these updates for the reader and reports on the recent developments.

Keyword Thermal Modeling / Pipes / Pumps / Heat Exchangers / Static Head / Media modeling

Session 2-C, 14:30 ~ 15:00, Room 203
An Integrated Optimization and Orchestration Toolchain for Adaptive Optimal Control in Modelica Simulations
| Zizhe Wang

This paper introduces a novel Python-based toolchain, "OptiOrch", designed to enhance optimal control in Modelica-based simulations by integrating an optimization framework and an orchestration workflow. OptiOrch leverages the "MOO4Modelica" optimization framework, which supports both single- and multi-objective parameter optimization, and incorporates the "ModelicaOrch" orchestration workflow to dynamically adapt models based on real-time input data and goals. The toolchain features a user-friendly interface, feature model transformation, parallel computing, and automated workflow coordination, making it a powerful and generalized solution for various applications. Practical examples and a case study demonstrate how this toolchain can be effectively applied to Modelica systems for optimal control.

Keyword Modelica / simulation / optimization / multi-objective optimization / parallel computing / self-adaptive systems / optimal control / feature model

PAPER ABSTRACT

Session 3-A, 15:30 ~ 16:00, Room 202

Modeling FCEV for performance prediction and optimal component selection

| Juhyeong Park, Kwonhee Suh, Junbeom Lee, Donkyu Joo, Junghun Yun and Daeoh Kang

This study involves modeling and simulating a Fuel Cell Electric Vehicle (FCEV) to predict whether it meets the target performance requirements. The FCEV model includes an electrified powertrain, composed of a hydrogen fuel cell, motor, battery, and controller, along with a chassis model. A test environment was also modeled to evaluate these components. Various combinations of chassis and motor candidates were examined to predict vehicle performance for each configuration and assess whether the target performance was achieved. The results of this study serve as a reference for selecting optimal components during the development process.

Keyword Fuel cell electric vehicle / Electrified powertrain / Model based system engineering

Session 3-B, 16:00 ~ 16:30, Room 202

Vehicle Health Monitoring for Driving Safety using Co-simulation between Dymola and Simulink

| Yeongmin Yoo, Yong Ha Han, Dae-Un Sung and Kyung-Woo Lee

A vehicle dynamics model-based health monitoring process is presented to enhance driving safety. The vehicle model can simulate driving by reflecting degradation performance of suspension and tires. The model was developed using Dymola, and driving simulation was performed by integrating the lane keeping assistant system with the vehicle model using Simulink. The degradation behavior was monitored with k-nearest neighbor and Gaussian mixture model. The remaining useful life for vehicle components was predicted using Gaussian process regression. The proposed method predicts remaining useful life with a 95% confidence level for vehicle components to improve safety for driving.

Keyword Vehicle Health Monitoring / Lane Keeping Assistant System / Prognostics and Health Management

PAPER ABSTRACT

Session 3-C, 16:30 ~ 17:00, Room 202

A Virtual Testing Environment for SDV Development: Towards CI/CD Integration

| Hongseok Lee

This study proposes a methodology for constructing a virtual testing platform to support the implementation of Continuous Integration and Continuous Deployment (CI/CD) pipelines, which are essential for realizing Software Defined Vehicles (SDVs). SDVs, characterized by their reliance on software for defining and managing vehicle functionality, require robust testing and validation frameworks to ensure reliability and scalability. The proposed virtual testing environment comprises a road model, traffic model, weather model, scenario model, and vehicle model, designed to evaluate and validate autonomous driving systems effectively. Real-world road conditions were reflected by converting MMS-generated road data into the openDRIVE format, while representative scenarios were developed using the ASAM OpenSCENARIO standard. Vehicle dynamics were modeled using a 15-degree-of-freedom Tabular Elastic-Kinematic Suspension (TEKS) model, and the Virtual Test Drive (VTD) tool was employed to simulate the testing environment systematically.

By automating test case generation and evaluation, this framework supports the CI/CD process by enabling continuous testing and deployment of autonomous driving software. The study demonstrates that the proposed virtual testing platform is a critical enabler for SDV development, offering a scalable and efficient solution for integrating testing into the software development lifecycle. This approach lays the groundwork for accelerating SDV-based autonomous driving system implementation and enhancing software reliability through iterative validation.

Keyword SDV / Virtual testing platform / Scenario

Session 4-A, 15:30 ~ 16:00, Room 203

Study on Determining Optimal Design Parameters of Solar Heating and Cooling System

| Byoungdoo Lee

This paper presents a methodology how to analyze the SHC system and how to determine various parameter values for optimal operation. Modelica, Pistache, and easyDesign tools are used for searching the parameter values. First of all, SHC base model is developed by using Modelica language. Second, Pistache is used for calibration and validation of the Modelica model. Last, easyDesign generates nearly minimum sampling points for constructing the initial meta-models and improves the fidelity of meta-models by adding new design sequentially. 15 parameters are decided and optimal values are determined by the process. Optimal TCOP of the model is 0.164 which is improved 7.3% points (44.5%ÿ) compared to TCOP of the base model. In order to quantify the performance level of the SHC base model and optimal model, 9 solar performance indicators are defined at different levels with each target value.

Keyword absorption chiller / heating and cooling / HVAC / Solar heating / heat storage / Solar heating and cooling system / SHC / 태양열시스템 / 냉난방시스템 / 축열시스템

PAPER ABSTRACT

Session 4-B, 16:00 ~ 16:30, Room 203

Study on nuclear and renewable hybrid energy system performance prediction by using Modelica

| Hae-Ryong Hwang and Daeoh Kang and Kagsu Jang and Jiyeon Kang

The production and use of electric energy is constantly evolving in the building, industrial and transportation areas [1,2]. Looking at the electric energy production sector, the market share of variable renewable energy such as wind and solar power (PV) is continuously increasing. Among the use sectors, the transportation area is encouraged to use eco-friendly fuels, and accordingly, the use rate of battery and hydrogen electric fuel vehicles is rapidly increasing. In the building area, energy efficiency is increasing due to building energy management system (BEMS) and high-insulation materials. Since 2010, researches in nuclear-renewable hybrid energy system (NRHES) have been actively conducted to maximize efficiency in electric energy production and use. The NR HES, which combines production and use, is a system that actively controls electricity production and use and surplus energy utilization [3]. In this study performance analysis is performed for the architecture depicted in the former study[3] by digital twin for securing operation efficiency of NRHES. Digital twin is built based on multi-physics system using Modelica. All components were modeled to consider electricity, heat, mechanics and environment at the same time[4,5].

Keyword Reactor / enewable / NRHES/ IP / Hydrogen / ESS

Session 4-C, 16:30 ~ 17:00, Room 203

Digital Twin for District Heating Substations: A Cyber-Physical Modeling Approach

| Jaeyoon Shin, Junghoon Wee, Yujin Seo and Young Tae Chae

District heating systems have emerged as a pivotal technology in sustainable urban energy systems, particularly fourth-generation systems that leverage low-temperature heat sources and renewable energy. These systems offer significant potential for improving energy efficiency and reducing greenhouse gas emissions in buildings.

However, optimizing the performance of district heating systems requires advanced control strategies. This study proposes a cyber-physical model for district heating substations, a critical component of these systems. The proposed model integrates real-time simulation and control techniques to optimize energy consumption, reduce operational costs, and enhance system reliability.

By accurately simulating the dynamic behavior of the substation and its interactions with the wider district heating network, the model enables the development and testing of advanced control algorithms. The implementation of this cyber-physical model can lead to significant improvements in the overall efficiency and sustainability of district heating systems.

Keyword Cyber physics model / Simulator / Control / District heating substation

PAPER ABSTRACT

Session 5-A, 10:30 ~ 11:00, Room 202

Testing Large Scale System Simulation using Linear Implicit Equilibrium Dynamics

| Dirk Zimmer

The concept of flattening where all model equations are collected in a single set is deeply hardwired into the Modelica language. While flattening enables effective symbolic manipulation such as the reduction of systems with a higher-index, it also imposes limitations. Two of these limitations are that the code generation for very large systems may not scale very well and that a statement on the regularity of the system often cannot be made before the flattening took place. Whereas it is difficult to overcome these limits in the general case, there is a sub-class within Modelica models that is comparatively easy to precompile while still enabling the modeling of complex systems. This paper explores this path and presents first experiments on the scalability for larger systems.

Keyword Compilation / Modelling Methodology / Large Scale Systems

Session 5-B, 11:00 ~ 11:30, Room 202

Requirements-based, early-stage Architecture Performance Validation on a Brake System Use Case

| Sinyoung Kang, Marcel Gottschall, Sunghyun Cho and Torsten Blochwitz

Automotive industry OEMs and suppliers are progressing their engineering processes and performance to the next maturity level gearing to digital thread solutions. Cur- rent challenges like continuous engineering, virtual cer- tification, distributed development, consolidated virtual proving grounds, homologation, digital twin and opera- tional applications, require well informed decision making in a comprehensive, reliable, traceable and customizable environment. In particular, in automotive domain, with widespread tight collaborative ecosystems between inte- grators and suppliers, the capability of tracing each decision and its underlying artifacts becomes a key value of an engineering platform.

This paper will outline a middleware approach to reuse generated artifacts and their relationships in a federated engineering environment and applying Modelica simula- tion models as the key integrator between architectural de- cision making and subsequent development up to detailed 3D design. Based on an exemplary, automotive brake sys- tem setup, the benefits of integrated data and workflows from specification to virtual architecture exploration and design verification are highlighted to motivate their value towards a realization of continuous model-based systems engineering methodologies.

Keyword MBSE / System Simulation / Virtual Validation / Automotive Brake System

PAPER ABSTRACT

Session 5-C, 11:30 ~ 12:00, Room 202

Development of a Modelica-based Multi-fidelity Simulation Framework for Semiconductor Infrastructure Digital Twin

| Jeehwan Lee, Chiwon Kim, Haeun Yoo, Minwoo Kim, Chanhee Moon and Sungmin Yoo

The semiconductor infrastructure is comprised of numerous auxiliary systems such as HVAC, bulk gas/chemical supply, and exhaust/wastewater treatment, and is highly complex due to the sheer number of components and cross-system interdependencies. In addition, the ultra-precise nature of fab operation dictates tight tolerances and allows little room for human error. Consequently, the traditional approach of manually designing and constructing 1-D simulators may not be applicable. To this end, we have developed a simulation platform which automatically generates both low and high-fidelity simulators for efficient infrastructure operation. Analyzing BIM and sensor data, a high-fidelity, physics-based simulator based in Dymola is first generated.

Simulation results are subsequently loaded into our built-in 3D viewer which can generate pressure, temperature, and flow rate profiles on demand. For the purpose of on-line prediction and optimization, hybrid surrogate models are automatically trained via active learning using both the generated Dymola simulator and sensor data. These low-fidelity, reduced-order models (ROM) can generate solutions under 0.01s whilst ensuring at least 95% accuracy compared to sensor data. Our simulation platform significantly reduces man hours required for simulation tasks and can serve as a test-bed for infrastructure digital twin.

Keyword Multi-fidelity / System simulation / Digital twin / Semiconductor infrastructure / Modelica / Dymola

Session 6-A, 10:30 ~ 11:00, Room 203

Multi-Physical Modeling and Analysis of AWD Electric Vehicles with Disconnector Actuator System and Regenerative Braking Control Using Modelica and FMI

| Minsu Hyun

This study presents a multi-physical model of an all-wheel-drive (AWD) battery electric vehicle (BEV) that incorporates a Disconnector Actuator System (DAS) and regenerative braking control logic using Modelica and FMI (Functional Mock-up Interface). The primary objective of the model is to analyze the effects of DAS and regenerative braking control on the energy efficiency and damage to the motor and gearbox in electric vehicles. The EV model, excluding the DAS and regenerative braking control logic, was developed using the Vehicle Dynamics Library (VDL) and Electrification Library from Modelon. The DAS and regenerative braking control models were developed in Matlab Simulink and imported as FMUs (Functional Mock-up Units) for co-simulation. Validation was conducted using drive cycles such as the Urban Dynamometer Driving Schedule (UDDS), the US06 Supplemental Federal Test Procedure (US06), and the Highway Fuel Economy Test (HWFET). The simulation results confirmed the proper behavior of motor and battery signals under the influence of DAS and regenerative braking logic. These findings highlight the significant role of control systems in the performance and durability of electric vehicle powertrains.

Keyword Disconnector Actuator System (DAS) / Regenerative Braking Control / Battery Electric Vehicle (BEV) / Multi-physical Modeling / Modelica / FMI (Functional Mock-up Interface) / Energy Efficiency / Motor and Gearbox Damage / Co-Simulation

PAPER ABSTRACT

Session 6-B, 11:00 ~ 11:30, Room 203

A Study on Model-Based Thermal Management Systems Architecture Modeling and Energy Efficiency Prediction of Fuel Cell Electric Vehicles

| Jun Beom Lee, Kwon Hee Suh, Ju Hyeong Park, Don Kyu Joo, Jung Hun Yun and Daeoh Kang

The purpose of this study is to predict the energy efficiency of Fuel Cell Electric Vehicles (FCEVs) based on the configuration of the Thermal Management System (TMS). The energy efficiency of an FCEV is closely tied to the effective thermal management of the electric powertrain. Therefore, this paper investigates TMS modeling for FCEVs and multi-physics modeling of FCEVs. The main modules of the target multi-physics FCEV model include the Vehicle Dynamics Model, Thermal Management System, Electric Powertrain, and controller. The core research focus is on the TMS, which includes a water-cooled TMS architecture and a water-cooled + two-phase fluid-based TMS architecture. Key thermal management components include the fuel cell, battery, motor, and balance of plant (BOP). The model was developed using Modelica and was used to predict the energy efficiency in various driving environments (extreme cold, normal, extreme heat) and driving conditions.

Keyword Vehicle System Engineering / Thermal Management System / Fuel Cell Electric Vehicle

Session 6-C, 11:30 ~ 12:00, Room 203

Digital Human Body Model for Occupant Monitoring System

| Man Yong Han, Yong Ha Han and Hyung Yun Choi

Occupant monitoring systems have been developed and used for Autonomous Driving (AD) level 3+. These occupant monitoring systems have limitations in accuracy and measurement items. To compensate for this, a Digital Human Body Model (DHBM) based on the Modelica language is developed, and its features are introduced. Inverse Kinematics (IK) and Inverse Dynamics (ID) DHBMs are interlocked with the occupant monitoring system to increase measurement accuracy and calculate various information such as motion sickness and fatigue. However, simulation of occupant behavior prediction is impossible. Forward Dynamics (FD) DHBM is a model that implements the characteristics of the live human studied through experiments and can predict occupant behavior. However, parameter verification is necessary to trust the results of FD DHBM. It is developing real-time validation and parameter update algorithms for FD DHBM using occupant monitoring data, which are expected to be available in various fields such as comfort and safety.

Keyword Digital Human Body Model (DHBM) / Occupant Monitoring / Autonomous Driving (AD) / Active Safety System (ASS)

PAPER ABSTRACT

Session 7-A, 13:30 ~ 14:00, Room 202
Modeling a Rotary Compressor
| Kosei Tsuji and Scott Bortoff

This paper presents a mathematical model for a rotary compressor, realized in Modelica. The model captures the thermofluid dynamics and refrigerant transport associated with vapor compression, and includes the mechanical dynamics of the rotary piston and the discharge valve. The geometry is modeled in detail with a volume function that depends on crankshaft angle. The model takes into account the effects of refrigerant leakage along multiple paths among the two compression chambers, the suction port, the discharge port, and a clearance volume above the compression chamber. It also includes heat transfer between the refrigerant, rotary piston and chamber walls, and the mechanical dynamics of the discharge valve. The model is a set of hybrid differential-algebraic equations, where the discrete state depends on the crankshaft angle and boundary conditions.

The model is useful to quantify various thermodynamic losses, and may be used to compute the volumetric efficiency. The model may be used directly in a cycle simulation, but its complexity may result in long simulation times. Therefore, reduced-order compressor models that are commonly used in cycle simulations, which are essentially polynomial curve fits that compute exit enthalpy, refrigerant mass flow rate and power consumption as a function of compressor speed, inlet enthalpy, inlet pressure and discharge pressure, may be computed from the detailed model, allowing for coefficient calibration at off-design conditions.

Keyword Rotary compressor / Thermodynamic system / Dynamic simulation

Session 7-B, 14:00 ~ 14:30, Room 202
Process modeling and simulation of a batch reverse osmosis process using modelica
| B Sai Mukesh Reddy, Seongpil Jeong, Jaichander Swaminathan

Batch operation of reverse osmosis (RO) systems has emerged as a promising strategy for enhancing energy efficiency and mitigating fouling in seawater desalination. This study utilizes a transient numerical/mathematical model implemented in Modelica to investigate the design and performance optimization of batch seawater RO (BSWRO) systems under practical conditions. The model incorporates critical factors such as energy consumption and membrane configurations aiding in evaluation of real-world operational scenarios. This study also highlights the potential of batch RO(BRO) systems along with pressurized feed tanks to achieve significant energy reductions. The adoption of Modelica underscores its utility in simulating complex thermal-hydraulic interactions in membrane-based desalination systems, paving the way for more efficient and sustainable technologies. The use of Modelica enhances the analysis by enabling dynamic simulations of system performance and optimal control, offering a more integrated and modular framework compared to other modelling tools.

Keyword Batch Reverse Osmosis / Modelica / mathematical modeling / transient

PAPER ABSTRACT

Session 8-A, 13:30 ~ 14:00, Room 203
Object Oriented Modeling of Single and Multi-Bed Pressure Swing Adsorption Processes using OpenModelica
| Nikhil Sharma, Kannan Moudgalya and Sunil Shah

Pressure Swing Adsorption has been implemented to produce pure oxygen from air. Its model is solved using the methods of finite difference and orthogonal collocation on finite elements. Discrete events of this process are modelled using state graphs. Solution to the PSA process using a single bed is presented. With two beds, it is shown that it is possible to produce oxygen continuously. All of these have been done using OpenModelica, and the code is released as open source.

Keyword Pressure swing adsorption / state graph / Open Source / High purity oxygen production

Session 8-B, 14:00 ~ 14:30, Room 203
Improving Automatic Parallelization for Equation Based Mathematical Modeling and Simulation using Metaheuristic Optimization
| Abdelazim Hussien and Adrian Pop

Modeling and Simulation tools need further improvements to run more efficiently in a distributed way. Our previous work has proposed solutions for automatic parallelization of simulation models by building a task systems library (ParModAuto) for efficient representation, clustering, scheduling, profiling, and executing complex equation/task systems with heavy dependencies. The ParModAuto library contains algorithms that are heavily relying on heuristics to tackle hard, NP complete, optimizations problems. In this paper we are investigating the use of metaheuristic optimizations such as swarm intelligence and biologically inspired optimizations to improve on the existing approach in our automatic parallelization library and achieve more speedup in the simulation execution. Furthermore, we asses the effect of matching and tearing choices on the opportunities for parallelization in the resulting task graph.

Keyword Modelica / Modeling & Simulation / ParModAuto / metaheuristic

SPONSOR ABSTRACT

Session ID	Sponsor Session 1
Sponsor Name	KOROAD
Title	A study to assess whether the driving ability of auto nomous vehicles in Real road traffic can be tested in virtual environments
Presenter	Taekyung Kim
Abstract	To license autonomous vehicles, countries around the world are establishing methodologies to evaluate and demonstrate autonomous vehicles, focusing on the functionality and performance of the vehicle integrated from the software level to the unit module level. Given the current technology level of autonomous vehicles, they will face mixed situations with regular vehicles on the road and will have to interact with various objects such as pedestrians, vehicles, and two-wheelers using the road. To evaluate these non-functional interactions with other road users, KOROAD is deriving traffic regulations that autonomous vehicles must comply with from the Road Traffic Rules, a law under the jurisdiction of the National Police Agency, and establishing evaluation methodologies and services that can be learned and performed in a virtual environment before being evaluated on real roads.
Keyword	Autonomous vehicles / virtual environment testing / Road Traffic Rules / Evaluation scenarios

Session ID	Sponsor Session 2
Sponsor Name	DASSAULT SYSTEMES
Title	Development of a Simulation Environment for Heat Pumps
Presenter	Nuri Kang / LG Electronics Inc
Abstract	This presentation deals with the development of an emulator for a room air conditioner(RAC) which consists of integrated control logic and dynamic model of a thermodynamic system to predict the its performance. In order to predict the dynamic response of the heating and cooling operation in time domain, the system should be modeled as a set of differential equations and the analysis becomes more complex and includes more nonlinear behaviors because of the thermo-fluidic system's properties. The Dymola is appropriate for the analysis such a huge complicated system's behaviors. To implement a thermal system within Dymola for a RAC, the Thermal System library (TIL, developed by TLK GmbH) is also used. The heat pump components are created and modified as individual objects, which are interconnected to form the complete system. In the next step, we integrated control logic and thermodynamic system to predict the actual heat pump in the form of the Functional Mock-up Unit (FMU). Finally, we describe the simulation results in this presentation.
Keyword	Dymola / Heat Pump / SILS / FMU / Emulator

SPONSOR ABSTRACT

Session ID	Sponsor Session 3
Sponsor Name	Modelon
Title	Exploring Modelon Impact : Transforming System Design with Cloud-Based Simulation
Presenter	Emily Hirai
Abstract	Modelon is a leading innovator in system modeling and simulation software, empowering engineers to virtually test and optimize physical systems. Headquartered in Sweden, with a global presence spanning Europe, North America, India, and Japan, Modelon is dedicated to revolutionizing system design across industries. Our flagship product, Modelon Impact, is a cloud-based simulation platform built on the Modelica standard. Featuring over 17 comprehensive libraries of component models, it offers unparalleled versatility for creating physical system models across multiple domains, such as thermofluids and mechanics. This integration capability makes Modelon Impact the ideal tool for designing complex systems that meet modern engineering challenges. Modelon collaborates with industry leaders, including Hanon Systems and General Electric, to design innovative solutions and retrofit existing systems to align with evolving climate targets. Join us to explore how Modelon Impact empowers engineers to design sustainable, efficient systems and drive the future of engineering innovation.
Keyword	System Simulation / Modelon Impact / Cloud-based Platform

TUTORIAL SESSIONS

Title	**Tutorial Session 1 : Modelica Language Basic**
Time	Day 1 09:00 ~ 11:00
Location	Hall B
Presenter	Junbeom Lee (iVH)
	We will teach you the basic grammar of Modelica. We will guide you through modeling methods, hierarchical structures, and simulation and analysis processes through simple examples. After the training, you will be able to acquire a general understanding of Modelica.
Title	**Tutorial Session 2 : Modeling complex thermal architectures using the DLR ThermoFluid Stream Library**
Time	Day 2 14:30 ~ 16:20
Location	Hall A
Presenter	Dirk Zimmer (DLR)
	The DLR ThermoFluid Stream Library introduces a new computational concept to enable the robust solution of even complex thermodynamic architectures. In this tutorial we provide you with hands-on examples to work, discuss the theoretical underpinning and present the newest additions to the library. For library access and tool compatibility, please visit the ThermoFluid Stream
Title	**Tutorial Session 3 : FMI Beginner's tutorial**
Time	Day 2 14:30 ~ 16:20
Location	Hall B
Presenter	Juhyeong Park (iVH)
	The first part consists of a presentation of the motivation, history, the FMI project, the basic technical idea, the different FMI versions, limitations and the current state of tool support. In the second part, hands-on exercises are given to gain first experience with creating, checking, coupling and simulating FMUs in different open source and commercial tools. At the end an outlook is given on further material: other resources such as tutorial modules for more advanced usage of FMI.

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