HUBCAP
Digital Innovation HUBs and Collaborative Platform for Cyber-Physical Systems

Newsletter 7 October 2022

HUBCAP Newsletter: Success Stories 1/2

Call #2.2 EXPERIMENT Success Stories

HUBCAP brings together Digital Innovation Hubs to support SMEs embracing digital innovation. Our focus is on model-based technologies and solutions to develop Cyber-Physical Systems (CPSs), for which HUBCAP has developed an open, cloud-based Collaboration Platform. This innovation portal enables businesses to contribute and access digital assets needed to undertake Model-Based Design (MBD) for building Cyber-Physical System solutions on the scale required for SMEs. Assets include both models and services, and they are made available to allow businesses to manage their investment in MBD technology and to promote experimentation.

HUBCAP has run three calls: PULL, EXPERIMENT, and INNOVATE. PULL attracted and engaged with individual SMEs to join and to integrate existing CPS and MBD tools in the HUBCAP platform to enlarge the HUBCAP ecosystem. EXPERIMENT encouraged SMEs to adopt or improve CPS products and services by applying assets from the HUBCAP platform in a two-SME consortium. INNOVATE funded the deployment of new products and demonstrations of highly-innovative collaborations using the HUBCAP platform.

In this newsletter, we invite you to peruse the outcomes of our experiment call #2.2 to see what the SMEs have been able to achieve with help from HUBCAP.

Exploiting cloud computing and AI technology for hydrogen storage & transportation towards net zero by 2050

Energy security and decarbonisation are top priorities of the EU, which supports numerous changes across the energy sector with the use of hydrogen being one of the biggest.

The project aimed to develop a viable solution for simulating liquid hydrogen storage and transportation for hydrogen-based energy systems. The solution in this case was to combine traditional methods of performing simulations — such as computational fluid dynamics (CFD) — with machine learning (ML), and simulate hydrogen-based storage and transportation scenarios more quickly and cheaply than the current solutions on the market.

The CFD simulations were performed using the massive simultaneous cloud computing facilities of KaleidoSim OpenFoam®. The simulation output data was used to train the convolutional neural network (CNN) of MultiFluidX MPflow®. About 500 simulations were performed, of which 100 were used to validate the CNN. The validation was successful, and comparison of CNN output with published empirical data was favourable.

H2AI has developed a CFD/ML-based workflow that uses computer simulations to perform 'virtual experiments', which can be used to make near-instant accurate predictions, and thereby help to produce a product that is both safe and performs optimally.

"HUBCAP has funded the first project for improving design for hydrogen energy infrastructure using HPC and machine-learning-accelerated digital tools." - H2AI Team

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More EXPERIMENT #2.2 Success!

Model-based design of the public transport operation run by zero-emissions buses

Efficient operation of a public bus service has always been important. Today, such operation has even greater importance, since society must become both energy-efficient and decarbonised because of climate change.

The project aimed to predict bus energy consumption, and thereby optimize their battery capacity, minimize running costs and CO_2 generation, and consequently reduce the duration and costs of bus operation planning.

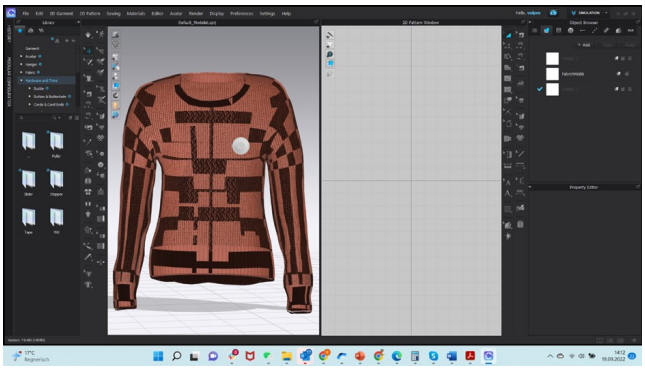
A mathematical model of an electric bus was built and data collected from third parties about bus routes. An existing simulator was used to run 180 scenarios of 4 bus routes with different parameters, including ground elevation, weather conditions (temperature, rain/snow), and passenger numbers.

The project has developed a simulator for planning and managing electric bus operation, also implemented on the HUBCAP platform, and produced two simulation reports for the Dancer Bus 530.

"HUBCAP funding enabled us to justify our place in the public transport value chain, which is much more than shooting blindly." - Electrification of Public Transport Team

SmarTexMod

The Internet of Things is becoming integrated with clothing, and the aim of this project is to improve the efficiency of designers in designing, developing, and prototyping smart clothes.



The project created 10 parameterized items (assets) required to create models of smart clothes, using Rhino and Autodesk Fusion 360. The models can be downloaded and imported into existing clothing design software (Clo3D) and rapid prototyping software (Slicer Cura, Ultimaker and MakerBot). Models were tested with these tools and the results were satisfactory.

SmarTexMod has produced 10 parameterized models for smart textile design, prototyping, and production, which can be downloaded from https://smartexmod.com/ along with a user guide. There is also a tool on the HUBCAP platform based on these models.

Flood and fire risk mitigation in wetlands using microwire sensing (FF-RIWER)

Wetlands are fragile ecosystems that are susceptible to flooding and bush fires, which can damage the habitat, cause pollution, and hamper the movement of people in the affected area. This project used a novel sensor technology to create an early warning system for flooding and fire in wetlands.

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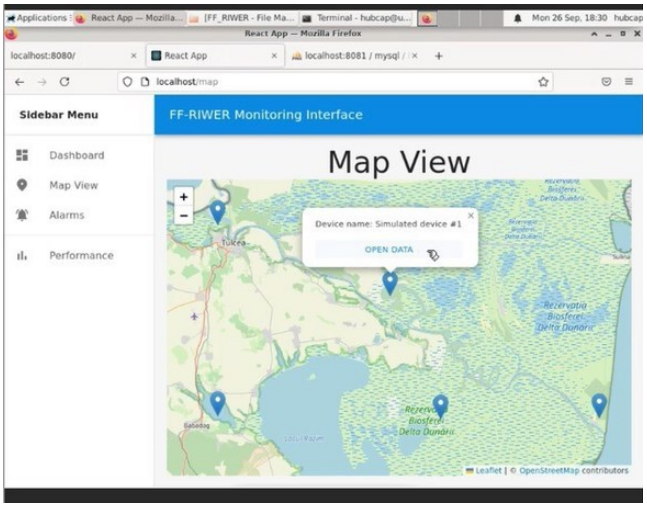
More EXPERIMENT #2.2 Success!



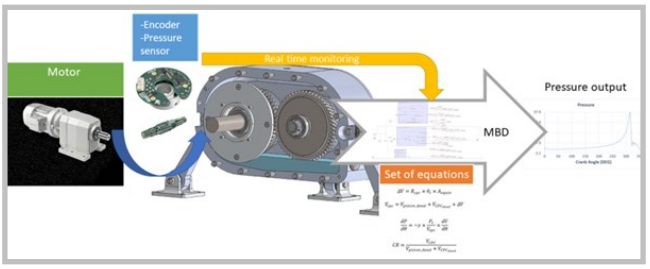
The project developed software to read data in real-time from MicroWire sensors, and transmit it wirelessly to a server for storage, generating alerts, and visualization of alerts. MicroWire is the world's smallest passive sensor, developed by RVmagnetics (one of the partners) to measure magnetic field, pressure, and temperature. The system was validated by varying the water level in a pool, and by varying the temperature using a hand dryer. The testing was done at the Center for Advanced Research on New Materials, Products and Innovative Processes, and showed no false alarm and >95% correct sensing.

The software system is an asset in HUBCAP.

"In FF-RIWER we combine RVMagnetics environmental sensors (a HUBCAP asset) with newly created software modules for communication, data storage and processing and visual data presentation (alerts, history etc) for a new CPS solution to be used in use cases related to wetlands (and envisioned to be first deployed in the Romanian Danube Delta). RVM's technology allows for precise fire and flood sensing with little energy consumption and small, unobtrusive devices, making it ideal for the fragile wetland ecosystem." - Laurenţiu Boicescu, ACC Team Lead

Accelerating the experimental process of a gas compressor's prototype, called SARC, using MODELTA platform (SARCproject)

The project aimed to develop a model-based design method that combines mathematical models with input from sensors to improve the design and operation of a novel rotary compressor.



The operation of the SARC compressor was modelled and analyzed using computational fluid dynamics and finite element analysis. The models were tuned using sensor measurements of temperature, pressure output and angular motion (made using a previous prototype). The MODELTA web platform was developed to support this. MODELTA was also used for real-time monitoring of sensors, and to predict through simulation (using Simulink) the performance of SARC.

Model-based design supported by MODELTA has had multiple benefits: the final SARC prototype has 25% less weight than the previous prototype, better performance and reliability, and lower costs for manufacturing and operation. Rapid prototyping was another benefit. The experience of using model-based design during the project has proved crucial for the development of other prototypes: a rotary internal combustion engine, an expander, and a pump based on the novel rotary working principle.

MODELTA is an asset in HUBCAP, and has resulted in further projects: one commercial, one research.

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More EXPERIMENT #2.1 Success!

MedaPlus

The outcome of this project enabled MedaPlus to address the needs of hospitals, polyclinics, doctors, and non-physician staff by offering a fully digitized auscultation solution—auscultation is the action of listening to sounds from the heart, lungs, or other organs. Additionally, the outcome of this project has enabled MedaPlus to offer its services globally and to address use cases not sufficiently addressed today like remote patient auscultation (telehealth). Further impacts include:

(1) increase in the frequency of auscultation, progressively increasing to continuous monitoring, leading to an increase in the quality of the auscultation analysis

(2) increase in the number of patients that can be screened, leading to more patients that can be treated early, early intervention is essential to mitigate potential health risks

(3) efficiency gains for physicians who can outsource the auscultation process and analyses the data at a chosen time at a remote place

4) reduced risk for doctors, hospitals and insurances because auscultation results are automatically documented, and second opinions reduce the chance of mis-interpretation and thus legal cases

"HUBCAP created the opportunity for our two SMEs to build an end-to-end telehealth solution that addresses the needs of hospitals, polyclinics, doctors and non-physician staff."
- MedaPlus Team

ARC

The aim of this project was to develop and test a controller for active sprayer boom stabilization and control. In order to achieve this, we explored opportunities to reduce physical testing and we decided to utilise model-based engineering approaches. In collaboration with Danfoil we modelled a sprayer boom and developed an active roll axis controller specifically for the sprayer boom. While this model contains dynamics of movement in both heave and roll directions for multiple joints, the primary focus of the project is evaluation of the controller tracking in the roll direction.

The first step of the project was to create a model that depicted the roll and heave axis dynamics of the system. For validation of this model, multiple test datasets based on both manual step inputs with different actuation times were used, to make sure that the model was accurate for various actuation scenarios. In the second step, we developed a controller in order to keep the boom within the maximum allowed deviation when spraying. This would mean the sprayer would maintain the boom within a stable position with minimal variation. The controller performance was evaluated through the digital twin utilizing data from actual driving tests that cover the normal operation range of the boom during field spraying.

Using initial results from the evaluation, we were able to fine-tune the controller and adjust the underlying model in order to achieve the desired performance.

"Funding from the HUBCAP project enabled the consortium partners to hire additional personnel to develop an active controller for sprayer boom roll control. The developed controller was tested and evaluated in a digital twin setting in order to minimise development costs and physical testing."
- ARC Team