NEWSLETTER °3
JUNE 2023

Welcome to the FOCETA project newsletter n°3!

In a context where applications are increasingly being developed based on complex autonomous systems driven by artificial intelligence, their safety, autonomy and trustworthiness are challenging, especially those of learning-enabled systems, not easily traced by continuous engineering.

The ultimate goal of the FOCETA project is to develop the foundations for continuous engineering of trustworthy learning-enabled autonomous systems. The underlying targeted scientific breakthrough of FOCETA lies in the convergence of model-driven and data-driven approaches. This convergence is further complicated by the need to apply verification and validation incrementally and avoid complete re-verification and re-validation efforts.

Our public newsletters keep you up-to-date on the progress made within the project. You will discover how the consortium partners cooperate to achieve the project objectives. You will also know how and when we disseminate the FOCETA results.

THE FOCETA PROJECT IN A NUTSHELL

- **4 985 540 € EU funding**
- **656 Person-months**
- **An international consortium**
- **36 months project duration**
- **Started on 01/10/2020**
- **13 partners from 8 countries**

Read more about FOCETA on the project website

This project has received funding from European Union's Horizon 2020 research and innovation programme under grant agreement N°956123.

EDITORIAL BY THE PROJECT COORDINATOR

We are approaching the epilogue of FOCETA. In this project, we have formulated clear and precise research objectives and activities that have guided us through each project stage. This final stage of FOCETA will allow us to evaluate the effectiveness of our developed methods and tools by applying them to the two case studies of the FOCETA project. In particular, beyond experimentation and validation, identify best practices, guide design, and implementation decisions, and avoid confirmation bias.

Our approach in this validation process only makes sense if we can avoid privileging only positive results. An essential feature of the quality of an experiment is to report both positive and negative effects. The negative consequences allow us to get closer to the truth. To put a hypothesis to the test of facts, it must be operationalized, that is, translated into measurable elements to obtain visual content.

Critical thinking and skepticism are necessary to produce knowledge in this crucial project phase. It will conclude the excellent work we have done together since the beginning of FOCETA, which has allowed us to make an impressive number of high-level publications and original tools that implement an engineering framework for learning-enabled autonomous systems..

Prof. Saddek Bensalem
Université Grenoble Alpes/Verimag
France

NEWS & EVENTS FROM FOCETA

SAVE THE DATE: Final FOCETA Project Public Workshop, 12 October 2023, Grenoble, France >> p. 11

44 scientific papers published by FOCETA partners are available on the project website >> Read

List of relevant Tools in FOCETA (created / developed / partially developed / used / extended) >> Read

FOCETA project **video** >> Watch

FOCETA project **leaflet** >> Download

FOCETA project **poster** >> Download

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PROJECT CONTACT INFORMATION

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Technical Coordinator: Dejan Nickovic (AITAustrian Institute of Technology)

PMO/Dissemination: Sofia Santi (L-UP SAS)

Figure 1: The FOCETA consortium gathered in Cairo, Egypt, at Siemens Industry Software (a Limited Liability Company under the Private Free Zones Regime) premises for the M30 General Assembly meeting.

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NEWS FROM FOCETA

CAPITALIZATION OF FOCETA RESEARCH IN THE TWO PROJECT USE CASES

Artificial Intelligence (AI), specifically Machine Learning (ML), has drastically evolved and is increasingly applied in many sectors, including mission-critical ones. For instance, in automotive, many companies such as Waymo and Tesla have been developing or even deploying their Automated Driving Systems (ADSs) using AI/ML. Despite several successful stories, there have been some disturbing accidents (e.g., Uber's fatal crash in 2018). The medical domain observes similar situations, where AI/ML is being applied yet challenged at the application frontiers.

As seen, these so-called learning-enabled autonomous systems (LEASs) are calling for more effective and efficient approaches for their rigorous development and assurance. In such regard, the FOCETA consortium has been working extensively to propose innovative modelling, verification, and validation techniques for trustworthy LEASs. Particularly, the consortium has put forth a holistic approach to deliver correct and safe LEASs and shared it with the community in our previous Newsletter (cf. FOCETA Newsletter n°2). This year, we will take a step further and share the latest developments in our use cases, where the FOCETA holistic approach is coming to fruition.

CAPITALISATION OF FOCETA RESEARCH IN THE AUTOMATED VALET PARKING USE CASE

This use case aims to establish a strong example of correct and safe Automated Valet Parking (AVP) system, one of the cutting-edge LEASs in the automotive sector, integrating FOCETA partners' verification, validation, and continuous engineering methodologies.

This article presents the use case by asking and answering a series of four questions. The first question motivates interests from different perspectives. The second and the third help showcase our use case structure and research outcomes, and the last question triggers an interim self-evaluation.

1. **What is an AVP system, and why should we care?**

As the term suggests, an AVP system offers a user to drop off the car in a designated zone and park the car in an empty slot for the user. Such an operation can be commonly seen at restaurants, shops, or other businesses. However, the key here is that all tasks after the car handover, including route planning, vehicle controlling, and obstacle avoidance, are automated without a human valet.

From a commercial perspective, AVP, like many other technologies, provides users with much more convenience than before (imagine simply leaving your car at the theater entrance just before the movie starts). It also would save quite some costs for the operating company. From a technological perspective, AVP, compared to open-world driving, allows for designing and testing new technologies in a more controlled environment. Nonetheless, despite seemingly fewer hazards, reports have shown accidents in parking lots are much more common and severe than expected[1,2]. Such observations make safety the last but not least motivation for us to investigate and construct an AVP system.

Figure 2: An example of our targeted Operational Design Domain (ODD) including dynamic road users and potentially varying weather conditions. The left image shows a bird's eye view with the drop-off zone in yellow and the designated parking slot in red. The right image shows a driving view, highlighting a pair of pedestrians at risk.

[1] The Impact of Autonomous Parking
[2] How Common are Car Accidents in Parking Lots?

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In fact, we are not alone in this investigation. Companies such as Audi[3] and research foundations such as Autoware[4] have been demonstrating their efforts. However, most demonstrations are either heavily dependent on indoor infrastructures such as on-pole sensors or tightly controlled without pedestrians and other driving vehicles. On the contrary, the FOCETA consortium targets operations with potentially varying weather conditions and many other active road users, especially pedestrians, thereby emphasizing advanced verification and validation techniques with a continuous engineering mindset to ensure correctness and safety. Figure 2 shows an example of our targeted operational conditions, technically termed Operational Design Domain (ODD), using the Siemens Prescan simulator[5]. Despite mainly focusing on virtual development in simulations, our target still challenges us in many ways and constantly fosters our research activities, which will be detailed subsequently.

2. What are the challenges, and how are we approaching them?

As can be imagined from Figure 2, even within a relatively controlled parking lot, there can still be many challenging factors. For instance, a pedestrian might walk out from behind a car, or another vehicle at an intersection might not yield according to conventions. In addition, the situations in the parking lot may vary over a day, not to mention weather conditions.

To tackle such challenges and ultimately deliver a correct and safe system, we follow the FOCETA holistic approach and establish a comprehensive use case architecture encompassing partners' contributions in various verification, validation, and continuous engineering methods such as design-time critical test case generation and run-time safety shielding. Figure 3 presents our overall use case architecture. All these contributions can be categorized into four phases within a continuous engineering process:

A. Baseline construction
B. Design-time testing
C. Run-time monitoring and enforcement, and
D. Incremental assurance and argumentation

We briefly introduce the first phase now and discuss the latter under the next question, where most of FOCETA partners' research efforts have been focused.

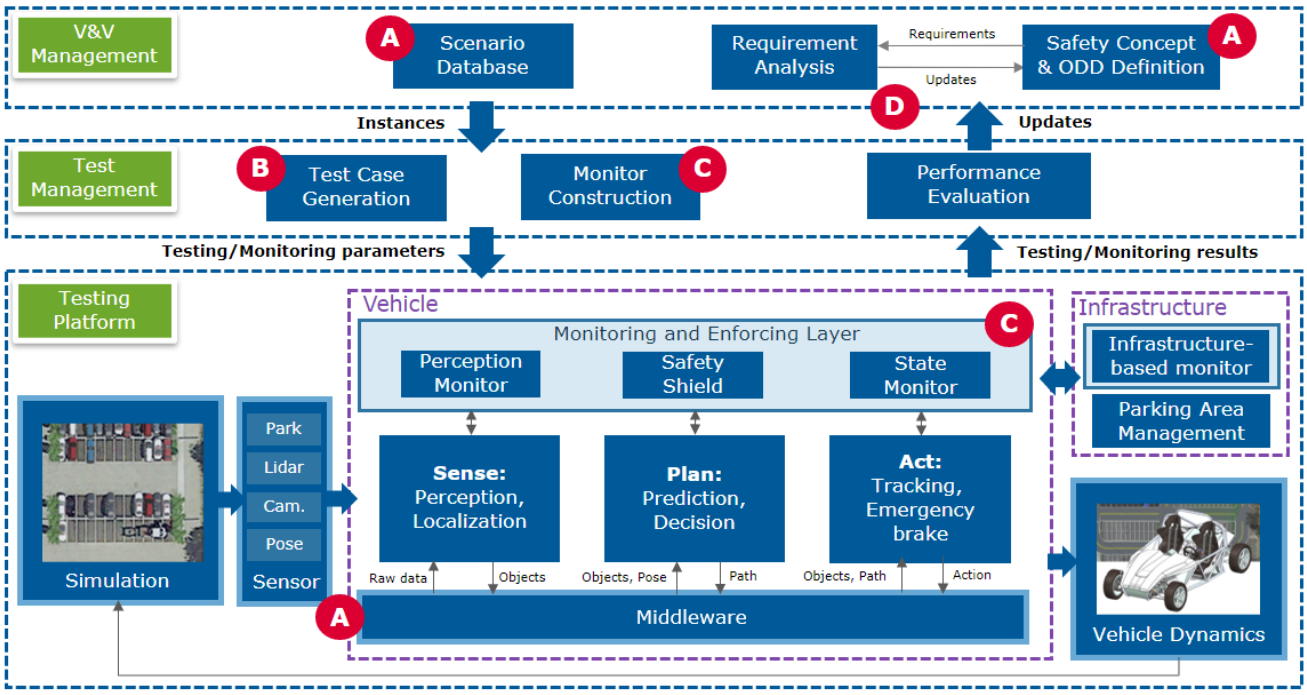

Figure 3: The overall AVP use case architecture encompassing all partners' contributions. The red tags mark the four phases in our continuous engineering process, namely baseline construction (A), design-time testing (B), run-time monitoring and enforcement (C), and incremental assurance and argumentation (D).

Intuitively, the first step for developing a LEAS (or any other system) is to set the requirements, including the ODD and system performance criteria. For the former, we construct an ODD using approaches similar to those of OpenDrive[6] and OpenScenario[7], prescribing scenarios based on specific parameters such as illumination, weather, and surrounding actor conditions. Regarding performance criteria, we first set a high-level safety goal that obligates the automated vehicle (AV) to cause no collision unless it is hit by other actors at a static state. Then, with the component-based design of the AVP system, we decompose the safety goal into low-level requirements. For instance, the learning-enabled controller is required to always follow a given path within a maximum deviation. Similarly, the emergency brake has to stop the AV whenever there is an obstacle situated within a safety

[3] Automated Valet Parking: That Time My Audi Parked Itself
[4] Autonomous Valet Parking - Autoware
[5] Simcenter Prescan Software simulation platform | Siemens Software
[6] ASAM OpenDRIVE®
[7] ASAM OpenSCENARIO®

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distance. This safety distance can in turn be derived from the maximum controller deviation and the maximum braking distance. Naturally, the learning-enabled object detector must then always recognize an obstacle within the derived safety distance.

Taking the described design of the system offers two potential benefits. First, the assurance of the overall AVP system can now be attributed to possibly more tractable and efficient verification efforts at the component level. Second, adopting the continuous engineering paradigm, we only need to refine and reverify components, typically the learning-enabled ones, that call for an incremental update at some point during testing or run-time. Based on the potential benefits, we now present our research outcomes that leverage on them and set new frontiers for the use case.

3. How is FOCETA research establishing new frontiers for AVP?

FOCETA Consortium partners' short names mentioned in the article	
AIT	*AIT Austrian Institute of Technology*
AUTh	*Aristotle University of Thessaloniki*
BIU	*Bar-Ilan University's*
DNDE	*DENSO AUTOMOTIVE Deutschland GmbH*
Fortiss	*fortiss GmbH*
Intel	*Intel Deutschland GmbH*
Siemens	*Siemens Industry Software SAS*
TUG	*Graz University of Technology*
UGA	*Université Grenoble Alpes*
ULIV	*University of Liverpool*

FOCETA research comes profoundly in the use case's continuous engineering process. While presenting all research outcomes within this article is difficult, we highlight a few in the following and defer interested readers to our complete publication list[8].

First, after the initial setting of the requirements, how do we know they are correct? FOCETA partners at AUTh and AIT answer this question. Specifically, AUTh has developed an ontology-based requirement validation tool that helps identify any inconsistency, ambiguity, or incompleteness in the requirements solicited during the first phase [1]. Their work further extends to formalizing the requirements to technical specifications that can be implemented in BIU's DejaVu monitoring tool [2][3]. Complementarily, AIT has proposed a data-driven method to mine the most important parameters within a scenario (e.g., rain severity or distance to the pedestrian at risk) and find the boundaries outside which the system shall not operate, thereby refining the ODD planned initially [4]. These research outcomes constitute early feedback on the requirements, reducing testing or monitoring burdens later.

Regarding design-time testing, the use case receives both component-level and system-level efforts. In particular, DNDE and ULIV have done several studies evaluating the safety and reliability of the object detector [5][6]. These measures provide insights within the overall system, allowing developers to know if the learning-enabled component performs correctly and how its performance is related to safety at the system level. Such analyses are followed by scenario-based testing in which searching techniques such as genetic algorithms are used to identify critical scenarios. In this regard, Fortiss has published the OpenSBT testing framework and worked with AIT, DNDE and Siemens to benchmark different searching techniques [7][8]. Furthermore, we are exploring methods for root cause analyses to identify the component at fault in case of a system failure, so that the specific component can be repaired if needed.

Then, considering the ever-changing world, an AVP system can hardly be fully assured by design-time testing only. Therefore, monitors and enforcers are usually added to the system to safeguard it during run-time. In the project, several research pieces have been done for monitoring the object detector to give timely warnings in case of abnormalities [9][10]. For instance, if the object detector registers an object that contradicts the monitor's free space detecting function, the monitor shall raise a warning. Such warnings are then passed to a controller shield developed by TUG that takes more conservative actions if needed [11]. The warnings are also passed to a global state monitor to ensure the overall correctness and safety of the AVP system. Moreover, as all these software components can be vulnerable to platform faults or cybersecurity threats, Intel and AIT have devised tools to supervise such events [12][13]. Altogether, the AVP system is protected by another layer of safety measures at run-time.

Finally, as introduced, we collect and aggregate evidence, such as evaluation metrics and reports, into an assurance case using Evidential Tool Bus (ETB) [14]. The automated ETB framework can construct an assurance case using the well-established Goal Structuring Notation (GSN), explicitly documenting evidence from different tools and allowing for incremental updates. For example, when the underlying object detector is re-trained with new data collected during run-time, the evidence that has been conditioned on it (e.g., its safety and reliability assessment) will be triggered for renewals involving minimal manual efforts. In such cases, we have also considered advanced techniques to utilize existing evidence and avoid the need of completely redoing the verification and testing steps [15][16].

With the notable research efforts by all consortium partners, the incremented assurance case will conclude a round of our continuous engineering process. Certainly, the proposed process can be iterated for further system improvement and completion.

4. How close is our AVP system to the handover of your car?

Although FOCETA does not aim for commercialization, we are much closer to such a handover point from where we started. On the widely adopted scale of Technology Readiness Levels (TRLs) as shown in Figure 4, we have progressed substantially from Level 2 and are now approaching the targeted Level 6.

For a full deployment and business transfer, multiple rounds of the proposed continuous engineering process are still needed to enhance the system. Specifically, our collaboration

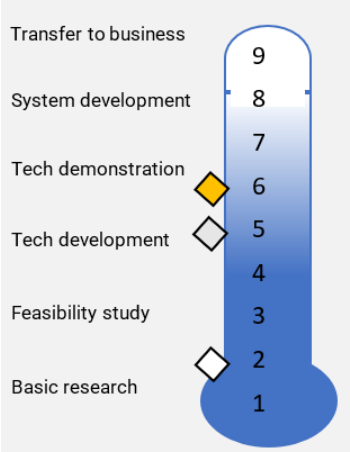

Figure 4 : The FOCETA AVP use case started from Technology Readiness Level 2, is now at Level 5, and will arrive at Level 6 as planned.

[8] FOCETA Publication List

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with standardization bodies such as technical committees of ISO/AWI PAS 8800[9] shows that it is essential to argue for the choices and the fulfillment of acceptance criteria (e.g., residual risks) at component and/or system levels before the deployment. Finally, as pointed out, the FOCETA AVP use case has been focusing on virtual developments, despite several real-world case studies using Siemens SimRod[10], a real vehicle platform, and Siemens PAVE360[11], a middleware and digital twin enabler [17, 18]. We leave these mentioned topics as future work.

Written by Brian Hsuan-Cheng Liao, DENSO AUTOMOTIVE Deutschland GmbH

References

[1] Konstantinos Mokos, Theodoros Nestoridis, Panagiotis Katsaros, Nick Bassiliades. Semantic modeling and analysis of natural language system requirements. IEEE Access 10, 84094-84119 (2022).
[2] Theodoros Nestoridis, Panagiotis Katsaros. Validation of requirements for autonomous systems under continuous development and operations. Under submission.
[3] Klaus Havelund, Doron Peled, Dogan Ulus. First-order temporal logic monitoring with BDDs. Form Methods Syst Des 56, 1–21 (2020).
[4] Ezio Bartocci, Jyotirmoy Deshmukh, Cristinel Mateis, Eleonora Nesterini, Dejan Nickovic, Xin Qin. Mining shape expressions with ShapeIt. SEFM (2021).
[5] Brian Hsuan-Cheng Liao, Chih-Hong Cheng, Hasan Esen, Alois Knoll. Improving the safety of 3D object detectors in autonomous driving using IoGT and distance measures. CoRR abs/2209.10368 (2023).
[6] Xingyu Zhao, Wei Huang, Alec Banks, Victoria Cox, David Flynn, Sven Schewe, Xiaowei Huang. Assessing the reliability of deep learning classifiers through robustness evaluation and operational profiles. AISafety (2021).
[7] Lev Sorokin, Tiziano Munaro, Damir Safin, Brian Hsuan-Cheng Liao, Adam Molin. OpenSBT: A modular framework for search-based testing of automated driving systems. Under submission.
[8] Adam Molin, Edgar A. Aguilar, Dejan Nickovic, Mengjia Zhu, Alberto Bemporad, Hasan Esen. Specification-guided critical scenario identification for automated driving. FM (2023).
[9] Yuhang Chen, Chih-Hong Cheng, Jun Yan, Rongjie Yan. Monitoring object detection abnormalities via data-label and post-algorithm abstractions. IROS (2021).
[10] Chih-Hong Cheng, Changshun Wu, Emmanouil Seferis, Saddek Bensalem. Prioritizing corners in OoD detectors via symbolic string manipulation. ATVA (2022).
[11] Bettina Könighofer, Julian Rudolf, Alexander Palmisano, Martin Tappler, and Roderick Bloem. Online shielding for reinforcement learning. CoRR abs/2212.01861 (2022).
[12] Florian Geissler, Syed Qutub, Sayanta Roychowdhury, Ali Asgari, Yang Peng, Akash Dhamasia, Ralf Graefe, Karthik Pattabiraman, Michael Paulitsch. Towards a safety case for hardware fault tolerance in convolutional neural networks using activation range supervision. CoRR abs/2108.07019 (2021).
[13] Sebastian Chlup, Korbinian Christl, Christoph Schmittner, Abdelkader Magdy Shaaban, Stefan Schauer, Martin Latzenhofer. THREATGET: Towards automated attack tree analysis for automotive cybersecurity. Information (2023).
[14] Tewodros Beyene, Harald Ruess. Evidential and continuous integration of software verification tools. FM (2018).
[15] Chih-Hong Cheng, Rongjie Yan. Continuous safety verification of neural networks. DATE (2021).
[16] Chih-Hong Cheng, Rongjie Yan. Testing autonomous systems with believed equivalence refinement. AITest (2021).
[17] Kevin Voogd, Jean Pierre Allamaa, Javier Alonso-Mora, Tong Duy Son. Reinforcement learning from simulation to real world autonomous driving using digital twin. IFAC (2023).
[18] Anastasios Temperekidis, Nikolaos Kekatos, Panagiotis Katsaros, Weicheng He, Saddek Bensalem, Hisham AbdElSabour, Mohamed AbdElsalam, and Ashraf Salem. Towards a Digital Twin Architecture with Formal Analysis Capabilities for Learning-Enabled Autonomous Systems. MESAS NATO conference for modelling and simulation of autonomous systems (2022).

CAPITALISATION OF FOCETA RESEARCH IN THE MEDICAL USE CASE

The goal of the medical use case in FOCETA is to develop a test-bench platform for an autonomous infusion pump controller for Depth of Anaesthesia (DoA) and to use the testbench to validate the proposed technologies.

An intelligent infusion controller for Vital Signs is a medical device that regulates the specific vital signs parameter such as Blood Pressure (BP), Neuromuscular transmission (NMT) or Depth of Anaesthesia (DoA) by means of drug infusion. For example, with a BP controller, the system operates delivering vasoactive drugs; the ultimate goal is to reduce the patient´s hypertension, and precisely control blood pressure measurements in a patient undergoing surgical intervention in the Operating Room (OR) or in postcardiac surgery in Intensive Care Unit (ICU). In FOCETA, we integrate partners' technical contributions and demonstrate one round of

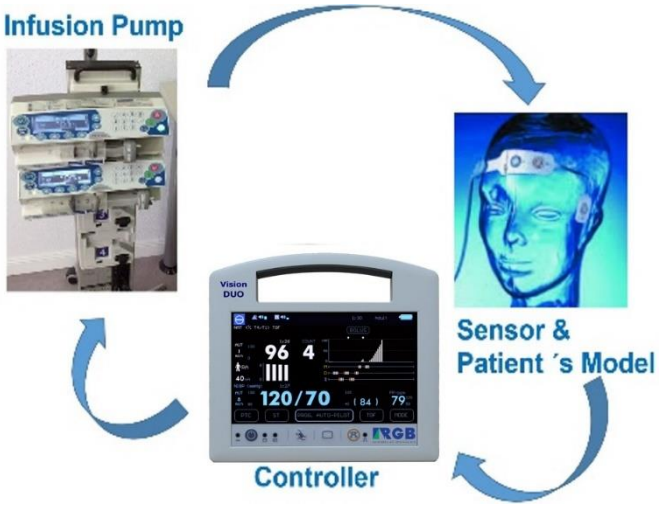

Figure 5: Depth of Anesthesia Controller concept.

[9] ISO/AWI PAS 8800 - Road Vehicles — Safety and artificial intelligence
[10] SimRod Experience: Model-Based System Testing in Practice
[11] Siemens PAVE360

This project has received funding from European Union's Horizon 2020 research and innovation programme under grant agreement N°956123.

continuous engineering utilizing FOCETA technologies: this starts from modelling, semantic reasoning, simulation, automatic test case generation, to abnormality detection, automatic repair (including LEC incremental training) and redeployment.

The holistic view

In total intravenous anesthesia (TIVA), general anesthesia is achieved using only intravenous anesthetics. The anesthesiologist assesses biological information and administers sedatives, analgesics, and muscle relaxants appropriately to maintain the desired state of sedation, analgesia, and muscle relaxation. However, anesthesiologists are humans and "to err is human", so safety must be ensured in anesthesia management, especially when the operation is long or lasts late into the night. Accordingly, automated anesthesia delivery systems have been investigated that assess biological information according to an appropriate algorithm on behalf of an anesthesiologist and, based on the information, continuously administer three components of TIVA-Anesthesia, muscle relaxation and analgesia (pain) - through a syringe pump. The dosage of the three drugs automatically delivered by the test device (propofol, remifentanil, and rocuronium) has to be within the approved dosage range.

However, it is difficult to develop an automated delivery system with a sufficient level of control accuracy compared to anesthesiologists, and currently no system is widely commercially available. Against this backdrop, we are developing in FOCETA a testbench platform for designing a control algorithm to improve automated anesthesia delivery with the purpose of controlling sedation. The aim of this study is to analyze the performance under laboratory conditions and finetune the design of a control algorithm that allows us to evaluate the quality of maintenance of TIVA given a certain number of control parameters.

The concept of Depth of Anesthesia

The concept of depth of anesthesia has not always been accepted. It can be said that a patient is either anesthetized or not and that depth is therefore a false construct. Whereas this statement is reasonable from the patient's perspective in terms of consciousness, there are additional neurological effects that take place beyond the point of loss of consciousness, and these effects constitute a progressive suppression of the Central Nervous System (CNS). The stages of anesthesia originally described by Guedel in 1937 show that increasing the dose of anesthesia progressively suppresses important neurological reflexes and functions. In the daily practice, there are two main indicators of anesthesia/sedation level: RASS (Richmond Agitation-sedation scale) and OASS scales (Observer's Assessment of Alertness/Sedation Scale). RASS ranges between -5 to +4 in the description of the continuum of anesthesia from the levels of least to most consciousness, while OASS ranges from 1 to 5.

Anesthesiologists skilled in total intravenous anesthesia in daily practice operates in a way similar as the one described below: Once the infusion of analgesic is carried out, after about 5 min, the target-controlled infusion (TCI) of propofol (Hypnotic drug) is started with a target blood concentration of 3 μg/mL. Relaxants are then administered to achieve muscle relaxation, followed by tracheal intubation. The anesthesiologist adjusts the continuous infusion rate of propofol to keep a certain level of sedation, which (when available) is measured with a BIS (BioIndex Score) between 40 and 55 when the depth of anesthesia targeted is high; otherwise, the target level of sedation can be low.

The patient´s behavior is different for each patient; even for the same patient it can change over time due to different sensibility of the patient to the drug.

The FOCETA testbench platform focuses on anesthesia alone (hypnotic drugs); it can be configurable, and different test cases are allowed. The objective is to evaluate the performance of the controller under different operating conditions. For example, change of weight, gender or age of the patient, distribution volume, change of target or sensitivity of the patient to the drug during the operation, noise injection on the values sensed by the perception system, etc.

Methods and tools applied to FOCETA Medical use case

Problem to solve: Test Robustness of Controller Design with different TESTCASE Manager Scenarios and at different Levels of abstraction when changing parameters of the Virtual Patient Model exported as Co-simulation FMU. This is carried out by introducing Virtual Platforms and Hardware-In-the-Loop model-based designs in addition to the BIP-based Controller developed in FOCETA; components are integrated via PAVE360 VSI tool automation flow.

The Controller for the regulation of Depth of Anesthesia (DoA) by means of drug infusion is optimized using an automated testbench platform where we can perform a large number of automated tests. The modules within the simulation infrastructure are the following:

- **Test Case Manager (MGR)** → Test Robustness of Controller Design with different Scenarios and depends on several components: A Generator script that generates different test-cases, each one representing a patient's profile. An exerciser that kicks-off operation of digital twin, and captures results saving them on database for a Capture script to visualize results (mainly BIS/OASS Vs Infusion Rate) and sends all metrics data using ROS collector node to AWS Cloud Watch metrics service for descriptive analytics, anomaly detection, etc.
- **Patient Model (PATMOD)** → Includes DoA Patient Model using SimCenter Amesim, which simulates the behavior response to Propofol.
- **Integration of run-time monitors** → The infusion controller in the simulated environment is equipped with advanced runtime monitors to detect potential abnormal behaviors.
- **DoA (Depth of Anesthesia) Sensor (SENSOR)** → The Patient Model itself provides DoA level based on dose infusion; RGB´s sensor for sedation level, will be used in the future; it includes Neuromuscular Transmission (NMT) discriminator based on generated raw data.
- **Propofol Controller (CNT)** → Uses NN based enhanced BIP Controller to be Noise tolerant.

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- **Infusion pumps (PUMP)** → The Infusion Pump Tree operates as Original Equipment Manufacturer (OEM) under the control of a customized software embedded in a Raspberry board, which includes alarm generation in the clinical setting.
- **Integration of Virtual Platform** → The integration of all components developed conform a prototypical implementation of the testbench platform and intelligent controller.

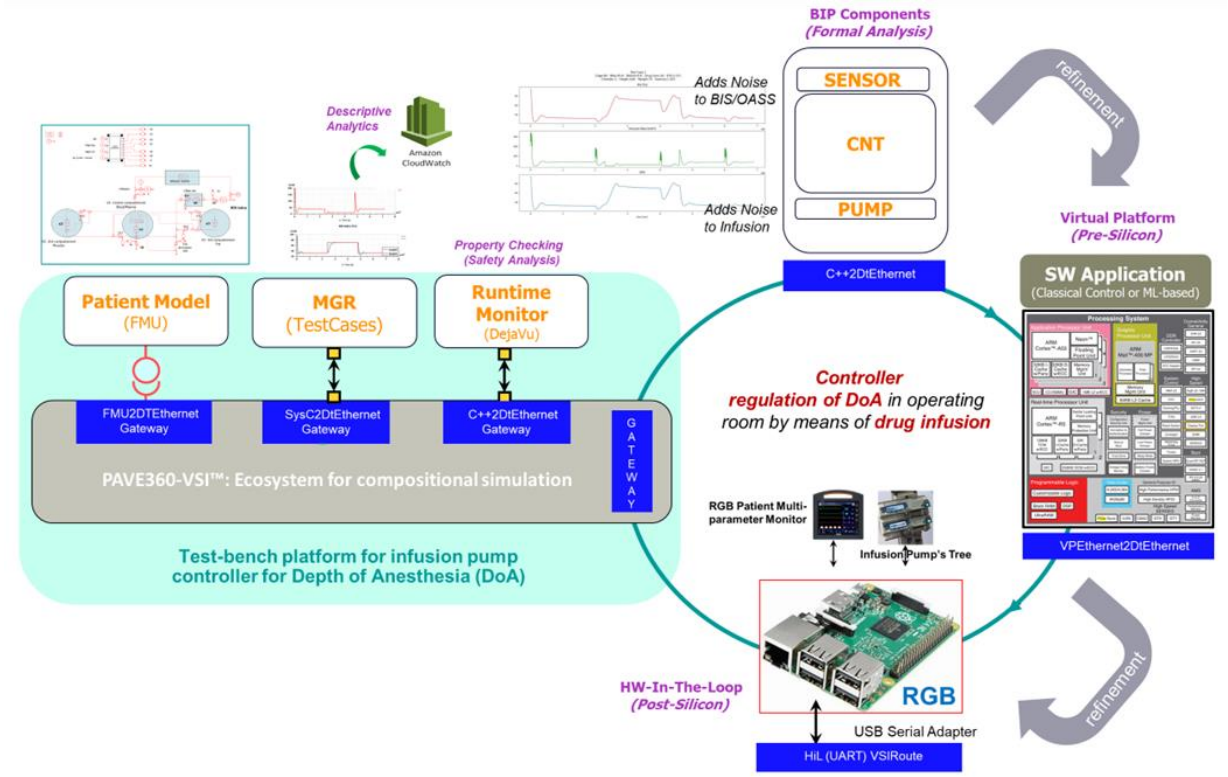

Figure 6: Testbench platform architecture.

Beyond the scope of FOCETA, the ultimate objective at system level is to incorporate the optimal control algorithm in RGB´s Multiparameter monitor. The result of FOCETA must mimic as much as possible the clinical environment. This also includes also the management of alarms in the handling process of the infusion pump. For example, it detects a cable disconnection, an "empty syringe" or an "amount of drug exceeded" condition.

Figure 7: RGB´s Multiparameter monitor and controller.

Written by Ricardo Ruiz, RGB Medical Devices

This project has received funding from European Union's Horizon 2020 research and innovation programme under grant agreement N°956123.

THE FLOOR TO THE PLAYERS: INTERVIEW WITH FOCETA PARTNERS

INTERVIEW WITH DEJAN NIČKOVIĆ, SENIOR SCIENTIST AT THE AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

Dejan Ničković *is a Senior Scientist at AIT Austrian Institute of Technology. His research interests include automatic methods for reasoning about safety and security of cyber-physical and autonomous systems. Dejan obtained a PhD in 2008 from University Joseph Fourier where he was advised by Oded Maler. Subsequently, he worked as a post-doc at EPFL and IST Austria. He has been in AIT since 2011. Dejan has been awarded the Runtime Verification Test of Time Award in 2021 for the impact of his work on the application of runtime monitoring to cyber-physical systems.* ***In FOCETA, Dejan covers the role of the Technical Manager****.*

Figure 8: Dejan Ničković (AIT Austrian Institute of Technology).

Question 1 (Q1): Dejan, how was AIT team involved in the FOCETA project? What are AIT key assets to contribute to FOCETA research?

Answer 1 (A1): AIT got involved in the FOCETA project pretty late in the process of preparing the proposal. There was already a competent consortium in place with a strong and convincing story to tell. The core team wanted nevertheless to further strenghten the consortium with a non-university research partner that is interested in both the safety and security sides of autonomous systems. AIT was fullfilling very well these requirements and hence we were invited to join the effort.

Q2: In FOCETA, AIT was the leader of two tasks, one related to Incremental modelling for cyber-security (which was achieved in Year 1), and the second to Specification mining for explainable and trustworthy autonomy (which ended in Year 2). What were the scope and main challenges of these activities? How will the results be integrated in the FOCETA Use Cases (i.e., the medical and the automotive UCs)?

A2: There are many security-related challenges associated to autonomous and learning-enabled systems. Autonomous agents require more and more connectivity and cooperation (between themselves, but also with the infrustructure), thus creating new attack surfaces. Learning-based systems are also increasingly evolving over time, possibly dynamically creating new vulnerabilities. The presence of machine learning components opens up completely new ways to compromise the security of the system, e.g. by using training data poisoning and adversarial perturbance of inputs. The incremental modelling of cyber-security task addressed some of these challenges, especially in the early phases of the design, by proposing incremental and compositional methods for developing learning-enabled systems that are secure by design. Cyber-security is highly relevant to both the medical and the automotive use cases. For example, threat modelling, analysis and repair will be applied to analyse the architectural design of the autonomous vehicles.

The learning-enabled systems also generate tremendous amounts of data and due to the presence of machine learning components, it is not always possible to fully understand what the system is doing and in which use contexts does it behave in a safe manner. Specification mining is an approach for inferring causal and temporal relations from time series data. In that task, we were exploring different specification mining methods to learn essential properties of our learning-enabled systems to render them more transparent, explainable and trustworthy. The main challenge in specification mining is to ensure that the inferred specifications are meaningful and that they provide additional insight into the system. In the medical use case, we combine specification mining with runtime verification to identify important vital signs of (virtual) patients during aenestesia. In the automotive use case, we use specification mining to identify environments in which the autonomous driving function can operate safely and to consequently refine its Operational Design Domain (ODD).

Q3: At the project start, AIT was involved in FOCETA as a project partner; then, as of September 2021, following the departure from the consortium of the former Technical Manager, the FOCETA General Assembly selected you as the new FOCETA Technical Manager. This is a key role, as you have to ensure the continuous coordination of the technical work in all work packages, as well as to support alignment of activities with the overall project objectives, in close cooperation with the Project Coordinator. Had you already covered such a role in other EU-funded projects in the past? Were there any unexpected challeges you had to face as the Technical Manager in FOCETA? What are the aspects you enjoy most in covering this role? And those you enjoy less?

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A3: While I coordinated multiple national smaller-scale projects in the past, this is the first time that I fulfill the role of a Technical Manager in a relatively large EU-funded project. Despite the high responsibility of this role, being the Technical Manager in FOCETA is rather easy, thanks to the clear vision of the project, the help from the Project Coordinator and the previous Technical Manager, the committment of the project partners, the impeccable administrative management of the project and the overall friendly and relaxed atmosphere in the consortium. Hence, I feel very honored and lucky to serve the consortium in this role. There are two main aspects that I enjoy while covering this role. First, my duty is to have an overview of the scientific results from all the partners and I have to say that I am continuously amazed by the breadth and the depth of the research done in FOCETA by its different partners. Second, I have the opportunity to steer at least a bit the overall direction of the project. I have not encountered yet negative aspects associated to the role of Technical Manager.

Q4: What are the strengths and unique selling points of the FOCETA consortium to tackle the complex issue of Continuous Engineering and Deep Learning for Trustworthy Autonomous Systems?

A4: FOCETA has a competent and ambitious consortium with the right balance between its partners and their complementary know-how to address this highly complex problem. The consortium has a great mixture of experienced researchers who are able to identify the grand challenges of today, young scientist who provide the fresh perspectives to the table, and some of the major industrial players who steer our consortium into answering the relevant questions. Starting from the observation that classical embedded system design paradigms are not sufficient to tackle learning-enabled systems, and that there is a need for new approaches that combine model-based and data-driven design, FOCETA provides a clear vision how to move forward.

Q5: Dejan, you are steering the work on the White Paper on FOCETA Methodology. The first issue of the White Paper was released in autumn 2022, whereas the updated version is expected to be finalised by September 2023. What is the scope of this work and how does it benefit the projet? Concretely, how do you coordinate the work on the White Paper?

A5: A large project like FOCETA starts with a vision that brings together its partners to jointly realize that vision over the next few years. All the partners bring to the project their specific expertise and once the project starts, each partner focuses on a particular subset of topics. In this process, it is easy to sometimes lose sight of the project's big picture. The first aim of the White Paper on FOCETA Methodology is to serve as a reminder about the project's big picture. It allows the project partners to not lose sight about the project's main objectives, and to continuously evaluate how individual bricks developed in the project contribute to the implementation of the overall vision. The White Paper has a second important role. It provides a concise summary of the main project outcome that can be used to communicate the FOCETA vision to the outside world.

This White Paper is not set in stone – it is a living document that is evolving throughout the project duration according to the results and findings from different partners. The Project Coordinator and I coordinate the work on the White Paper. For every new iteration of the FOCETA Methodology, we first form a small core team, consisting of Work Package and Use Case leaders who help us sketch the draft of the White Paper. The draft is then shared with all the partners who can provide their feedback and updates to the document.

Q6: Dejan, your studies and research career are characterised by a number of international experiences, which have enhanced your intercultural and negotiation skills. Do you think that these skills benefit the FOCETA project?

A6: The international perspective is one of the most attractive aspects in today's research. I personally love the collaborative research and find it very rewarding. My previous international experience helps me to fully appreciate the diversity present in science today. FOCETA is a perfect example of this diversity – the project is represented by 8 countries from 3 continents and this gives to each of us an amazing exposure to different cultures, ways of thinking and work styles. The multi-cultural FOCETA setting creates a truly inspiring collaborative environment that is enriching for its participants and that ultimately benefits the project.

Q7: Dejan, you have a 10-year experience as a Senior Scientist, you have served as programme co-chair, special session chair and programme committee member in more than 40 international conferences and workshops and you published more than 80 scientific papers in peer-reviewed international journals, conference and workshop proceedings. Given your confirmed experience, how would you assess the impact of the FOCETA project on your field of research, both at European and International level? Does FOCETA considerably contribute to the progress of the state-of-the-art, and if so, how?

A7: I am genuinly impressed by the FOCETA outcomes and I am convinced that the project is already creating a significant impact across many dimensions. First, there is an outstanding scientific output, demonstrated by more than 40 research papers that are already published and reported on the EC portal. Many of these publications were presented in top-tier conferences associted to the fields of formal methods and verification, machine learning, robotics, cyber-physical systems and software engineering. This tells us that the quality of the multidisciplinary FOCETA work on safe autonomy is widely recognized and appreciated in several communities. In addition, there are more than other 30 papers that are either submitted and under review or already accepted and in the process of formal publication. Apart from publications, there are many new tools that were developed in FOCETA, and some of them integrated with the existing platforms. The strong industrial presence in the consortium with some of the major players (Denso, Intel, Siemens) and the SMEs (RGB) greatly facilitates the creation of the industrial impact. I would like to highlight that more than 10 from the 40 reported publications were (co-)authored by our industrial partners, which is extraordinary and demonstrates their committment to create innovation in this vivid research field.

DISCLAIMER - The information, statements and opinions in the above interview are personal views of the individuals involved in the FOCETA project and do not necessarily reflect the views of the FOCETA consortium as a whole, nor of the European Commission. None of them shall be liable for any use that may be made of the information contained herein.

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GET TOGETHER

In this issue of our Newsletter you will find a selection of upcoming conferences and other events which are of interest for the FOCETA community.

SAVE THE DATE - FOCETA FINAL PUBLIC WORKSHOP - THURSDAY, 12th OCTOBER 2023 – GRENOBLE, FRANCE

The FOCETA project is happy to announce the organisation of the Final Project Public Workshop which will take place on Thursday, 12th October 2023 in Grenoble, France.

The Final Public Workshop of the FOCETA project aims to showcase and discuss the main results of the FOCETA project, which will end in September 2023. The workshop will also host invited external expert presentations on topics which are relevant for FOCETA research. The workshop agenda is still under consolidation, and more information will be communicated in the coming weeks. Follow the FOCETA project on LinkedIn for up-to-date information on the event.

We look forward to meeting you at the workshop!

UPCOMING DISSEMINATION EVENTS

Since the project start, FOCETA partners are very active in disseminating project results through conference presentations and papers. In this section we present a list of conferences where partners plan to present their works in the coming months.

DSN 2023 INDUSTRY TRACK - 53RD ANNUAL IEEE/IFIP INTERNATIONAL CONFERENCE ON DEPENDABLE SYSTEMS AND NETWORKS, 27-30/06/2023, PORTO, PORTUGAL

FOCETA partner Intel Deutschland GmbH will give a presentation based on their paper entitled "Large scale application of fault injection into pytorch - an extension to pytorchfi" at DSN 2023 Industry Track.

Website: https://dsn2023.dei.uc.pt/calls_cfp-industry.html

ICAPS 2023 - 33RD INTERNATIONAL CONFERENCE ON AUTOMATED PLANNING AND SCHEDULING, 8-13/07/2023, PRAGUE, CZECH REPUBLIC

FOCETA partner Graz University of Technology will give a presentation based on their paper entitled "Safety Shielding under Delayed Observation".

Website: https://icaps23.icaps-conference.org/

IFAC WORLD CONGRESS 2023 - 22ND WORLD CONGRESS OF THE INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL, 9-14/07/2023, YOKOHAMA, JAPAN

FOCETA partner Siemens Digital Industries Software will give two presentations based on their papers entitled "Reducing the Sim2Real gap for path-tracking in autonomous driving" and "Learning from Demonstrations of Critical Driving Behaviours Using Driver's Risk Field".

Website: https://www.ifac2023.org/

IJCAI 2023 - 32ND INTERNATIONAL JOINT CONFERENCE ON ARTIFICIAL INTELLIGENCE, 19-25/08/2023, MACAO, CHINA

FOCETA partner Graz University of Technology will give a presentation based on their paper entitled "Analyzing Intentional Behavior in Autonomous Agents Under Uncertainty".

Website: https ://ijcai-23.org/

ASE 2023 TOOL DEMONSTRATIONS TRACK – 38TH IEEE/ACM INTERNATIONAL CONFERENCE ON AUTOMATED SOFTWARE ENGINEERING, 11-15/09/2023, KIRCHBERG, LUXEMBOURG

In case of acceptance of their paper, **FOCETA partner Fortiss GmbH plans to give a presentation** at ASE 2023 Tool demonstration track.

Website: https ://conf.researchr.org/track/ase-2023/ase-2023-tool-demonstrations

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EMSOFT 2023 – INTERNATIONAL CONFERENCE ON EMBEDDED SOFTWARE, 17-22/09/2023, HAMBURG, GERMANY

In case of acceptance of their paper, **FOCETA partner AIT Austrian Institute of Technology plans to give a presentation** at EMSOFT 2023.

Website: https://esweek.org/emsoft-call-for-papers-page/

SAFECOMP2023 - 42ND INTERNATIONAL CONFERENCE ON COMPUTER SAFETY, RELIABILITY AND SECURITY, 19-22/09/2023, TOULOUSE, FRANCE

SafeComp 2023 will be a key event for FOCETA dissemination. **FOCETA partner DENSO AUTOMOTIVE Deutschland GmbH** will give a presentation based on their paper entitled "Are Attention Networks More Robust? Towards Exact Robustness Verification for Attention Networks".

Furthermore, the paper jointly written by **FOCETA partners AIT Austrian Institute of Technology and Graz University of Technology** and entitled "Attribute repair for threat prevention" got accepted as well and will be presented there.

Last but not least, **FOCETA partner Intel Deutschland GmbH** will give a presentation based on their paper entitled "Tapping deep neural networks for scalable and interpretable error detection".

Website: https://safecomp2023.cnrs.fr/

MEMOCODE'23 - 21ST ACM-IEEE INTERNATIONAL SYMPOSIUM ON FORMAL METHODS AND MODELS FOR SYSTEM DESIGN, 21-22/09/2023, HAMBURG, GERMANY

In case of acceptance of their paper, **FOCETA partner Bar-Ilan University plans to give a presentation** at MEMOCODE 2023.

Website: https://memocode2023.github.io/

Follow the FOCETA project on LinkedIn

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