

International Federation of Automatic Control

12th IFAC Symposium on Fault Detection, Supervision and Safety for Technical Processes SAFEPROCESS 2024

Ferrara, Italy, June 4 – 7, 2024

PROCEEDINGS

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FOREWORD

The IFAC SAFEPROCESS 2024 is continuing the successful series of symposia held in Baden-Baden (Germany, 1991), Helsinki (Finland, 1994), Hull (UK, 1997), Budapest (Hungary, 2000), Washington DC (USA, 2003), Beijing (China, 2006), Barcelona (Spain, 2009), Mexico City (Mexico, 2012), Paris (France, 2015), Warsaw (2018), and Paphos (Cyprus, 2022). The Department of Engineering of the University of Ferrara, Italy, organized the IFAC SAFEPROCESS 2024 in Ferrara, Italy, for the first time since its first edition, on June 4–7, 2024.

The theory and practice of control and technical diagnostics are facing big problems as the complexity of modern industrial systems and processes keeps growing. The need for greater reliability in their operation, control quality, and security is also growing. Early detection and diagnosis of faults and cyberattacks are critical to avoid performance degradation and damage to machinery or human life.

The SAFEPROCESS symposium is a triennial IFAC meeting and a major international gathering of leading academic and industry experts from all over the world. It aims at strengthening the contact between academia and industry to build up new networks and cultivate existing relations. High-level speakers have given talks on a wide spectrum of topics related to fault diagnosis, process supervision, safety monitoring, fault-tolerant control, cyber-security, as well as state-of-the-art applications and emerging research directions. The symposium has also served as a forum for young researchers, giving them the opportunity to present their scientific ambitions and work to an audience consisting of international technical diagnostics and control communities.

Fault diagnosis and fault-tolerant control have developed into major research areas at the intersection of system and control engineering, computer science, applied mathematics and statistics, or soft computing, as well as application fields such as mechanical, electrical, chemical, and aerospace engineering. IFAC is recognised as playing a crucial role in this aspect by launching a triennial symposium dedicated to this subject.

The SAFEPROCESS 2024 program can be accessed at <https://www.safeprocess2024.eu/#>. The program consisted of nineteen regular and five invited sessions on three parallel tracks. It also contained six keynote talks prepared by outstanding academics and industrials who introduced advanced results on fault diagnosis, fault-tolerant control, root cause analysis, and cyberattack prevention. In particular, Prof. Ron J. Patton (UK), from the Univ. of Hull, delivered the speech entitled “Offshore Wind Turbine Rotor Imbalance, a Fault-Tolerant Control Problem”; Prof. Christophe Combastel (FR), from the Univ. of Bordeaux, delivered the speech entitled “Reachability and Filtering for Safe Processes: From Zonotopes to Functional Sets with Typed Symbols”; Prof. Roger Dixon (UK), from the Univ. of Birmingham, gave the talk “Fault Tolerance in Railways: The Evolution of a Radical Next Generation Track Switch”; Dr. Steinert Olof (SE) from Scania, delivered the speech “Harnessing Data for Predictive Maintenance and Collaboration, Boost Innovation”; Prof. Biao Huang (CA), from the Univ. of Alberta, talked about “Advancing Causal Analysis for Fault Detection and Root Cause Analysis in Process Systems Engineering”; and Prof. Ping Zhang (DE), from the Univ. of Kaiserslautern-Landau, gave the talk “Detection and Avoidance of Cyber Attacks on Industrial Control Systems”.

The symposium received one hundred seventy-eight submissions, divided into three sets: one hundred forty regular papers, thirty-one invited papers, and seven invited sessions. The rejection rate for submissions was 23%. The symposium had one hundred eighty-seven participants, including one hundred twenty-two academics and sixty-five students. Regarding the statistics, we identified an average of 3.6 authors per paper. The number of participating countries was forty-eight. Regrettably, we failed to achieve a satisfactory balance between geographical regions. The countries with the most papers, in decreasing order, are China, France, Germany, Italy, Spain, Sweden, the United Kingdom, the United States of America, the Netherlands, and Mexico.

One pre-symposium tutorial, a roundtable, and a benchmark competition were also included in the technical program. As a result, Vasso Reppa from Delf University of Technology, Mayank S. Jha, and Didier Theilliol from the University of Lorraine organized the roundtable titled “Gnosis for Maintenance: From Diagnosis to Prognosis and Health-Aware Control.” The meeting was very active, with comments and questions from more than fifty attendees in a two-hour session. Additionally, Eric Frisk, Daniel Jung, and Mattias Krysander from Linköping University organised a competition on fault detection and isolation techniques with incomplete data. The airflow system of an internal combustion engine was considered an industrial benchmark. The competition was intriguing and a good motivating example for young researchers. A two-hour special session presented the results of the six participants. The young researchers Nicolas Anselmi, Andrea Arici, Francesco Corrini, and Mirko Mazzolen from the University of Bergamo, Italy, took first place in the competition, and the two next classified also obtained a diploma.

Regarding the pre-symposium tutorials, three proposals were received; however, only one met the minimum registration quota defined by the organizers. Linlin Li from the University of Science and Technology Beijing, Zhiwen Chen from Central South University, and Steven X. Ding from the University of Duisburg-Essen integrated the tutorial, entitled "Control Theory-Informed Machine Learning for Fault Diagnosis in Dynamic Control Systems." The tutorial was free for students, and there were thirty-three attendees.

The symposium recognized three awards: the *Paul M. Frank Theory Paper Award* given to Louis Goupil, Louise Travé-Massuyès, Elodie Chanthery, Thibault Kohler, Sébastien Delautier for the paper entitled "Tree-Based Diagnosis Enhanced with Meta Knowledge Applied to Dynamic Systems"; the *IFAC Young Author Award* given to Henrik Sebastian Steude*, Lukas Moddemann, Alexander Diedrich, Jonas Ehrhardt, Oliver Niggemann for the paper entitled "Diagnosis Driven Anomaly Detection for Cyber-Physical Systems"; finally, the *Best Application Paper Award* was given to Andrea Mattioni, Lucas José da Silva Moreira, Herve Yves Guy Bernard Louis Roustan, Gildas Besancon, Mirko Fiacchini for the paper entitled "A step towards implementation of state observers in industrial aluminium smelters".

SAFEPROCESS 2024 was the first IFAC SAFEPROCESS symposium to be streamed thanks to the University of Ferrara YouTube channel, enabling researchers and practitioners to participate either physically or online. As a result, the sessions are still accessible through the complete playlist at www.youtube.com/playlist?list=PLL80i9P61J-O-4-Y79u-KKkoHybZw9d0k. The presentations provided participants with an invaluable opportunity to learn from the knowledge and experiences of world-renowned scientists and experts. Covering a range of exciting topics, these sessions generated ideas, concepts, and methods that will make future industrial systems and processes more efficient and safer.

As International Programme Committee Chair and General Chair, we are filled with immense pride and joy as we reflect on the success of this remarkable event. The hard work, dedication, and collaborative spirit of everyone involved have truly paid off, creating an unforgettable experience for all participants. We extend our heartfelt gratitude to all who contributed, and we look forward to many more successful IFAC SAFEPROCESS symposia in the future.

Cristina Verde
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