AUTOMATICA and INFORMATICS

ISSN 0861-7562 Print, ISSN 2683-1279 Online

URL: https://sai-bg.com/category/journals/automatica-and-informatics/

Year LIX **No. 3/2026**

CONTENTS

AUTOMATICA

V. Tsolov N. Nikolov. Essence and Implementing ESD Systems for Emergency Shutdown in Control of Technological Processes 6

Key Words: *Emergency Shutdown Systems (ESD); automation systems; automatic control systems; temperature; pressure; level; Safety Integrity Levels (SIL).*

Abstract. *Emergency Shutdown (ESD) systems are a fundamental part of the functional safety structure of modern industrial plants and are intended to protect personnel, equipment, the environment and production assets when hazardous deviations occur in technological processes. Their principal task is to detect conditions that may lead to loss of containment, fire, explosion, equipment damage or uncontrolled release of hazardous substances and to bring the process, or a defined part of it, to a predetermined safe state within the available process safety time. Unlike the basic process control system, which maintains production variables around their normal operating set points, the ESD system performs independent safety functions and remains capable of acting when the normal control layer is unavailable or has failed. For this reason, appropriate physical and functional separation from the BPCS/DCS, independent power supplies and communication paths, fail-safe design principles and controlled access to application software are essential requirements. A typical ESD architecture comprises field sensors and transmitters, a safety logic solver and final control elements. Pressure, temperature, flow, level, flame, smoke and gas concentration may be monitored depending on the hazards identified during the risk assessment. The logic solver evaluates the input signals, applies alarm limits, hysteresis, time confirmation and interlock conditions, and initiates a trip when the defined safety criteria are fulfilled. The final elements, including shutdown valves, solenoid valves, motor contactors, dampers and isolation devices, execute the required action and must move reliably to their safe position, including in the event of loss of electrical or pneumatic energy. Redundancy and voting arrangements such as 1oo1D, 1oo2, 2oo2 and 2oo3 are selected according to the required balance between safety availability, resistance to spurious trips and fault tolerance. In particular, 2oo3 voting enables continued operation after a single channel fault while preserving the capability to initiate shutdown when two independent channels confirm the hazardous condition. The implementation process begins with hazard identification and risk analysis, followed by the definition of Safety Instrumented Functions in the Safety Requirements Specification. Each SIF is assigned a target Safety Integrity Level in accordance with the required risk reduction and the applicable principles of IEC 61508 and IEC 61511. The selection of technical means therefore cannot be based only on measurement range, accuracy or purchase price. It must also consider systematic capability, failure rates, diagnostic coverage, hardware fault tolerance, environmental resistance, response time, proof-test interval, maintainability, common-cause failures, cybersecurity and the availability of documented operating experience. Verification of the achieved performance includes evaluation of the average probability of failure on demand, architectural constraints and the contribution of sensors, logic solver and final elements to the total probability of failure. Since final elements commonly represent a substantial share of the SIF failure probability, suitable actuator sizing, de-energize-to-trip philosophy and partial-stroke testing of shutdown valves are especially important. Reliable operation throughout the entire safety lifecycle requires continuous self-diagnostics, time-stamped event logging, alarm transmission to HMI/SCADA, management of bypasses and overrides, periodic proof testing, calibration, preventive maintenance and formal procedures for modification and restart after a trip. Diagnostic information supports early detection of degraded channels, but it does not replace proof testing of dangerous failures that remain hidden during normal operation. Human factors are also significant: alarms must be unambiguous, operator actions must be clearly defined, and reset of the shutdown function should be possible only after the initiating cause has been removed and the plant has been verified as safe. The article examines the essence and application of ESD systems and systematizes the*

principal criteria for selecting sensors, safety controllers, communication interfaces and final control elements. The presented approach emphasizes that effective emergency shutdown is achieved not by a single certified device, but by the coordinated design, validation, operation and maintenance of the complete safety instrumented function. Properly implemented ESD systems reduce the probability and consequences of major industrial accidents, improve protection of people and the environment, and contribute to the dependable and sustainable operation of technological installations.

ENERGY SYSTEMS

B. Deliyska, A. Ivanova. Research and Analysis of Sustainability of Bulgarian Bioenergy Production 13

Key Words: *Bioenergy; sustainability index; Bulgarian bioenergy production; information system.*

Abstract. *The sustainable production of bioenergy (including bioelectricity and solid, liquid, and gaseous biofuels) is an important factor in reducing greenhouse gas (GHG) emissions. Bioenergy sustainability is determined by international and national standards and certification schemes. In addition, bioenergy sustainability assessment may consider other environmental, economic, and social indicators, such as the existence of circular production, wages, company profits, social benefits, etc. In the present work, research and analysis of the sustainability of Bulgarian bioenergy production are carried out. For this purpose, a research methodology is developed, including the formulation of an index of bioenergy production sustainability; collection of data on Bulgarian bioenergy-producing firms; and calculation and analysis of the sustainability index using a prototype information system and database for data storage and querying. Due to the relatively complete data available, the analysis was conducted for 148 firms in 2022. The firms are ranked according to their sustainability index values, and an analysis is provided based on their type of production and raw materials, availability of certificates, etc. Overall, the results of the analysis indicate insufficient sustainability of bioenergy production and the need to develop and implement national standards and certification schemes corresponding to European and international ones. It was found that accurate and reliable data are not available for a large number of firms in the bioenergy sector. One of the reasons is the high dynamics of this relatively new industrial sector, including the frequent opening, closing, and re-registration of firms; another is untimely reporting. The present research and analysis constitute a first attempt to investigate the sustainability of Bulgarian bioenergy production. As a next step, an extended analysis of bioenergy sustainability over a period of several years is planned, including a georeferenced digital map of Bulgarian bioenergy producers.*

ACHIEVEMENTS AND APPLICATIONS

V. Ivanova, A. Boneva, P. Vasilev. Robotic Systems in Medicine and Surgical Education – an Invisible Revolution 18

Key Words: *Advanced Robot System; medical robots; surgical robotics; Augmented Reality (AR); Virtual Reality (VR); software applications; surgical training; Training Program Simulation (TPS).*

Abstract. *Robotic systems represent a quiet yet significant revolution in medicine. They do not replace humans but rather complement them, enabling more precise diagnostics, safer treatment, and faster recovery. The future of medicine lies in the harmonious collaboration between humans and machines, where technology serves humanity and places the patient at the center of a smarter, more humane approach to healthcare. This study presents a comprehensive approach to developing a surgical training system that simulates realistic interactions between instruments and tissues. The findings contribute to the advancement of minimally invasive surgical training by enabling personalized, data-driven learning experiences. The proposed system offers a scalable and ethical alternative to traditional training methods, with potential applications in both academic and clinical settings. Simulation programs successfully facilitated the transfer of acquired skills to real-world scenarios, demonstrating the system's potential to enhance surgical training. Built on a modular principle, the system is designed to accommodate future upgrades, both in terms of hardware and the development of new VR- and AR-based applications. These enhancements are aimed at improving the quality of training for medical students and supporting the professional development of surgical staff. The system allows users to acquire and test various skills and explore instrument capabilities before using them in actual laparoscopic procedures. Surgical training can be significantly enhanced through modern educational methods, such as simulation, structured curricula, and telemetering, as well as through cutting-edge technologies such as AI and AR. As surgical procedures continue to evolve, the methods used to train surgeons must also evolve, embracing the highest standards of patient care and surgical practice. Regarding information protection and access control, the potential for implementing additional measures will be explored. These measures would be applied at all levels*

of data utilization to improve the secure and effective handling of laparoscopic instruments. Investigations will also address combinations of access-control and information-protection mechanisms within the developed mechatronic laparoscopic training system and its associated applications, including the application discussed in this publication. Plans also include the secure transfer of data to central servers at educational or medical institutions or to specialized medical cloud servers.

P. Blagov, P. Ruskov. VeloxWallet: A Digital Identity Wallet Conformant with the European Blockchain Services Infrastructure (EBSI) 26

Key Words: *EBSI; OpenEBSI; digital identity; TAO; blockchain; eIDAS 2.0.*

Abstract. *This paper presents VeloxWallet – a digital identity wallet developed by Veloxoft Ltd. to operate in full compliance with the European Blockchain Services Infrastructure (EBSI). It outlines the European Blockchain Partnership's (EBP) vision for utilizing Distributed Ledger Technology (DLT), as well as the application of the eIDAS 2.0 model and EBSI for individual and organizational accreditation. The paper examines the wallet's architecture, components, and core functionalities. VeloxWallet enables the creation, storage, and presentation of Verifiable Credentials (VCs) in accordance with the eIDAS 2.0 framework and supports integration with Qualified Trust Service Providers (QTSPs). The empirical results obtained through the development and application of VeloxWallet in Bulgarian and European projects are also discussed, including TraceFarm, OnePass (Horizon Europe: Digital Identity for SMEs and Access to Finance), and Digital Europe Node Expansion (Integration of TAO and Node services for public administrations). The potential strategic advantages of using the wallet are outlined, together with the security and compliance aspects of operating within eIDAS 2.0 and EBSI environments.*

NEWS, INFORMATION, SOCIETY

General Assembly of the John Atanasoff Society of Automatics and Informatics (SAI) – 2026 .....**31**

Governing Bodies of SAI **32**

Guidelines for the Activities of the John Atanasoff Society of Automatics and Informatics (SAI) for the Period 2026-2029 .....**33**

This issue was published in 2026.