PROJECT PROFILE

16027

Direct integration of latest SiC power and IT electronics expected to produce unprecedented performance gains in smart drives

[CosmoDU]

As machines (such as robots or conveyor-belt systems) become more intelligent, electric drives – the most active parts of these machines – will also need to evolve in intelligence. To achieve this, the CosmoDU project (its name is derived from 'compact, highly smart, modular drive-control-unit, directly integrated in electric motors') will deliver the hardware platform of next-generation drive units for production machines. Notably, sensors, signal processing, secure communication and control and power electronics will be directly integrated in the housing of the motor, and this new drive unit will use its self-learning capabilities to adjust and improve its performance (at application-level) in the field.

The evolution of machines, from closed-loop-controlled to truly self-deciding automates, will require electric drives, the most active parts of these machines, to actively adjust their own key operational parameters (such as speed, direction and power) according to the local situation. This will be based on their cognitive abilities, like self-learning and condition monitoring, whereby they gain and apply their own experience, as well as information from similar systems. Smart motors can also easily form a comprehensive system of connected drives as they have bi-directional communication channels and are connected to the infrastructure through Wi-Fi and cable.

Of course, these next-generation devices do not exist yet. However, they are the future and we need to prepare for, and assist with, their arrival. They are essential for a wide variety of applications and should therefore be available on the market. Most importantly, these applications include fabrication processes, which need high flexibility in order to reach the mass-production efficiency envisaged in Industry 4.0.

Hardware platform for next-generation electric motors

The CosmoDU project will develop and deliver the hardware platform for next-generation drive units required by fabrication machines, like intelligent industrial robots and conveyor belts. It will integrate – directly in the motor housing – sensors, signal processing, secure communication and control electronics (for comprehensive performance control and health monitoring), as well as the power and driver stages. Smart drives will have self-learning capabilities for adjusting and improving their performance at application level (such as the robot) in the field. A comprehensive system of sensors will also identify the actual needs of the drives, as reflected in their maintenance and safety status.

The project will first develop a modular hardware architecture for the integration of all sensors, microelectronics and power modules directly into the housing of an industrial synchronous motor-drive for conveyor belts or industrial robots as target applications. Based on this architecture, component development, module and system integration, as well as demonstrator development and validation testing, will be conducted.

The key technological features include:

- On the information technology (IT) side, highly dense, yet reliable, heterogeneous integration of MEMS, sensors, security, electronics and antenna structures using system-in-package (SiP) and 3D stacking technologies;
- On the power electronics side, wide-bandgap (WBG) devices, a direct combination of driver and power stages, as well as advanced cooling techniques;
- Developing a novel 3D multi-layer-planar integration technology for adding all sensors and signal processing;
- Communication interfaces for active health-monitoring of the power sub-module;
- The direct combination of the latest technologies from both fields – 1200V SiC (silicon carbide) power-electronics, and best-in-class IT electronics operating µV signals. This is the basis for an unprecedented gain in drive performance.

This project brings together 14 partners – three large companies, eight small and medium-sized enterprises (SMEs) and three research institutes or universities – from Germany and the Netherlands. This well-balanced consortium covers the whole value-chain: from investigating, designing and developing the new processes and equipment; to manufacturing the future smart motors; and finally to their end-use.

Penta

KEY APPLICATION AREAS

- Transport & Smart Mobility
- Health & Well-Being
- Energy
- Digital Industry
- Digital Life

ESSENTIAL CAPABILITIES

- Systems and Components Architecture, Design & Integration
- Connectivity & Interoperability
- Safety, Security & Reliability
- Computing & Storage
- ECS Process Technology, Equipment, Materials & Manufacturing

PARTNERS

AMITRONICS Angewandte Mikromechatronik GmbH / Berliner Nanotest und Design GmbH Fairchild Semiconductor / Fraunhofer Institute for Electronic Nano Systems (ENAS) / Fraunhofer Institute for Integrated Systems and Device Technology (IISB) / Langer EMV-Technik GmbH Robert Bosch GmbH / iemens AG / Advanced Packaging Center BV / Boschman Technologies B.V. / Catena Holding BV / Heliox / Technolution BV / Delft University of Technology

COUNTRIES INVOLVED

- Germany
- The Netherlands

PROJECT LEADER

Dr. Kai Kriegel
Siemens AG

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KEY PROJECT DATES

01 Mai 2017 - 30 April 2020

Project challenges, standards and European leadership

Together with functional performance, CosmoDU will also address new challenges of electro-magnetic compliance (EMC), thermo-electro-mechanical reliability, functional safety and system availability that specifically arise from an ultra-compact design. It will also develop proof-of-concept software for a functional demonstrator drive. Furthermore, project partners will make efficient and effective use of resources by focusing on their particular skills and specialisms: SMEs will be pilot investigators, employing their specific competencies (thus providing them with needed visibility and market acceptance to grow their business significantly); larger industrial firms will use their market knowledge and contacts; while research institutions provide their methodology-research findings.

CosmoDU's novel approach towards integration and self-learning will set the trend for next-generation industrial electric-drives. Its core advantages of flexibility, connectivity and system availability will ensure that the vision behind Industry 4.0 is realised. This project will also act as a template for similar efforts in neighbouring domains, such as electric-mobility, smart energy, and smart infrastructure. Furthermore, its aim to standardise key elements of the architecture, interfaces, and protocols will contribute substantially to strengthening the technological leadership position of the project partners, and of Europe as a whole.

Employment, financial and societal benefits

The self-learning feature will also provide flexibility and increase product quality. This will maintain – and even increase – European manufacturing jobs. While CosmoDU specifically focuses on next-generation electrical drives (for industrial robots or conveyor belts, for instance), this 'template' can easily be adopted and adapted subsequently by other industries and application areas. Tool machines, automated driving and full-scale electro-mobility can produce significant financial benefits, as can smart energy and smart infrastructure. What is more, societal needs for carbon-free and ultra-safe individual mobility and living are also addressed, as are those for resource-efficient production.

Healthy market outlook

According to IHS, industrial drives (including those used in pumps, fans, compressors and the like) have the highest market-share in terms of IGBT (insulated-gate bipolar transistor) applications. Here, huge potential savings with factory automation are possible by using variable-speed drives, where some 10% of worldwide electricity-consumption could be saved. Furthermore, combining the trend in factory automation towards Industry 4.0, with the large savings achievable by improved drives, industrial electric-drives seem most attractive, particularly when deployed in industrial robots. And basic economic numbers support this: the total market for 400-1200V powertrains relevant to industrial drives is about US$ 25 billion, compared with an annual growth of more than 10% for drives using conventional technology. With integrated power and IT technology, the market share of these ultra-intelligent integrated powertrains will grow even faster than the market itself. Therefore, the prospects for high return-of-investment (RoI) are good. However, while we see a large market potential, this integration still needs extensive research into such typical areas as feasibility and yield.

Work done on the CosmoDU project can also benefit directly from another strong trend: according to IHS, the number of internet-connected things will grow to 50 billion units by 2025, with the most dominant growth in industrial applications. The technological basis and drivers for this growth will come from smart sensors capable of detecting changes and anomalies in vibration, sound, temperature, humidity, pressure and other physical properties. IHS estimates that the revenue from semiconductor-based sensors alone will grow from US$8.9 billion in 2014, to more than US$10.6 billion by 2017.The future looks bright for CosmoDU.

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