BEMO-COFRA

Brazil-Europe Monitoring and Control Frameworks

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## Welcome to the BEMO-COFRA project

I would like to welcome you to this first newsletter on behalf of the BEMO-COFRA consortium. It will provide you with a first overview of the BEMO-COFRA project, its aims and goals. The BEMO-COFRA project is one of the five projects that received funding in the first Brazil-EU coordinated call and it brings together universities and businesses in Brazil and Europe, creating the grounds for future successful collaborations between Brazil and Europe.

The BEMO-COFRA project is an Internet of Things project which aims to develop a framework that will strengthen networked monitoring and control of large-scale complex systems. The idea is to enable and support holistic management and improve system efficiency with respect to energy and raw materials in the production domain. The concrete application domain is monitoring and control in a car assembly line. The project results will have a significant impact on future industrial technologies and industrial production processes.

As a starting point, the project developed a vision scenario from the user perspective, describing the integration of the BEMO-COFRA framework in the body welding and assembly line in a car manufacturing plant, which is driving the development work. The framework will be deployed and tested in a car manufacturing plant provided by Comau in Brazil, thus ensuring that it meets the users' needs and requirements.

This newsletter will be circulated via e-mail and posted on the BEMO-COFRA website: http://www.bemo-cofra.eu

I wish you an insightful reading and look forward to interesting and fruitful feedback.

Dr. Markus Eisenhauer, Project Coordinator, Fraunhofer FIT

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## *Bem-vindo!*

I would also like to take the opportunity to welcome you all to read more about the BEMO-COFRA project in this first newsletter. We are pleased to report that during the first year of the project significant progress has already been achieved. Despite the great distances, the project partners have met and worked together face-to-face several times both in Brazil and in Europe showing their dedication to the BEMO-COFRA project. On the Brazilian side, a test-bed has been setup and development is being shared on both sides of the Atlantic.

The research and development work done in the BEMO-COFRA project will enable the adoption of large-scale networks composed of heterogeneous smart objects provided with sensing and actuating capabilities. The objective is to allow energy savings in manufacturing plants as well as create a cleaner, wireless and noise-free environment. The testing and evaluation of the BEMO-COFRA in an actual car manufacturing plant will enhance the transfer of knowledge from research to deployment in the industry. The BEMO-COFRA project thus represents a unique opportunity for cooperation between Brazilian universities and the industry benefitting both parties, in addition to creating new working relationships with European companies and universities.

I hope that you will enjoy the newsletter and if you are interested in finding out more about the project you may also visit BEMO-COFRA's website.

Judith Kelner, Brazilian project administration and co-ordination manager, Federal University of Pernambuco UFPE.

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## Using Smart Cameras in the Automotive Industry for Wireless Sensor Monitoring

## In this issue



## In other news

**BEMO-COFRA features in the Brazilian newspaper, Jornal do Commercio**

Jornal do Commercio, the biggest newspaper in the state of Pernambuco, brought an article about BEMO-COFRA in connection with the project's Kick-Off in September 2011. The article entitled "Software will create new industrial technology" describes how the results of the BEMO-COFRA project will have a potentially significant impact on the future of industrial production processes.

## Dissemination events:

**Workshop on Brazil-EU cooperation in ICT Research and Development**

7 November 2011, Brasília, Brazil

The workshop celebrated the launching of the first Coordinated Call projects and prepared the ground for identifying topics for the 2nd Coordinated Call. As one of five selected projects for co-funding by the EC and Brazil, BEMO-COFRA was invited to a EU-Brazil workshop in Brasília on 7th November 2011.The BEMO-COFRA project was presented by Markus Taumberger, VTT. BEMO-COFRA was also represented at the event by Djamel Sadok (UFPE) and Trine F. Sørensen (IN-JET).

**FIRE Thematic pre-FIA Workshop 4 - Brazil-EU cooperation in ICT Research and Development**

9 May 2012, Aalborg, Denmark

The workshop involved ICT research experts interested in future EU-Brazil cooperation, in view of the new coordinated call for research and development proposals in the ICT field, planned for this summer. The BEMO-COFRA project was presented by Claudio Pastrone (ISMB) as part of the workshop presentations on related running projects. The workshop formed part of the Future Internet Week under Denmark's EU Council Presidency.

**Today, smart cameras can be used in industry to provide an efficient way to monitor the processes, detecting and tracking objects, inspecting the conformity of the product with specific models or measuring with a required precision to cite a few examples. A camera thus functions like an artificial eye by providing systems with visual capabilities to distinguish the shape, size, colour and dynamic of the object.**

In industrial scenarios, the task starts with the acquisition of an image from the inspected region or object. To comprehend the acquisition process we must first understand three different subsystem: 1) the sensoring system composed by a sensor with a known resolution, gain and colour balance 2) the optical system composed by lens that specify the working distance and working area and 3) the illumination system designed to avoid variability that can increase the complexity of computer vision solutions.

In the BEMO-COFRA project we will use wireless smart cameras that are an improvement from the standard wired devices. As any wireless sensor, these cameras must work in environments with a series of problems such as high network traffic in relation to the data packets to be delivered. The wireless cameras will be used to monitor the state of either devices or processes. For example, cameras can be used to inspect the position of an object or, in a more complex example, it can be used to inspect the temperature of equipment with a special thermal sensor. In both cases, the inspection is based on the analysis of the image captured. After this analysis, the camera sends a signal indicating the status of the device or the status of the process.

The integration of the wireless camera first of all required us to create a demonstration simulating the welding station in an automotive manufacturing plant. The task of the cameras is to identify when the car body is in the correct position necessary in order to proceed with the welding task. In order to accomplish this, we divided the work in two stages: 1) developing an embedded algorithm in the camera that will identify the position of the car body using colour calibration and 2) transmission of the result (correct position or not) through the LinkSmart Network.

The picture (left) illustrates the setup composed of a wireless smart camera pointing to where a car body is present. The software embedded in the camera is able to identify the position of the car body and send a signal if the position is correct. The software is based in the segmentation of the car body. This segmentation depends on the colour of the object to be inspected, in this case the car body.

The tasks in the first stage also included adjusting a series of parameters such as 1) binarization thresholds obtained by colour calibration 2) definition of inspection regions in order to define which regions of the image are going to be analysed, and 3) define the size of the inspected object. As a result, a complete setup composed of a box, a stack to hold the camera and a smart camera has been prepared. Through this setup it has now been possible to define the correct optical system and parameters that will be used in the project.


In the second stage, the Event Manager in LinkSmart will be configured to transmit data on the position of the car body. This data will either trigger a continuation of the events on the process line or a warning. If the car body is in the correct position, the process Body Welding and Assembly Line will continue as normal onto the next stages.

The wireless smart cameras developed in the BEMO-COFRA project will also be used to test the transmission of data and the integration with different devices in relation to the project's research and development work on wireless sensor networks.

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## Dependability in Wireless Sensor and Actuator Networks

## Deliverables released:

The following deliverables have been completed:

- D1.1. Project Quality & Risk Management Plan (confidential)
- D1.2.1 Intermediate progress report for the commission 1 (confidential)
- D1.3.1 Period 1 activity, management and financial report (confidential)
- D1.4 Plan for managing knowledge and intellectual property (confidential)
- D2.1 State of play in production monitoring and control systems (public)
- D2.2 Initial requirements report (public)
- D2.3 Validation framework (restricted)
- WD2.1 Lessons Learned (restricted)
- WD2.2 Updated requirements report (restricted)
- D3.1 Robotics and sensor integration state of art (public)
- D5.1.1 Initial infrastructure for distributed control logic (public)
- D6.1 IoT-enabled legacy devices for production monitoring (public)
- D8.1 Report on the business strategies and the exploitation plan (restricted)
- D8.2.1 Dissemination report I (public)
- D8.4 Training package for software developers (public).

Public deliverables can be downloaded from the project website after they have been reviewed and approved by the EC: www.bemo-cofra.eu



SEVENTH FRAMEWORK PROGRAMME

CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico

The BEMO-COFRA project is a 30-months EU-Brazil cooperative research project which started in 2011. The project is partly funded by the European Commission under the 7th Framework Programme in the area of EU-Brazil Research and Development cooperation under Grant Agreement no. 288133. The Brazilian funding is provided by CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico.

Read more at:
www.bemo-cofra.eu

**Wireless Sensor and Actuator Networks (WSANs) have proven great flexibility and convenience for monitoring and interfacing the digital world with the physical world.**

The small footprint, ease of deployment in inaccessible situations, low cost, and reduced energy consumption, make WSANs a unique candidate for an ample field of applications.

Industrial manufacturing scenarios can employ the feature-rich WSANs for effective observation and control of physical production processes.

However, in the considered scenario, the operations and interactions of the different processes must be extremely accurate, and therefore, the dependability of the system is of utmost importance.

**Dependability in WSANs**

The Wireless Sensor Network (WSN) in the BEMO-COFRA system aims to realize a dependable network, via the integration of the following features:

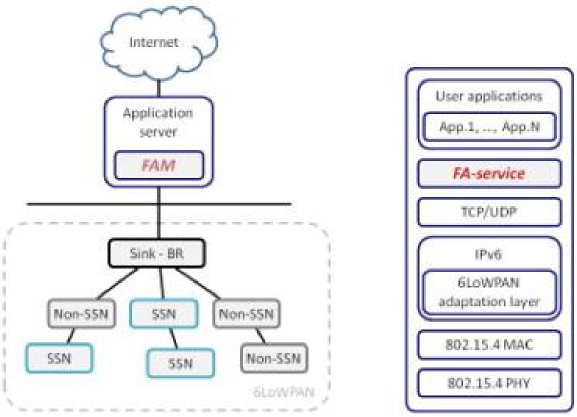
- **Context awareness**: The network features a *Frequency-Agility* (FA) service, enabling the nodes awareness of the current spectrum conditions, as well as providing the best available operating channel whenever a channel switch is necessary.
- **Cooperation and detection**: Cooperative sensing procedures are adopted in order to ensure information reliability against outliers, and to distribute the workload for energy efficiency. Real-time monitoring of the available channels is performed by spectrum sensing, furthermore, internal network health is monitored, thus keeping track of packet losses and end-to-end delay.
- **Self-configuration and self-healing**: Network discovery mechanism is executed at startup and/or after a network failure. Furthermore, a network manager is available, assigning roles to the different connected nodes as required by the application.

Equipped with the aforementioned features, the WSN of BEMO-COFRA is expected to fulfill the following dependability requirements:

- **Availability**: by maximizing the time during which the network end-to-end connectivity is up and running, providing sensing information, data, etc., at the receiving end.
- **Robustness**: by ensuring that the system functions correctly under - and reacts properly to - abnormal conditions, thanks to the FA service.
- **Reliability**: by ensuring the correctness of the received information in terms of content and timing, thanks to the cooperative monitoring.

**Frequency-Agile WSN System Architecture**

The figure below shows the reference system model for the WSAN, operating with a 6LoWPAN stack and provided with FA extensions. The WSAN features *RPL* as the routing protocol, where an RPL *Border-Router* (BR) is deployed that acts as a sink node, and moreover, it manages the two-way data between the 6LoWPAN and the *Application server*. In the 6LoWPAN based WSAN, nodes can be either *Spectrum Sensing Nodes* (SSNs) or *Non-SSNs*. SSNs perform spectrum sensing on the available radio channels and do not participate in the application, while Non-SSNs carry out network application functions and do not participate in spectrum sensing.




All WSAN data are communicated to the application server for processing, while spectrum sensing information is further processed at a component called the *Frequency Agility Manager* (FAM). The FAM processes the spectrum sensing data and obtains the spectrum occupancy state. If the FAM determines that a critical level of interference is present in the current operating channel (OC), it generates an OC switch command to reallocate the network to the best available channel.

In order to provide individual nodes with FA capabilities, the 6LoWPAN stack is extended with an FA service, as shown in the figure to the right. The FA service manages the FA-related operations and routines in the local node; in addition, it reacts to the various commands arriving from the FAM.

Please note that the data acquisition process by the sensor nodes and the information transfer to the FAM are all performed in real time.

Within the BEMO-COFRA context, Non-SSNs can have two responsibilities:

• **Skid orientation monitoring**: Leveraging on the onboard 3-axis accelerometer sensor, a node that is affixed on the skid, constantly provides accelerometer readings to the server, thereby determining the orientation of the skid during the manufacturing process.

• **Robot gripper state monitoring**: A sensor node is mounted on the robot arm to detect whether the gripper is locked or unlocked. The sensor node leverages on a mechanical button that is attached to the node through an extension wire, and placed inside one of the gripper's two pads.

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## Visit to FIAT in Brazil

**The Brazilian partners in the BEMO-COFRA project made a visit to the Fiat production plant in Betim, Brazil, to learn about the complex automotive industry.**

The visit was organised to allow partners to gather information on the existing technologies used in manufacturing process. The team visited the production plant where the vehicle manufacturing line and its automated processing stages were described by Fiat employees.

The team were able to study the main components of the manufacturing process and the interaction between them. These observations will be used to feed into the project's work in developing an infrastructure for monitoring different devices through wireless links.

The manufacturing line consists of various so-called "stations" and BEMO-COFRA has chosen to focus on the Framing Stations; thus defining the user requirements that will feed into the development work based on this particular station. Therefore the team focused specifically on the Framing Station components and their interaction. A successful case of wireless connection between devices (robots, grippers) and a PLC was demonstrated.

The issues concerning communication, such as the interference in wireless links and the difficulties in monitoring the state of some devices, were discussed with the FIAT employees. The main objective of BEMO-COFRA is precisely to develop a framework that can resolve these issues.

The information gathered during the visit to FIAT, which took place in April 2012, will also feed into the development of a demonstration of the chosen scenario which will be presented in a review meeting in November 2012.

The Fiat production plant in Betim (Minas Gerais, Brazil) was established in 1976. Fiat currently runs three daily shifts with a production capacity of up to 800,000 vehicles per year. With a $5 billion investment in 2010, it is one of the largest automobile factories in the world.

The following partners participated in the FIAT visit: Judith Kelner (UFPE), Eduardo Souto (UFAM), Luis Fernando Moreira (Ivision), Marcelo Borghetti (Ivision), Felipe Madeira (Comau), Marina Moraes (Comau) and Marcos Figueiredo (Comau).

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