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Cyber Physical Systems oriented Robot Development Platform

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Abstract

The development of systems, of various levels of complexity that can integrate physical with virtual components has become a priority for research in the context of emerging paradigms such as Cyber-Physical Systems or Internet for the Future. The authors propose a Robotic Development Platform architecture that integrates principles of Cyber-Physical Systems. The proposed architecture, is scalable, by facilitating the integration of different existing development and simulation tools and will allow robot systems to be tested in different environments, with different characteristics, and facilitate the integration of real world simulation with virtual environment simulation.

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Keywords: Robotic Development System, Cyber Physical Systems

1. Introduction

In the actual, continuously enlarging European Union, there is a permanent increasing need to strengthen the capacity and capability of stakeholders in order to embrace science and integrate different technologies. Thus, it is necessary to sustain different initiatives and to continuous invest in the Research and Technological Development (RTD) activities, in an efficient manner in order to contribute to the economic development.

In this context, an international "Universe of Discourse" started, emphasizing on developing Artificial Systems (robots, smart devices, smart systems, a.s.o.) beyond the human perception, shaping new limits.

The research and development in robotics shifted, in the last years, from industrial robots to intelligent robotics and defining methods of easier integration in order to create robotic systems, capable to provide promising results in different areas of robotic research (artificial intelligence, cognitive robotics, human – robot interaction, multi-agent systems for mobile robot collaboration).

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The following topics have to be taken into consideration when attempting to design a robotic system:

- Intelligent sensor technologies
- Integration and fusion of sensors, sensor networks
- Intelligent algorithms in order to assure optimal data acquisition
- RFID based intelligent objects integrated in the Internet of Things
- Intelligent decision support systems integrated into robotic systems,
- Robotic system interoperability and security
- Energy-Efficiency robotic system
- Adaptive robotic systems
- Integration of real-time requirements for robotic applications
- Multi-robot collaboration, synchronization and management
- Human-machine interface
- Augmented and virtual reality systems
- Service oriented robotic systems

2. Robotic Systems in the Context of new Paradigm Shifts

2.1. Human – Robot Collaboration

Regarding human-robot collaboration, we must take into consideration the following aspects: The mobile should act as “on sight” service provider and both robot 2 robot and robot 2 smart device collaborative agent and human 2 robot collaborative control.

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Thus, the main goal is to assure robot to robot autonomous collaboration and robot to smart devices communication and interoperability. Many researches have been conducted in this field. One of them enforces collaboration at the software level, robots being described as collaborative agents based using service oriented architectures. Another approach was focused on embedded heterogeneous robotic systems that allowed the possibility of data acquisition and exchange at different levels, both physical as well as software that define virtual functionalities in order to perform complex tasks .

Collaboration in a human-machine system has the main advantage that hierarchical level where the supervisor is dictating to a subordinate approach will be replaced by a human-machine interaction aiming at information exchange, asking questions and resolving different tasks. The human centered systems involves a Dual Desing Approach that requires and increased level of technical development and integration of human aspects in a human-machine system.

The design process will be structured as to include the technology based aspects in order to create an autonomous system focused on the human work situation, based on the three dimensions of human-centered systems: The Workplace as individual worker and his/her work environment, The Group-work as the group of people co-operating to achieve the same task and The Networks as organizational networks of groups. In this way, human-robot interaction becomes more natural and more direct than the existing conventional approaches.

The communication channels represent one of the most important parts of a robotic system, because the represent a link between the data acquired from the sensors, the intelligent decision support systems and the control system. Regarding the audio communication there are numerous systems available for automated speech recognition (ASR) and text to speech (TTS) synthesis. The requirements for a robust dialogue management system are shortly expressed as follows: the capacity of taking the appropriate human input from the ASR system and convert this input into appropriate robot commands, the capacity to take input from the robot control system, convert this information into suitable text strings for the TTS system to synthesize into understandable audible output for the human collaborators.

Related to video channel, three main research fields can be identified. One is represented by the augmented reality, second by telepresence and the third one by the interaction with virtual objects.