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A Review on System-on-Chip (SoC) Designs for Real-Time Industrial Application

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ABSTRACT

Now-a-days System-on-a-chip (SoC) technology is used in small, increasingly complex consumer electronic devices. A system-on-a-chip (SoC) is a microchip with all the necessary electronic circuits and parts for a given system, such as a Smartphone or wearable computer, on a single integrated circuit (IC). Day by day the scope & use of the electronics concepts in industrial field is increasing step by step. In this paper the review of newly developed concepts is done for the SoC design for real time industrial application. This paper also reviews a power and area efficient for industrial application. Further the study of SoC designs for real time industrial application has been carried out.

Keyword: SoC (System on chip), IC(integrated circuit)

I. INTRODUCTION

Modern industrial control systems need to comply to different requirements to make a high and fast market impact. From the designer's point of view, all requirements can be summarized into two key factors: improve quality (in terms of performance, resource usage, power dissipation, etc.) and reduce time-to-market. Modern industries systems need to respond to various requirements to compete on their products which must be fast, high performing, reliable and very flexible. Another key issue is the cost, in order to minimize it, time-to market must be shortened and the price of controller device should be cheap. The cost reduction, increasing the complexity of the control algorithms and reduce the time execution are the most challenging aspects for a new industrial control system to make a high and quick market impact. To achieve these challenges, developers need to depend on the most advanced digital electronics technologies which come now with familiar software developments tools. To develop a high quality real-time industrial control systems, developers have to choose one of the main two families of digital device technologies. The first family relies on a pure software platform. Digital Signal Processors controllers (DSP controllers) and the microcontroller are the associated devices. These components integrate a performing microprocessor core with external devices which are very important to implement the targeted systems in real-time and to communicate with the industries environment.

A SoC is specially designed to meet the standards of incorporating the required electronic circuits of numerous computer components onto a single integrated chip. Instead of a system that assembles several chips and components onto a circuit board, the SoC fabricates all necessary circuits into one unit. The challenges of an SoC include higher prototyping and architecture costs, more complex debugging and lower IC yields. IC is not cost effective and takes time to manufacture. However, this is likely to change as the technology continues to be developed and employed. A system on a chip (SoC) combines the required electronic circuits of various computer components onto a single, integrated chip (IC). SoC is a complete electronic substrate system that may contain analog, digital, mixed-signal or radio frequency functions. Its components usually include a graphical processing unit (GPU), a central processing unit (CPU) that maybe

multi-core, and system memory (RAM).Because SOC includes both the hardware and software, it uses less power, has better performance, requires less space and is more reliable than multi-chip systems. Most system-on-chips today come inside mobile devices like smart phones and tablet.

II. LITERATURE SURVEY

In the last few years, there is different SoC design for Real time industrial application proposed by many researchers.

ShebliAnvar, Olivier Gachelin, Pierre Kestener, Herve Le Provost, and IrakliMandjavidze, [2006], [1]describe the designing real-time hardware/software systems for data acquisition and analysis applications in particle physics, which are based on a system-on-chip (SoC) approach. Modern field-programmable gate array (FPGA) devices with embedded reduced instruction set computing (RISC) processor cores, high-speed low voltage differential signaling (LVDS) links and ready-to-use multigigabit transceivers allow development of compact systems with a substantial number of input-output (IO) channels, where required performance is obtained by a subtle separation of tasks among closely cooperating programmable hardware logic and user-friendly software environment.

Pengfei Zhang, [2009], [2], PTL (Projection Temporal Logic) is a kind of temporal logic which can handle both sequential and parallel com pupation. A formal approach of specification and verification of SOC using PTL.With this approach, PTL is used in high level design and hardware/software co-design for the formal specification and verification of a SOC system or its hardware/software parts. A simple CPU is specified in different abstract levels as an application illustrative example.

Slim BEN OTHMAN, Ahmed Karim BEN SALEM, HediAbdelkrim, Slim BEN SAOUO, [2012], [3],Modern embedded control systems require more performance digital devices to answer their growing complexity. The performances of System on Chip (SoC) and the Field Programmable Gate Array (FPGA) particularly, are increasing continually. Recent FPGA technology makes it possible to include processor cores into the FPGA chip. A high flexibility can be realized for the construction of the control processor in industrial power electronics application. Indeed, greater functionality of hardware and system software, Real-Time (RT)platforms and distributed subsystems are demanded. In this paper, design concept of FPGA-based controller for electrical machine system is proposed. In this method, a full speed RT motor control drive algorithms are implemented by using MultiProcessorSoC (MPSoC) architecture based on processor. Test and validation of this whole controller system is performed by RT motor emulator implemented on the same FPGA. There are discussed different design architectures for the implementation on embedded processor cores and performance analysis of such embedded systems. Experimental results, carried on a real prototyping platform, are given in order to illustrate the efficiency of adopted architecture designs helping to support hard RT constraints.

Somsubhra Ghosh1, Ranjit Kumar Barai2, Samar Bhattarcharya, Prarthana Bhattacharyya3,Shubhobrata Rudra4, Arka Dutta5, RownickPyne, [2013], [4],This paper is present a novel way to implement digital controllers with a successful implementation of a digital PID controller. The design shows significant improvements over the present way of implementing digital controllers in Microcontroller Units in terms of latency, response, flexibility, and robustness. It can be extended to accommodate other advanced controllers that may also result into superior, reliable and flexible systems.

VicentRutagangibwa, Babukirshnamurthy, [2014], [5], Real Time Systems are at the heart of industrial automation applications and thus, a time response mechanism is required to be able to implement such systems. This paper presents a survey of Implementing Real Time Systems for industrial automation applications. Recently, PLCs have dominated industrial automation implementations but however, they do present some challenges especially in meeting real time constraints due to its centralized control and cyclically scanned program execution mechanisms. This paper proposes an alternative implementation approach using Free RTOS platform that can act as a benchmark for time bound services. This would help in having a hybrid system that can work with PLCs and/or where possible replace PLCs for deterministic service delivery.

NicoSurantha∗, Astri Maria†, Yuhei Nagao†, Hiroshi Ochi, [2016], [6], In the recent years, wireless technology has a raised as a promising alternative to Ethernet technology as a trans mission medium for industrial automation system. This paper presents our wireless solution for industrial application, which is

based on wireless LAN (WLAN) system. In this system on chip (SoC) design and FPGA implementation for industrial wireless local area network (iWLAN) systems is introduced. The SoC design includes the dual-processor ARM based reconfigurable CPU, high-performance AMBA bus, mode l based WLAN PHY, and HW/SW co-design WLAN MAC layer, and high-speed peripheral IP. The FPGA implementation is performed on our advanced FPGA verification platform. We utilize the multiprocessor architecture to satisfy the real-time property of iWLAN system. Our simulation results and FPGA implementation show that our design and implementation can meet the requirement of the system.

D. Tormo*x*, L. Idkhajine*x*, E. Monmasson*x*, and R. Blasco-Gimenez*z*, [2016], [7], New System-on-Chip (SoC) devices, which include powerful general purpose processors and FPGA in the samechip are particularly suitable for Real-Time (RT) simulation of electromechanical systems. This is introduces a systematic analysis of the capabilities of one of these devices for RT electromagnetic simulation. Considering all the capabilities of these platforms, it is not straightforward to use them efficiently and port existing developments due to the SoC relative complexity and variety of programming models. In this paper to evaluate some of the benefits of moving to such platforms through the implementation of an example application on the Xilinx Zynq-7000 SoC. Simulation results concerning execution time, resources usage and precision of the calculations are presented, compared and validated using MATLAB/Simulink.

ZoranSalcic, Muhammad Nadeem, Heejong Park, JuergenTeich, [2016], [8],A new multi-core SoC platform designed for industrial automation applications with mixed criticality. The applications are written in System J language. The multi-core platform consisting of three different types of cores is implemented in a SoC that contains a standard dual-core ARM and a FPGA, which is used to run the critical part of the system. The platform is fully customizable in terms of number and types of cores to the needs of the application. An industrial automation case study is used to demonstrate the use and performance of the multi-core SoC

Axel Rothstein, Thomas Stoetzel, Volker Staudt, [2016], [9], Current control systems and emulation systems(Hardware-in-the-Loop, HIL or Processor-in-the-Loop, PIL) for high-end power-electronic applications often consist of numerous components and interlinking busses: a micro controller for communication and high level control, a DSP for real-time control, an FPGA section for fast parallel actions and data acquisition, multiport RAM structures or bus systems as interconnecting structure. System-on-Chip (SoC) combines many of these functions on a single die. This gives the advantage of space reduction combined with cost reduction and very fast internal communication. Such systems become very relevant for research and also for industrial applications. The SoC used here as an example combines a Dual-Core ARM 9 hard processor system(HPS) and an FPGA, including fast interlinks between these components. SoC systems require careful software and firmware concepts to provide real-time control and emulation capability. This paper demonstrates an optimal way to use the resources of the SoC and discusses challenges caused by the internal structure of SoC.

Gilberto Ochoa-Ruiz,1 Romain Bevan,2 Florent de Lamotte,2 Jean-Philippe Diguet,2 and Cheng-Cong Bao3,[2017],[10],This paper is present the implementation of a SoC FPGA-based intelligent electronic device, which has been seamlessly integrated into a previously existing infrastructure for an advanced fiber placement system. The implementation here can be subscribed to the smart factories paradigm, since the overall platform is in fact a distributed control system, which relies on complex industrial communication network to properly operate. Furthermore, some of the most demanding aspects of the original application have been migrated to a SoC FPGA to add a higher degree of intelligence and flexibility in the control of the deposition subsystem, which can accommodate future developments as well. To very specific requirements of the application, which demanded not only very low response times but also flexibility in terms of reconfiguration of the deposition head and the control hardware and software, made a strong case for the use of FPGAs. To application necessitated a real-time and low latency Ethernet communication, remote configuration and storage of the deposition programs, and the availability and customization of a large number of I/Os.

Ali Al-Mahmood, Michael OpokuAgyeman, [2017], [11],The main goal of this paper was to explain the FPGA's technologies and to illustrate the uses of FPGAs in industries. This paper showed the benefits of using FPGA and how it is going to help industries to produce the best products. As mentioned in the introduction part that the industrials' applications should be on a high performance, reliable, fast, and

very flexible. The contributions of the controller embedded systems have discussed and declared the main issues with the applications. These issues have been discussed to find the best solutions to avoid them. FPGA-SoC trends have been discussed to compare between the two groups of processors which are the synthesizable and the non-synthesizable and highlights the benefits of them and the uses. The Evaluating of FPGA-SoC has been discussed to evaluate the performance of it within the industrials' applications. A real-time application has been used to prove the high performances of the FPGA-SoC. The application was a face detection and tracking system to detect and truck human faces. The result shows that system on chip (SoC) design for real time industrial application. The application is a real time face detection and tracking. It can be implemented on the FPGA platform.

III. CONCLUSION

This review paper gives brief survey on SoC deign for real time industrial applications. The industrials' applications should be on a high performance, reliable, fast, and very flexible. A real-time application has been used to prove the high performances of the FPGA-SoC. The application was a face detection and tracking system to detect and track human faces. Some testing has been done on a live human face and on a picture that has a human face. Some algorithms of images' filleting have been implemented on the captured image in order to detect the right pixels to present the expected results. From the literature review it can be concluded that there is prerequisite to implement on SoC deign for real time industrial application technique on FPGA in order to achieve with great accuracy and less complexity. So, in order to develop precious and optimize system for real time industrial application is preferable.

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