AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Computer Engineering and Systems

Enhancing the Performance of the AUTOSAR COM Module

A Thesis submitted in partial fulfillment of the requirements of
Master of Science in Electrical Engineering
(Computer Engineering and Systems)

by
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Bachelor of Science in Electrical Engineering
(Computer Engineering and Systems)
Faculty of Engineering, Ain Shams University, 2011

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Dr. Mona Mohamed Hassan Safar

Cairo, 2016

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Date: 04 09 2016

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

Summary

Today's automotive software applications exhibit high communication within Electronic Control Units (ECUs) and between networked vehicle nodes. This causes high Central Processing Unit (CPU) load on these ECUs, which affects the overall performance of the system. It is needed to think for approaches to enhance the performance of these ECUs without the need to reduce the amount of the exchanged information, which is not feasible.

In the past years, the model-based design became an important field that needs to be explored in many fields/applications due to the increasing complexity of these fields/applications. Due to the restricted timing constraints of these fields/applications, the hardware/software codesign became a pressing part in the model-based designs.

This requires splitting the functionality of the software applications into two parts. The first part is the primary part that controls the flow of the software applications and performs the non CPU-intensive operations on a general purpose CPU. The second part contains the CPU-intensive operations that are needed to be expedited in order to enhance the performance of the system to meet the timing requirements of the used software applications. A coprocessor is used to support these CPU-intensive operations by offloading these operations from the main CPU and speeding them up by executing them on a dedicated Hardware (HW) that is customized for doing these operations.

In this research, we explore the usage of coprocessors in the AUTomotive Open System ARchitecture (AUTOSAR) Layered Software Architecture. We analysed the execution time consumed by the main functions called from the application used in an Engine Control Management AUTOSAR-based ECU. The analysis shows that the operations done by the AUTOSAR Communication (COM) module are the most ECU time-consuming operations. Our approach modifies the AUTOSAR Layered Software Architecture by adding the COM coprocessor. This model-based hardware/software codesign expedites the COM operations while keeping the application interfaces with the upper and lower AUTOSAR layers unchanged. The COM coprocessor covers two operations, which are the SendSignal and the ReceiveSignal operations.

We implemented two versions of the coprocessor. The first one is a non-pipelined version, which achieves up to 140x speedup over the Software (SW) COM solution. The second one is a pipelined version, which achieves up to 5.52x speedup over the non-pipelined version. This speedup gained by both versions of the coprocessor gives a room

for the Original Equipment Manufacturer (OEM)s and Tier1 suppliers to extend their automotive applications and increase the amount of the exchanged information by these applications without affecting the performance.

The thesis is divided into six chapters as listed below:

Chapter 1

This chapter introduces the thesis by presenting the research motivations, objectives, challenges, methodology, and thesis organization.

Chapter 2

This chapter presents an overview about the AUTOSAR Layered Software Architecture and the modules contained in it and their functionalities.

Chapter 3

This chapter explains the implementation details of the non-pipelined version of the AUTOSAR COM coprocessor.

Chapter 4

This chapter explains the implementation details of the pipelined version of the AUTOSAR COM coprocessor.

Chapter 5

This chapter discusses the experimental results for the pipelined and the non-pipelined versions of the AUTOSAR COM coprocessor.

Chapter 6

This chapter ends the thesis by conclusions and the expected future work.

Key words:

Automotive, AUTOSAR, hardware/software codesign, model-based design, coprocessor, COM, I-PDU, signal, ECU, ECU Extract, OEM, Tier1, Tier2

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Contents