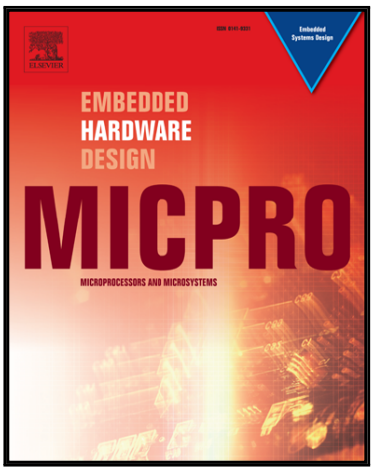

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Application Specific Instruction Set Processor for Sensor Conditioning in Automotive Applications

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Abstract

In the automotive electronic market, sensor conditioning is one of the driving applications. Sensor solutions are pervasive in the vehicle, while signal processing in such application is getting more and more complex. Currently the design strategy is often the standard ASIC flow, but the design effort can be reduced by automatic or platform-aided design strategies, or by using software-based solutions. In this paper SensASIP platform is presented. It is a design platform targeting a microprocessor architecture enhanced by dedicated instructions for computing intensive sensor signal processing tasks. SensASIP allows a seamless design flow from MATLAB-based algorithm definition and instruction set design and simulation, down to hardware macrocell HDL description and implementation in CMOS technology. SensASIP features are described through two automotive sensor conditioning examples. Special focus is put on its increased flexibility and reduced design-effort vs. standard ASIC design approach and on its low complexity overhead vs. other state-of-art software-based solutions.

Keywords: ASIC (Application Specific Integrated Circuit), ASIP (Application Specific Instruction set Processor), digital design, sensor conditioning, automotive, signal processing, design platform

1. Introduction

Sensor conditioning in automotive application is one of the greatest shares of the market. The number of sensor-based solutions for each vehicle is growing, together with the requested features. As observed in [1], the number of sensor systems in each vehicle was around 60-100 in year 2013, and it is expected to reach 200 in next years. Automotive sensor technologies have usually peculiar features and require different processing capabilities. However, a big part of the market is made up of sensor families, which feature quite low complexity and data rate. Some examples of such sensor systems are capacitive sensors, for pressure, acceleration or angular rate measurements, inductive sensors for linear and angular position measurement, and magnetic sensors for position measurements. In addition to processing specification, in automotive electronic market also functional safety features are important specifications. Sensor conditioning electronic in automotive application must be functioning and safe. Signal processing growing complexity and more strict safety features lead to an increasing area for automotive sensor ASIC devices, and hence increasing cost and static power consumption. Moreover, in this field the ASIC design flow is traditionally custom. It is possible to assert that each of the additional features to be implemented on silicon requires an additional design effort. Of course, blocks reuse and designer experience play a key role in custom, i.e. hardwired design, in a scenario where the hardwired complexity is getting larger, and the too high design effort puts the design at risk of not to meet the time-to-market. The emerging features growth is leading to new design strategies (e.g. [2, 3, 4]), and to novel design tools ([5]). The trend is to move the design effort to higher level. However, the complexity overhead due to high-level design strategies, and to their lack of optimization capability, is a cost that companies are typically reluctant to pay.

In order to address the above issues, in this paper a novel design platform, called SensASIP, for sensor conditioning devices is proposed. In Section 2 the state of the art of possible design paradigms

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