AutoVision – Flexible Processor Architecture for Video-assisted Driving

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Future automotive security systems will benefit from visual scene analysis based on a fusion of video, infrared, and radar images. Today we have already functions like lane departure warning and automatic cruise control (ACC) for pretty well defined driving environments, such as highways and primary roads. Recent research activities concentrate on more complex environments, such as city traffic with a wide variety of traffic participants moving in a unpredictable manner, e.g. bikes, pedestrians, children, and even animals, and under changing weather and lighting conditions.

The ITRS semiconductor roadmap for microelectronics forecasts a continued doubling of transistor capacity per chip every 2 to 2.5 years enabling Billion transistor ASIC designs in the near future. Multi Processor System on Chip (MPSoC) solutions with 8, 16 or even more standard RISC CPU cores, Mega-Bytes of fast (ns access latencies) on-chip SRAM memories, Giga-Byte per second interconnect buses or NoC (Network on Chip) meshes, high-speed serial I/Os and, last but not least, Million gate equivalent dedicated hardware accelerator functions in eFPGA (embedded Field Programmable Gate Array) logic are becoming reality on a single silicon substrate. Examples of current research projects shall illustrate our perception on how this tremendous increase in functionality and computational performance per chip area may impact automotive control unit (ACU) architectures for driver assistance applications. The AutoVision processor is a dynamically reconfigurable MPSoC prototype where video-specific pixel processing engines are on-the-fly loaded or exchanged without interrupting regular system operations. For the time being, pixel processing engines cover functions such as object edge detection or luminance segmentation, and are implemented as dedicated hardware accelerators to ensure real-time frame processing capabilities of the AutoVision processor. Dynamic replacement of processing engines ensures an automatic and area efficient adaptation to various driving conditions. Segmented objects are, in a subsequent step, characterized by means of standard MPEG-7 descriptors and entered as search criteria into traffic scene analysis databases. Goal is to obtain a clean distinction between passenger cars, trucks, and big rectangular traffic signs, and to identify pedestrians or bikers in complex traffic situations. The AutoVision processor project is supported by the German Research Foundation (DFG) in the special emphasis research programme “reconfigurable computing”.

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