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Using FPGA Structures For Automotive Electronics

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***Abstract*—As microelectronics becomes increasingly important in automotive systems, transport electronics developers are increasingly relying on FPGA programmable structures to create applications with better performance and flexible architectures.**

Keywords—electronic control units, transport applications, programmable logic blocks, automotive information technology, hardware, digital signal processing

I. Improving Computing Performance for Transport

Although cars have a long and rich history, electronics have been used extensively in transport applications relatively recently, becoming an integral part of the automotive world only in recent decades. Today, car companies compete fiercely not only with each other, but also with the latest and most modern technologies [1].

Currently, manufactured cars rely on many sensors to measure many internal and external variables that could affect the car's driving behavior, as well as additional parameters such as visibility and passenger comfort. Depending on their level of sophistication, sensors can be classified from simple sensors that directly measure individual physical parameters (eg ambient light sensors and temperature sensors) to complex intelligent sensors that determine environmental parameters using broad-spectrum signals (eg radio frequency, radars and light, video); in addition to measurements, they perform data processing and have the ability to perform drives [2].

Using processor-based electronic control units (ECUs), it is difficult to keep up with consumer electronics due to the long cycles of chip development and strict standards of reliability and quality applied to the automotive industry. The automotive industry uses increasingly sophisticated electronic systems to offer the driver better safety and efficiency. Programmable arrays of valves (FPGAs) can play an important role in filling this gap, providing up-to-date performance and high flexibility to system architects to customize projects through a flexible (programmable) electronic circuit structure.

The main goal in automotive design is to reduce the total number of ECUs, as they increase the overall cost of the vehicle and reduce reliability. Thanks to the latest advances in FPGA structures, it is now possible to combine electronic components inside the car more intelligently.

For example, the implementation of a purely hardware processor architecture is a problem that needs to be addressed urgently. However, one possible solution to these interferences is a hybrid approach that combines processors and ECUs with FPGA-based chip systems (SoC), Fig.

FPGAs contain an array of programmable logic blocks, such as built-in memory, digital signal processing units (DSPs), and high-speed receivers. With FPGAs, the automotive system becomes easily scalable with minimal hardware changes.

In this way, FPGAs create opportunities for automotive original manufacturers and suppliers to more effectively build innovative safety programs, such as adaptive cruise control, driver assistance, collision avoidance and blind spot warning.

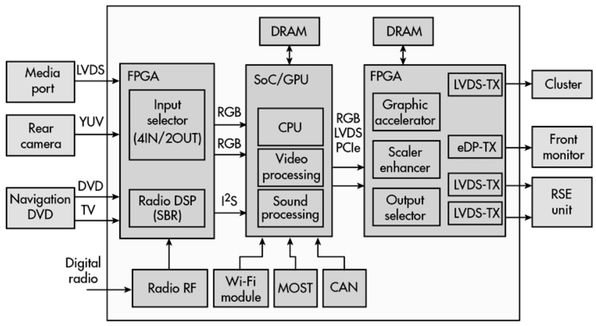

Fig. 1. Hardware processor architecture

As the name implies, driver assistance includes fea-tures such as reversing cameras, three-dimensional sur-veillance cameras, lane departure warning systems, pe-destrian detection and more [3].

II. Hardware and Software

FPGA is a semiconductor device based on a matrix of programmable logic blocks, which are determined by their functionality. This feature distinguishes FPGAs from specialized integrated circuits (ASICs) designed for applications designed for specific design tasks. ASICs and FPGAs have a number of key benefits that need to be carefully evaluated before making a decision. With the development of unmatched logic density and many other features such as digital signal processing, clock speed and high-speed serial bus, FPGAs become a reliable helper for almost any type of design.

For example, automotive infotainment systems are of great importance in modern vehicle design and have a significant impact on the sale of global vehicles. In these systems, it is important to choose the right main system processor to differentiate the user interface with the latest graphics. With several models to support, you may have to choose different SoCs due to system variations and the emergence of new interoperability technologies.

Thanks to FPGA, the system becomes easily scalable, which allows you to update the firmware remotely to support more manufacturers, regions and models with minimal hardware modifications. You can use the FPGA to support any combination of I / O interfaces [4].

The most important design factor of FPGAs is that they are programmable logic devices. Of course, CPU software can be upgraded, but the same cannot be said for computer architecture. On the other hand, FPGAs can be configured or reprogrammed to perform various functions an infinite number of times. In many recent cars, the software tracks many functions during operation. For example, Tesla models already support software updates remotely.

Thanks to this feature, FPGAs are able to constantly support the original software of manufacturers with the latest versions of programmable or customized hardware architecture systems. Such software updates can be applied to various car features, which may include more FPGA-oriented structures as they become more powerful, smaller and cheaper [5].

Connected vehicles are able to analyze information in real time to provide new information to car users, optimizing their experience. Meanwhile, IoT connectivity can help develop new development models for the automotive market by transforming the relationship between automakers and drivers.

III. Automotive Information Technology

As more IoT technologies are implemented in automotive applications, this is a prerequisite for the convergence of innovations - especially in the electronics in-dustry. However, experienced engineers know that there is a learning curve when using something new that comes into direct conflict with less development time. In turn, this increases the project risk.

For this reason, designers tend to reuse technologies that are already well known or have been used before. Over time, this philosophy transforms some architecture into widely used industry standards, while most others are used only in narrow market niches.

IoT engineers will have to deal with significant issues such as energy efficiency and management of incompati-ble interfaces. The FPGA-based design approach can help solve these problems by offering a fully functional hardware platform for very low-power IoT applications.

When researching which 32-bit processor will best serve customers, many companies realize that the stand-ard industry architecture offers significant benefits to the owner. Standard industry processors, as a rule, have a wide range of development tools, a large number of available software codes and designers who have the knowledge and experience to use them. Such benefits ac-celerate project development time (and therefore time to market) and also reduce a project risk, which in turn pro-vides users with higher value-added solutions [6].

On this front, the ARM Cortex – M1 processor, de-signed from scratch for use in FPGAs, stands out. One of the main functions - it helps to minimize the amount of resources needed to meet the requirements of the devel-oper. For example, debugging functions can be enabled or removed. Operating system extensions for system tim-ers and software interrupts are not required. Cortex-M1 works with most basic FPGAs, which means that switch-ing from one FPGA device to another requires minimal effort.

IV. Conclusions

FPGAs are now implemented separately or together with processors in many automotive systems, as they provide more efficient and faster solutions for hundreds of ECUs in a vehicle. They provide higher performance without consuming more energy, and improve customiza-tion and scaling capabilities [7].

FPGAs can also help reduce overall car ownership costs by integrating and / or reducing the number of ex-ternal components, speeding up time to market, and con-solidating accelerated project development.

In addition, thanks to innovative and cost-effective imaging solutions, FPGAs support the implementation of even more automotive features. Finally, they often offer a more cost-effective option in programs such as traffic control systems or engines. At present, it is expected that the design needs of the growing hybrid and electric vehi-cle industry will also focus on expanding the FPGA mar-ket.

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