Let’s look at the problem

Developers of medical devices need powerful integrated embedded SoCs and a clear embedded roadmap. By Zeljko Loncaric.

Medical devices and medical pcs need to become more powerful, faster and smarter, with the goal of saving money and improving patient care. This is being made possible through the development of smaller, more powerful processors that enable wider use of computer technology; for example, in the home care sector.

There are many medical applications which require particularly fast data processing and visualisation; examples include emergency service vehicles, during hospital consultations, at the bedside or in the operating theatre. This applies to stationary and mobile medical devices alike, whether compact ultrasound devices, medical tablet pcs or patient data monitoring systems. With better display resolutions, more data from diagnostic imaging systems and higher information density in visualisation applications, embedded processors must be capable of processing and presenting more and more graphical source data. At the same time, devices need to become more compact, energy efficient and cost effective in order to succeed in an increasingly mobile and wider field of application.

Meeting these needs requires the provision of more computing power in a smaller footprint. Classic pc processor cores, such as the AMD G-Series SoC platform, which integrates two or four cores, are well suited for traditional IT tasks, in particular the rapid execution of applications such as radiology information systems, hospital information systems, picture archiving and communication systems and MS Office programs. In these applications, AMD G-Series SoCs can double the cpu performance available from AMD Embedded G-Series APUs.

While overall computing power is important, when it comes to processing and displaying two and three dimensional image and video data, there are more efficient cores, such as those provided by the integrated AMD Radeon graphics processors. Despite its compact size, the AMD G-Series SoC platform features powerful graphics processing: up to 20% more performance than available from AMD G-Series APUs.

In addition, AMD has designed the SoC platform as a programmable, high performance parallel data processing unit. Typical applications include image processing tasks in diagnostic workstations and image generation.
from sensor data in ultrasound devices and radiology systems. For such applications, the integrated gpus provide up to 256GFLOPs via OpenCL APIs. Physically, the SoCs, manufactured using 28nm technology, require only 600mm² of pcb space and integrate an I/O controller. The processor also implements standard interfaces such as PCIe, SATA and USB3.0.

While they bring a number of benefits, the latest processors also present medical device developers with a number of practical challenges. These include: high integration density, with barely resolvable pin grid array interfaces; extremely high clock frequencies; and a higher slope. Implementing these parts into medical applications can often require specialist know how that is rarely the core competency of a medical device manufacturer. It therefore makes practical and economic sense to buy the critical ‘core module’ as a preintegrated computer on module (COM).

The experience of the module supplier and the effects of consolidation translate into a number of benefits for device manufacturers, including:

- Scalability, through module interchangeability
- Preintegrated platform
- Drivers and board support packages for several operating systems.
- Shorter development times and reduced time to market
- Higher quality

It is also useful for other system components to be preintegrated on the COM or for users to have the option to configure them. This applies in particular to battery management systems in battery powered or battery backed units.

For applications requiring higher graphics performance, a COM Express Type 6 Basic module makes the best use of the AMD Embedded R-Series APUs. Alongside powerful graphics, the modules offer excellent performance/Watt values. The congato TFS, for instance, offers superior graphics representation for a range of medical applications.

Connecting seamlessly to the performance available from the congato TCG, the congato TFS allows developers to benefit from scalability when designing products ranging from low power mobile devices to stationary high performance systems. The integrated graphics core supports DirectX 11 and OpenGL 4.2 for fast 2d and 3d displays supporting resolutions of up to 3940 x 2160 pixels. This allows them to be used in sophisticated diagnostics workstations or in preoperative systems.

Meanwhile, existing medical systems may need to be upgraded. Some of these may use ETX format boards, with an ISA bus, or XTX format, without ISA. Upgrading these systems allows them to be equipped with modern graphics and computing power and congato has developed the ETX COM congato EAF and the XTX COM congato XAF for this purpose. Both modules, based on AMD G-Series APUs, are available with single or dual core processors and thermal dissipation of less than 18W.

By combining graphics and processor technology in one package, AMD has developed efficient x86 based SoC solutions suitable for a range of medical applications. With a clear roadmap and success with semi custom designs, AMD has a sound solution for the medical sector.

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Until recently, desktop computers needed special hardware to enable medical image data to be visualised. However, the latest embedded systems can handle these tasks and consume less power. White Lion Technologies has taken advantage of this ability to develop a dental chair with a COM system and a high resolution touch screen.

In addition to accessing general patient information, the dentist can view and modify case specific data during examination. Images taken by an intraoral camera can be displayed or stored and data from digital volume tomography (DVT) devices represented. DVT captures image slices using an x-ray tube which rotates around the patient and an opposing detector. Using cone beam reconstruction, a volumetric dataset can be generated and stored in high resolution.

The system takes advantage of OpenGL to represent high resolution volumetric data and to enable live modification of display parameters. To enable this, a raycaster was written as a shader for the graphics card. This sends virtual rays in the direction of the patient’s 3d line of vision through the DVT volume, accumulating colour and transparency in the process. To make the representation even more realistic, it is possible to analyse the surrounding voxels (volumetric pixels) and produce a shading effect. Depending on the system settings, it is possible, for example, to represent a patient’s dentures or to see root fillings of individual teeth.

The raycaster sends many simultaneous rays through the volume, with the image generated using data from the complete cycle. Since this is usually done at 30 frame/s and with a volume of 5123 voxels, the dentist can see a high resolution virtual model of the patient, rotate it and adjust parameters relevant for the treatment. By applying intelligent algorithms, practitioners can determine certain anatomical properties, including nerve channels, or show a panoramic view of the jaw structure. congatec expects that cpus and gpus will continue to merge into high performance embedded systems. In the future, embedded systems with APUs will be able to handle extremely compute intensive cone beam reconstructions and it should also be possible to account for any unintended patient movement during recording. And a further benefit will be the development of algorithms which allow the radiation dose to be reduced.