Digital Cockpit Application Development

July, 2020

Goal

Deliver highly-optimized immersive user experiences for vehicle cockpits of the future.

Solution

A mixed reality HUD (heads-up display) providing navigation and infotainment, optimized for high performance on Arm-based automotive SoCs using Streamline Performance Analyzer software.

Key Points

✦ The solution removes the distractive disconnect between the real world seen through a vehicle's windshield and the virtual one plotted on infotainment and navigation device

✦ Apostera Mixed Reality Guidance uses augmented reality (AR), machine learning (ML) and computer vision to accurately calculate and render navigation and information directly onto the windshield

✦ Novel Samsung Exynos Auto V9 processor with powerful combination of Cortex-A76 CPU and Mali-G76 GPU, that enables premium experiences on uniquely consolidated cockpit domain controllers

✦ Combined CPU and GPU system analysis in Arm Development Solution

Today's vehicle infotainment systems supply navigation, vehicle status information and entertainment via one or more screens embedded in the dashboard and instrumentation cluster. Combined with touchscreens, steering-mounted controls and, increasingly, voice and gesture recognition, they offer an intuitive 'one stop shop' for vehicle interaction.

However, infotainment systems such as navigation displays, require drivers to interpret what they see on the screen to the view through their windshield. Those extra seconds could result in anything from a missed exit to something far more catastrophic.

Munich-based automotive company [Apostera](#) aims to remove this disconnect between the real world and the infotainment system by transforming the windshield of a vehicle into a mixed reality screen, providing a more pleasant and distraction-free driving experience. More than a simple graphical overlay, Apostera's solution enables OEMs to combine information from a vehicle's cameras, sensors, maps and telematics in order to accurately plot virtual objects into the real world in 3D, using augmented reality, machine learning and computer vision.

Apostera enables active safety applications at up to 250km/h. This 'look through' heads up display (HUD) enables navigation of a route by highlighting the road itself, lane keeping and departure warning, object tracking, trajectory projection, forward/side/rear collision avoidance and, ultimately, autonomous driving. The driver's eyes remain on the road at all times.

Intelligence at the endpoint

To achieve the most reliable output possible, Apostera performs complex artificial intelligence within the device itself without reliance on cloud connectivity for any machine learning (ML) inference. ML models are used within the perception subsystem for detection and tracking of road objects (e.g. lanes, vehicles, pedestrians) and in within the sensor fusion subsystem for interpretation of input data from multiple sources in order to effectively model the environment. It is also capable of using V2V (vehicle to vehicle) and V2I (Vehicle to Infrastructure) communications to plot other vehicles or obstacles on the road before they are in line of sight. These algorithms are designed and optimized to run on automotive-grade embedded hardware, powered by Arm.

AI capabilities supported by powerful compute and rendering hardware

In applications such as gaming, augmented and mixed reality relies upon low latency processing and a stable frame rate to avoid user motion sickness, minimize rendering errors and maintain display clarity. This is even more important in an automotive application as the real-world environment is moving far more quickly. In a vehicle moving at 100 km/h, a latency of 200ms will result in up to a 5-meter misplacement of the augmented object position compared to the real world. That level of inaccuracy is unacceptable for safety-critical applications in vehicles.

This level of low-latency, near real-time processing alone requires powerful hardware. But given the scale of sensor fusion and artificial intelligence (AI) also involved, Apostera's solution required best-in-class hardware in order to ensure reliable operation at all times. To meet its comprehensive compute requirements throughout development, automotive OEMs rely on Arm-based solutions.

The Samsung Exynos Auto V9 processor is a 64-bit octa-core Arm-based SoC (system on chip) that has become proven in the market since its launch in January 2019. An automotive powerhouse, the Auto V9 integrates eight Arm Cortex-A76 CPU cores supported by 3 Arm Mali G76 GPUs. The processor integrates dedicated features supporting today's, as well as future requirements for infotainment systems in terms of security, functional safety, virtualization and multi-OS operations. It has been selected to power Audi's next-generation in-vehicle infotainment (IVI) system, which is expected to make its debut by 2021.

Ensuring low latency through performance analysis

To achieve the level of performance critical to Apostera's solution, performance was monitored continuously throughout development to identify bottlenecks and ensure all operations completed in time with no dropped frames or data misplaced in output. This level of intensive monitoring and optimization required a capable development tool, and Apostera used the Arm Streamline Performance Analyzer (a component of Arm Development Studio) for this purpose.

A complete software system profiler, the tool quickly identifies the code 'hot-spots' by combining software trace with performance metrics and events from across Arm Cortex CPUs and Arm Mali GPUs. Arm Development Studio's Streamline enables developers to quickly identify issues and optimize software running the complex heterogeneous SoCs of future digital cockpits.
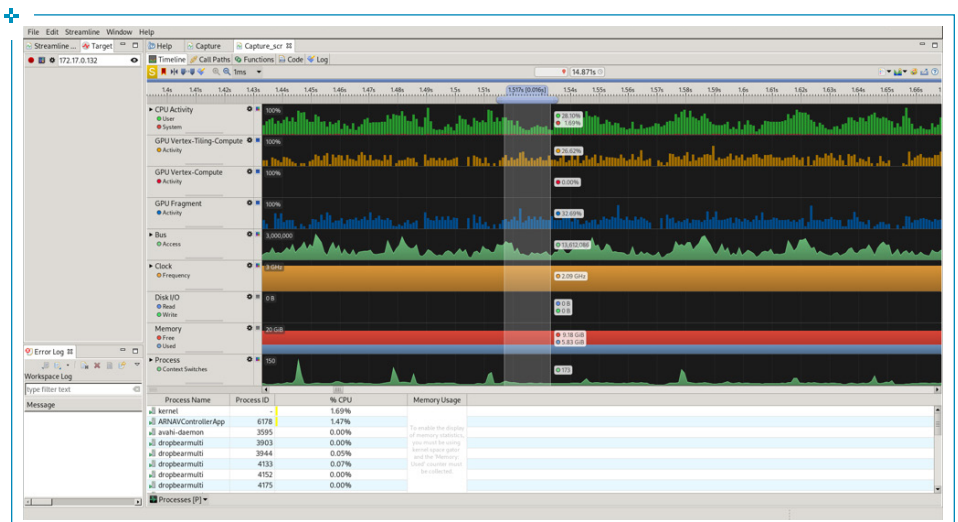
Apostera used the tool to identify and focus on problematic code that is taking up the most hardware resource time during execution. **Here is how developers used Streamline to identify 'hot-spots'.**

"Using the Arm Streamline Performance Analyzer, we immediately identified a code area that the application spent an inordinate amount of time in." – Nikolay Spasonov, Chief Architect at Apostera.

"Furthermore, linking the source code to the tool and loading the application debug information to Streamline helped us to find the exact file and line number of the problematic code."