Virtual instrument panel opens new perspectives in vehicle control

By Jürgen Betz, Fujitsu Semiconductors Europe

Inspired by multi-faceted graphic visualisation in programmable instrument panels, this revolutionary concept enables unrestricted display of priority information to vehicle drivers, thanks to virtual instruments. Engineers can focus on search of the optimised solution.

The virtual instrument panel is a revolutionary concept that allows vehicle drivers to have unrestricted display of priority information. This concept is inspired by multi-faceted graphic visualisation in programmable instrument panels. Engineers can focus on searching for the optimised solution.

In the late 1960s, some vehicle manufacturers dared to advance into the fully digital driver information centre in order to lend authority to sports vehicle codes. This era did not meet with a particularly positive response from the market, as it was terminated at the change of generations. Yet like the start-stop automatic system, it is precisely this technology that is enjoying a second birth, more than 20 years later. Nowadays, driver information, which is shown on a traditional circular instrument with needles, can be quickly recorded. The instrument panel is also of very high quality thanks to the sophisticated materials which make it up. However, interface designers are now pushing their way into a completely new dimension. They want to turn driver information into an experience that you can live. Thanks to virtual instruments, there are now no restrictions on displaying priority information in relation to driving situations. At the very same time, core questions regarding scalability, the required system components and the necessary development tools arise.

Fujitsu Semiconductors is therefore going down a completely different road with the system solution idea. The company is using a scalable, application-specific family concept for this purpose. This technical approach builds on a similar principle to that used in the building block structure of some vehicle manufacturers and can be expanded as required. Semiconductor modules from this entire family use the same components within the chip. The modules can be combined flexibly with each other on a common system architecture.

At the same time, it is also possible to expand such architectures with solutions from a different family, e.g. MB88F3524 Indigo. The new evaluation set Compact Indigo System (UK-88F352-02) is already available and can be used to develop a separate display or a head-up display unit with APIs (automotive pixel link). For the instrument panel in the vehicle, all future system-on-chip (SoC) product families will feature ARM 32-bit RISC Cortex processors, which have a scalable frequency range. All automotive and standard interfaces are supported. The low-end segment contains single MCUs in different power classes and memory configurations.

Stepper motor controllers and simple LCD and TFT drivers are still used in this area. Expansion of the family into the mid-range class is now being achieved by means of an additional 2D pixel engine for rapid copying, blending, rotation and filter operations. A display and a timing controller (TC1411) form the interfaces to the outside world. For the virtual instrumentation, the power class of the Cortex processors is increased. A digital signal processor (DSP) supports the decoding of media and signal applications. The camera signals are synchronised and dynamically optimised by means of the integrated image processor.
The four stand-alone video capture units allow a 360 degree panoramic view (omni-view) for a car-based driver assistance systems. The two-dimensional camera images are projected onto a hemispherical grid model in real-time. The two-dimensional image can be created, using this projection and a dedicated algorithm, by freely selecting the viewing angle, area around the vehicle, which would otherwise be difficult to see, can be made visible.

Both variants from the high-end segment are equipped with an additional powerful 3D graphic core. Vertex and fragment shaders can be freely programmed in this graphic core architecture using the OpenGL ES 2.0 shading language. OpenGL ES 2.0 is a version of OpenGL for a platform and programming language-independent API (application programming interface) for the development of 3D graphics which has been specially adapted for embedded platforms. Up to three display controllers, which support the embedded-specific resolutions such as dual SVGA (1600 x 600 pixels), are available in the highest-level configuration. Increased screen refresh rates facilitate the necessary data transfer. At the same time, these minimise the after image effects of rapid indicator applications and makes this the picture sharper.

With regard to the integrated APX interfaces, the complete coupling of the data signals makes it possible to transmit the supply voltage for the displays with power over APX as well. With these permanently integrated, fully duplex-capable communication channels, data can also be exchanged between the display and graphic unit bidirectionally and in real time, independent of the video signal. Information from the head unit such as video flows or map, arrow and menu display can be sent directly to the instrument cluster by means of APX into the video capture units.

FEAT developed the 3D software engine Can-3D in order to round-off the system concept. This engine is based on the OpenGL ES 2.0 standard and can therefore be used regardless of the hardware. Can-3D enjoys the level of flexibility required to ensure that it is not bound to specific operating systems or applications. An interconnected software tool landscape is also required in order to create complex designs. The translation into the third dimension is network-agnostic and offers the interface designer many opportunities. If 3D programs were used in the past primarily as support in the design process (pre-rendering of various GUI elements of 2D arrangements, the approach adopted by the tools and their significance is now changing. A further element in such a tool landscape has been created with FEAT software development environment CCG studio.

This stand-alone software development platform has been specially developed for automotive 3D applications. The platform supports the seamless development process from design right up to the target hardware. With Icon Incan, FSEE has selected an experienced automotive interface design agency for designing the HMI layer. After defining the basic elements, the designer analyses the information architecture. This is followed by the design determination phase (visual exploration); initial elements that will serve as a template for the modelling and texturing of the scenes in 3D are first created in 2D. Particular attention is placed on motion design because fluid, logical transitions between the individual modes as well as animation of elements is a particular strength of 3D real-time calculation. It is at precisely this point that the high-quality impression of the draft is created. A common evaluation showed that the reference application must be characterised by the following three key elements: comfort, purism and flexibility.

This approach offers all the data currently required regarding the driving comfort in everyday driving. The colours associated with ice have a matter-of-fact, calming effect here. Important information such as the speed is displayed at a fixed position so that the driver can register it quickly. The needle image has also been re-interpreted. Instead of a centrally positioned needle the needle moves down, thereby creating a logical link to the distance warning, which is based on the principle of a semi-speedometer. The impression of a tunnel in the centre opens the view into an endless space and creates a platform for changing contents. The area allows objects to be oriented in a virtual space. The metaphor of distance is used specifically in order to define the importance of elements, and it allows the necessary staggering. The central menu stretches in four directions and allows media, phone, navigation and assistance to be selected in accordance with a four-way button on the steering wheel. Animated sub-menus crossfade the area on the left and push the main menu out of the field of vision. The speed area remains untouched and can be easily read at all times.

The four sub-menus each represent different focal points of the visualisation. Elements are embedded in the media selection in order to show an alternative variant of the obligatory cover flow. The depth effect is used here and a representation of a CD shell displayed on the left. The list handling has been defined as a focal point in the phone menu and can be operated using a capacitive touch sensor controller (TSC) from Fujitsu. The navigation menu shows very static 3D elements such as arrow navigation, compass or even the possible presence of blocks of houses. What was important was not to replace the central display by a display of a navigation system here but only display important sub-areas. Highly dynamic 3D elements dominate the assistance functions in the centre; the vehicle moves in changing scenes in order to convey a sense of the distance from the object by means of spatial depth. Vehicles play a key role in the visualisation of driver assistance systems and of door and hatch warnings. These objects contain elements that can eat up system performance. A 3D vehicle model with a polygon count of 100,000 or more is standard. The skill is to model such a 3D object in such a way that all of its detail is in harmony with the display size of the scene in question. The resulting performance gains is immediately discernible in the overall system.

The sporty design shows the shift of emphasis in the display through three fundamental factors. The colours associated with Fire brimmed with energy and vitality in combination with the display of conventional circular instruments and a fundamental change to the prioritisation of the information content. This visual change is accompanied with a modified driving performance such as streamlining of the chassis. In this mode, only absolutely minimal information is provided from the comfort functions area so that the driver can concentrate on the primary driving task. The focus in the sporty display is the tachometer; this device is located in the centre and is fitted with a variable red area. The speed is shown using a standard needle as well as a clearly legible number to the right. The sport mode is rounded-off by a stop watch located on the left.

This flexible variant is primarily brought to bear in stop mode. This mode allows otherwise important information such as the speed to be hidden. The driver can use the entire display surface flexibly and enlarge elements. Information on anything other than the vehicle status can be displayed. Sending information into the vehicle about the status of the traffic lights or the image of traffic lights will remain useful and is also conceivable.

A reference application uses the graphics processing unit (GPU) MIB8629R Ruby as a technical basis in combination with the ARM Cortex development kit and Linux as the operating system. It was possible to display the entire development process here, from design through to implementation. Interaction between the components and evaluating the power were important milestones. However, there is still a long way to go before the driver can select his own preferred design and transfer it into the vehicle.