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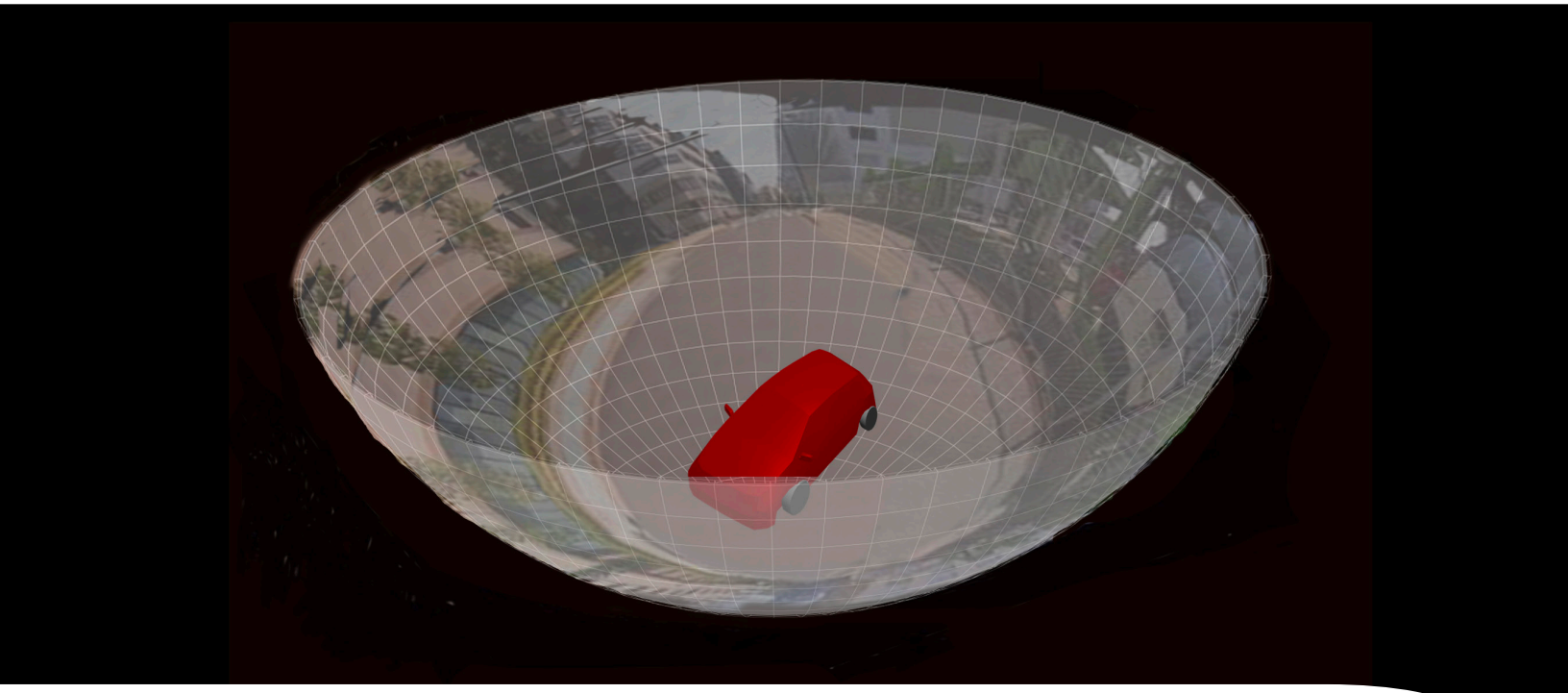

360° Wrap-Around Video Imaging Technology Ready for Integration with Fujitsu Graphics SoCs

Provides a 3D, Omnidirectional View around a Vehicle for Unmatched Driver Visibility, Safety and Convenience

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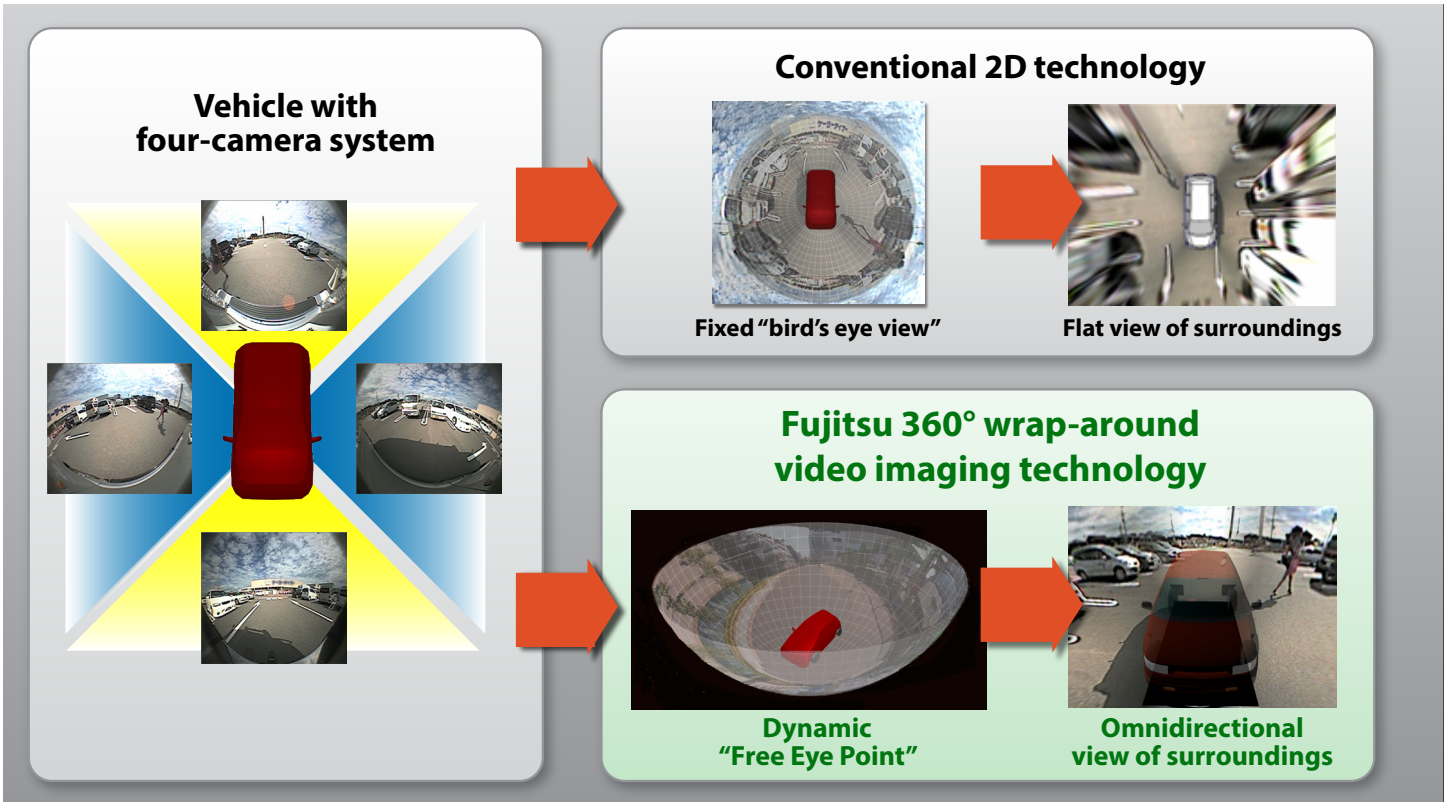


Figure 1. Four cameras enable the capture of a 360° perimeter view. With conventional technology, the resulting image is distorted. With the new Fujitsu 360° Wrap-Around Video Imaging Technology, the image is clear, with no distortion.

Introduction

There has been growing global interest in car-mounted cameras to improve the driver's visibility and make driving safer. Studies have found that cameras are the best way to improve visibility. Not surprisingly, vehicle-mounted cameras have grown in popularity as a tool for enhancing driver safety.

Fujitsu has developed a new video imaging technology that enables a complete 360° wrap-around view of a vehicle's perimeter in real time. This technology is called the 360° Wrap-Around Video Imaging Technology, or 360WAV.

This driver-assistance technology adapts to different situations, enabling the driver to peripherally view the entire surroundings of a vehicle from the most appropriate point of view and field of view. The technology improves driving safety by helping the driver to negotiate a variety of situations, such as parking, passing and turning.

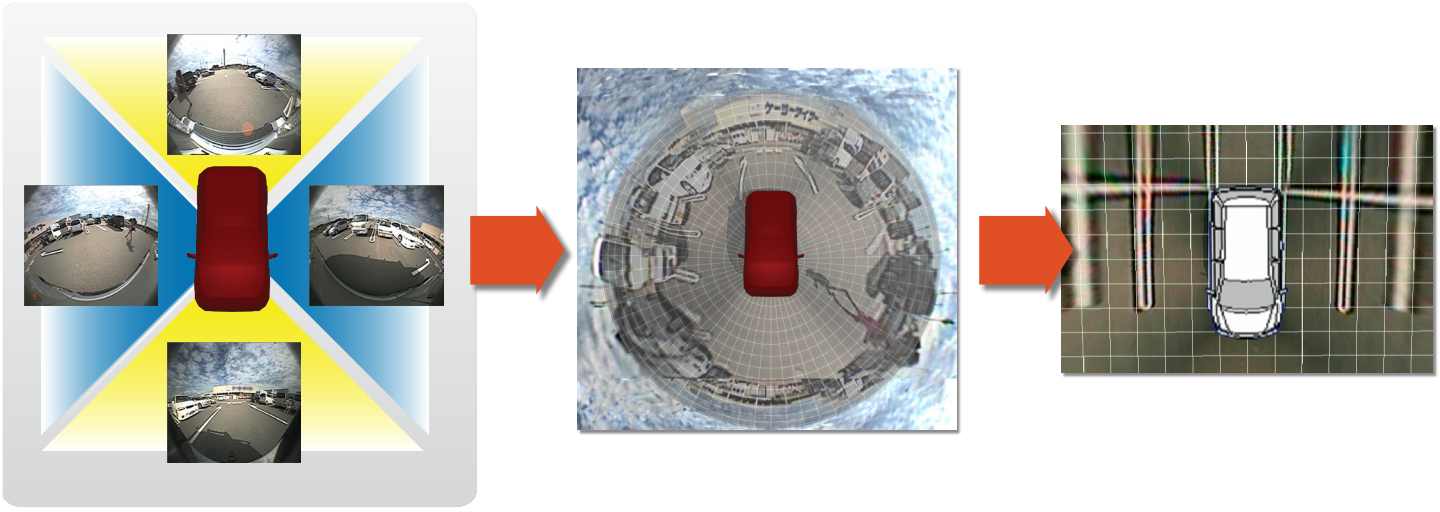
This technology is now commercially available in the Americas. Fujitsu is offering system designers a complete 360° Wrap-Around Video Imaging Technology toolset ready for integration with the company's latest graphics SoCs.

This Application Note explains the technology, its background and benefits, and how it works.

The Major Technological Challenges

Drivers navigate their vehicles in a variety of situations–such as parking, turning, and merging–that demand immediate visual checks of the vehicle's perimeter. Current reversing and peripheral-vision cameras demand too much of drivers. With conventional technologies, each camera shows a different perspective and sightline. Because the display is continually changing, the driver must be able to instantly recognize which view is being presented. This can be difficult.

The underlying technologies behind such systems are conventional, multi-camera, "bird's-eye-view" technologies



Four cameras capture video images of four different views (perspectives).

Video images of each view are processed and converted to create a virtual "birds-eye-view".

Synthesized video images are projected onto a virtual roadway.

Figure 2. Example of conventional "bird's-eye-view" driver-assistance technology

(Figure 2) that stitch together two-dimensional images showing a vehicle's perimeter from front, side and rear cameras. The resulting "top-view" images typically are distorted or have poor stitching at the seams. These images do not provide enough detail about the surrounding area, and drivers could easily miss something important.

The "bird's-eye-view" systems do not meet the following needs:

Need to reduce the burden on the driver for visual checks in the driver's field of view

In addition to the driver's own direct-eye field of view, rear-view and side-view mirrors, as well as rear-view monitors, can enhance the field of view. Although these features can be used to quickly cover a large field of view, the need to instantly refer to all of them imposes a great cognitive load on the driver.

The four-camera "bird's-eye-view" systems (Figure 3) can only provide a video of the roadway within about six feet of the vehicle, necessitating a rear-view monitor. These cameras do not integrate the field-of-view information drivers need, leaving them with a large cognitive load.

Need to help the driver recognize the point of view (perspective), sightline, and field of view shown on the monitor

With conventional technologies, each camera and function differs in perspective and sightline. Because the display changes continually, the driver must be able to instantly recognize which view is being presented. This makes it more difficult to make a perimeter check and limits the situations in which the technology can be used effectively.

The New Fujitsu Technology

To address these problems, Fujitsu developed the world's first video-processing technology that can show any perspective and any sightline on the vehicle's periphery, and that can instantaneously and smoothly transition from one view to another. The Fujitsu 360° Wrap-Around Video Imaging Technology enhances driver visibility and safety by providing a complete, three-dimensional view of a vehicle's surroundings, in real time.

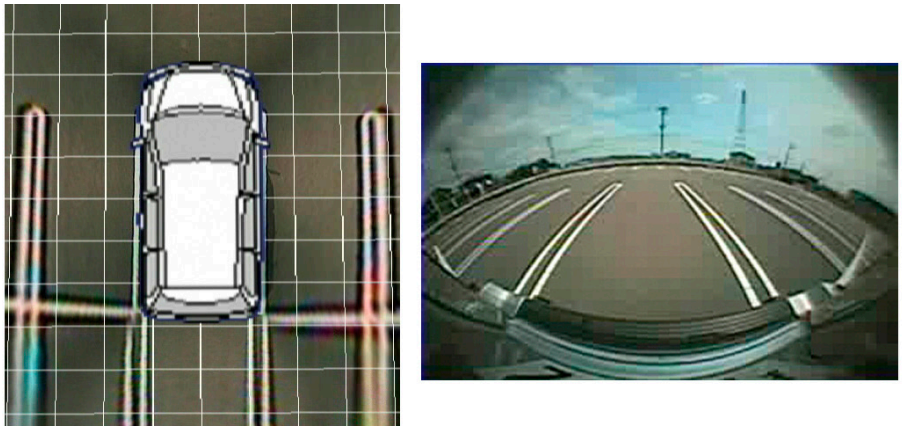
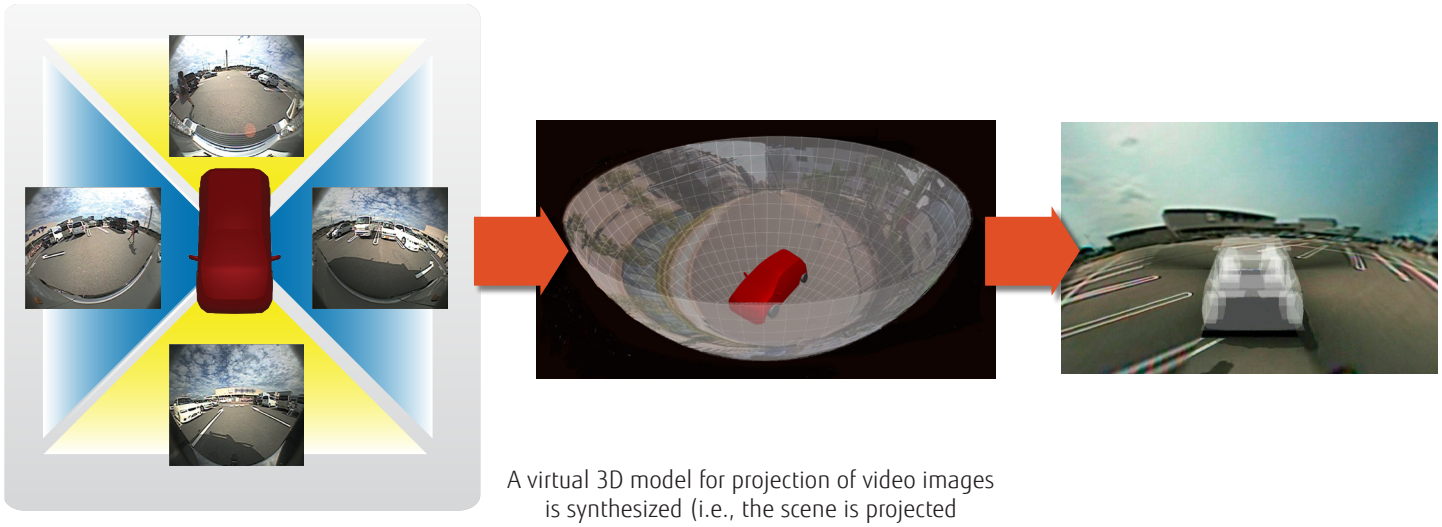


Figure 3. Conventional-technology-based images



Four cameras capture video images of four different views (perspectives).

A virtual 3D model for projection of video images is synthesized (i.e., the scene is projected virtually onto a 3D curved plane). The image is changed to the desired perspective.

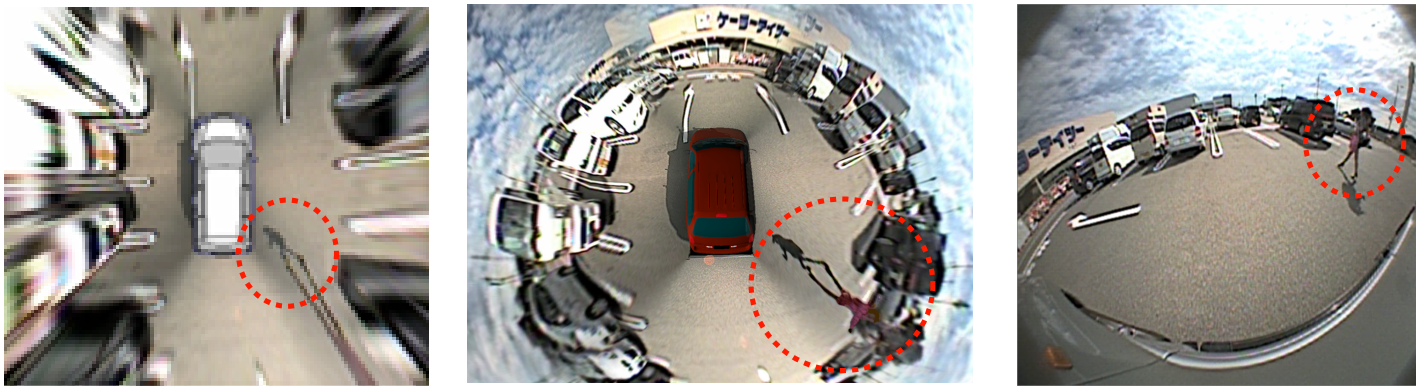
The desired view (perspective) is displayed.

Figure 4. Overview of 3D virtual-image-projection conversion technology

With this technology, the driver can get a wrap-around, hemispheric view around the vehicle, all from a driver-defined perspective or "free-eye-point." The driver can obtain an overview from a single image, instantly understanding the situation surrounding the vehicle. And the driver can easily check views from any direction or perspective, reducing the cognitive burden involved in recognizing the displayed view (Figure 4). The images are clear, with no distortion.

The technology adapts to different driving situations, enabling the driver to easily navigate tricky situations such as parking, passing or merging.

For example, when parking, the driver can easily stay aware of the roadway as well as nearby cars and people (Figure 5). When turning, the driver can easily view the surroundings of the side opposite the driver, to ensure that pedestrians are not too close (Figure 6). When merging, the driver can see in front of, behind and on both sides of the vehicle, and can easily determine whether there is enough room to merge. Indeed, the system eliminates "blind spots" to a degree that cannot be matched by two-dimensional technologies.

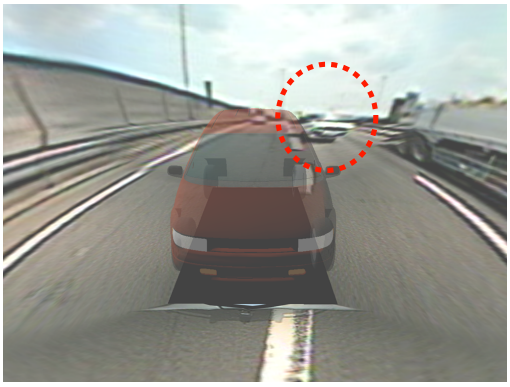


Sample view using conventional technology. The pedestrian behind the vehicle is not clearly visible.

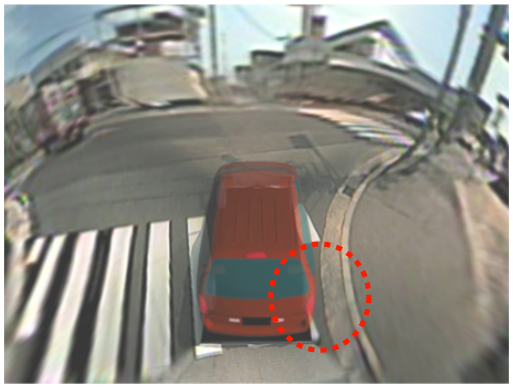
Sample view showing the same video using Fujitsu's 360WAV technology. The pedestrian behind the vehicle is seen in clearer detail on the 3D curved plane.

Sample showing the driver's view of the video images. Note the pedestrian behind the automobile is clearly visible to the driver.

Figure 5. Comparison of results achieved using conventional technology and Fujitsu's 360WAV technology (using the same raw video as the source data)



Highway merging example: The "third-person" perspective from the front of the vehicle clearly shows the available merging space and approaching vehicles.



Right-turn example: When turning right with the perspective from the above-rear, the curb clearance of the right side of the vehicle is clearly visible.

Figure 6. Results achieved employing Fujitsu's new video-processing technology

As the driving situation changes, this new technology makes a smooth transition from one view to another by continuously interpolating points of view, fields of view, and sightlines. This helps drivers quickly orient themselves to the new view, allowing them to get an overview from a single image and instantly understand a situation.

Another unique feature is the technology's ability to offer a dynamically definable perspective—a "free-eye-point"—which lets drivers see images from anywhere around a vehicle. The virtual "free-eye-point" perspective allows the driver to see images from the front, rear, and sides of the vehicle as well from a virtual, "third-person," omni-directional overview of the vehicle. System designers can utilize the "free-eye-point" feature to change the perspective to give the driver the best possible view.

The driver can also use the "free–eye-point" feature to select the optimal viewpoint for the driving scene or situation. For example, when approaching a right turn, the driver can change the eye point and zoom in to see the curb side of the vehicle. When backing up, the driver can use the technology to clearly see behind the car, while still maintaining the view of both sides and the surrounding area.

The "free-eye-point" and algorithms that seamlessly stitch together the four independent camera images are two major features setting Fujitsu's technology apart from other systems.

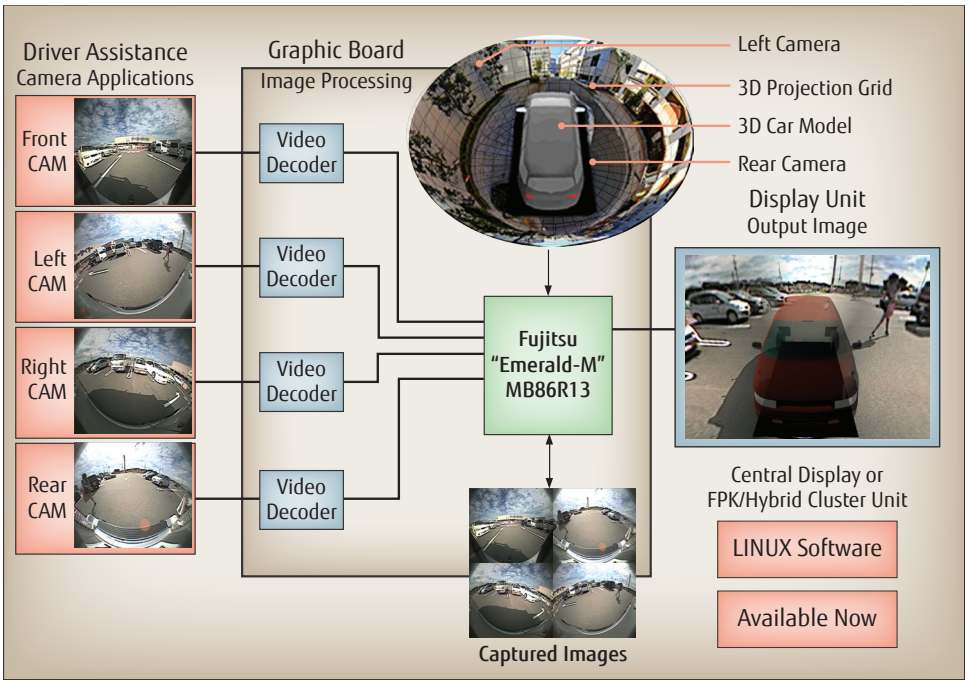
The Fujitsu 360° Wrap-Around Video Image Technology provides freedom in system design, and increases convenience and safety for the driver. While the primary application is in automobiles, the system can also be used for surveillance cameras and other security systems.

How It Works

The technology provides views from all sides of the vehicle. The cameras are installed around the vehicle's perimeter, and their video images of the vehicle's surroundings are synthesized by Fujitsu's 3D virtual projection/point-of-view conversion technology. Advanced three-dimensional algorithms smoothly combine images from four independent cameras to offer a seamless and clear 360° view. This vehicle-view-assistance system achieves real-time operation with a 30 millisecond video-processing time.

Specifically, images from the four cameras are sent to the video-processing LSI, which includes video-capture and 3D functions. The camera images are synthesized into a single 3D image in real time and projected onto a three-dimensional bowl-shaped mesh, generating a virtual 3D wrap-around video. That video is then converted into views from any desired perspective of the vehicle's surroundings. The 3D curved mesh is one of the features differentiating the Fujitsu viewing technology from other systems.

Integration with Graphics Display Controllers



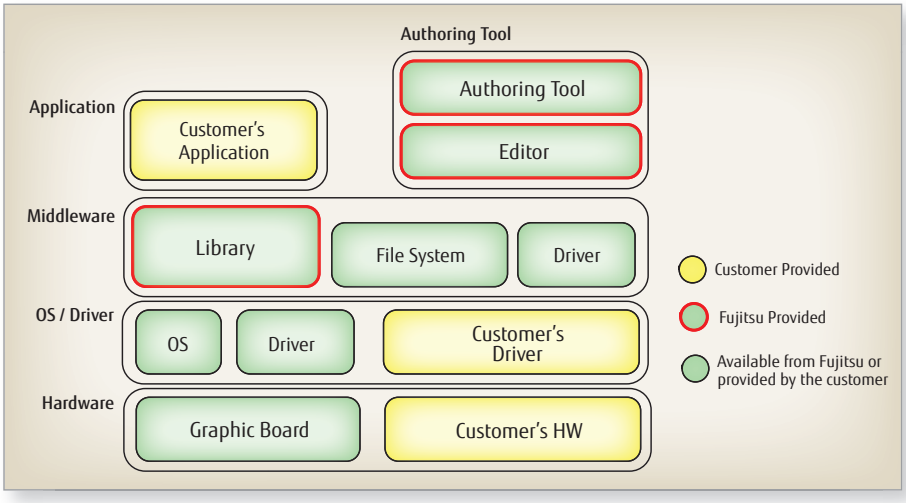


Figure 7. Development hardware and software

The Fujitsu 360° Wrap-Around Video Imaging Technology is a middleware toolset ready for integration with the Fujitsu graphics SoCs. This complete software and hardware development solution consists of:

- An embeded image-processing platform
- A video-processing chip that combines video images from four cameras, and
- The new MB86R13 "Emerald-M" graphics SoC for automobiles, which supports the OpenGL ES specification.

Designed for high-end embedded graphical applications in the automotive market, the MB86R13 "Emerald-M" integrates graphics and central processors, memory controller and power management with support for the Fujitsu 360° Wrap-Around Video Imaging Technology.

The MB86R13 "Emerald-M" is well-suited for the most demanding cluster, center information display, navigation and in-car multimedia graphics applications. The SoC is based on the 400MHz ARM® Cortex™ A9 processor and a powerful custom graphics core that delivers leading-edge 2D and 3D graphics. "Emerald-M" is fully compliant with the OpenGL ES 2.0 specification. A visibility-enhancement feature performs adjacent pixel comparisons to reproduce images with natural colors and fine detail.

The MB86R13 "Emerald-M" features a large variety of popular peripherals such as a USB and Flash controller. Four video-capture ports and three display controllers can drive up to up to a total of five displays. A dithering unit and an ARM Neon DSP core help enhance images and manage certain audio-video processing. By offloading the less complex graphics tasks from

the processor to the 2D engine, the MB86R13 delivers superior graphics quality with a minimum of processing overhead and memory accesses.

The graphic core for the MB86R13 uses a unified shader array supporting vertex and fragment shaders. The pipeline allows for OpenGL ES 2.0-compliant graphics, along with drawing features such as anti-aliased graphical object drawing. The array incorporates 16 parallel floating point units, 16-bit and 32-bit pixel color formats, a 32-bit pixel-format frame buffer, and textures that support RGBA, ARGB, and ABGR color ordering.

The shader architecture is complemented by a proprietary, highly optimized 2D core. That core includes Fujitsu's recently developed PixBlt unit, which offers a variety of functions relating to blending, anti-aliasing, and many levels of filtering.

A DDR3 memory controller ensures high throughput and optimal graphics performance. The "Emerald-M" DDR 2/3 controller can access up to 1GB of memory. A unified memory architecture allows seamless access to the memory by the processor core and graphics engine, enabling "Emerald-M" to provide a maximum memory performance of 3.2GB/second. The device's flexible power-management unit enables selective enabling and disabling of the graphics core to control power consumption under various conditions.

The key graphics capabilities of the MB86R13 include:

- Anti-aliasing (2x2 full scene)
- Simple scaling by repetition or skip
- Blending (OpenGL 2.0 and OpenVG 1.1 modes)
- Logical Raster Operations (ROP2/ROP3)
- 3x3 filtering with OpenVG 1.1 tiling support
- 7x7 filtering support in combination with unified shader.

Future Developments

While continuing to enhance the effectiveness of its field-of-view driver-assistance technologies, Fujitsu plans to incrementally introduce new imaging solutions comprised of on-board graphics SoCs and image-processing software and hardware.

Summary

The Fujitsu 360° Wrap-Around Video Imaging Technology enables "free-eye-point" viewing within the 3D imaging space. Today a complete hardware and software solution is available, giving system designers the tools needed to implement this 360° technology quickly and easily. The recommended hardware is the new "Emerald-M" graphics display controller, which combines the most sophisticated graphics rendering capability with integrated support for the Fujitsu 360° Wrap-Around Video Imaging Technology.

This technology provides unparalleled freedom in system design, and makes driving more convenient and safe. The omni-directional 360° viewing technology will provide a clear advantage in OEM-designed systems, as well as in after-market systems.

http://us.fujitsu.com/semi

Reference

- Fact sheet for 360° Wrap-Around Video Imaging Technology
- Fact sheet for MB86R13 "Emerald-M"

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Printed in the U.S.A. GDC-AN-21436-03/2014