Micron Technology, Inc., has just introduced a new image sensor designed to promote safer, smarter driving. As technically advanced automobiles continue to hit the roadways, imaging technology is a key feature that provides drivers with an intuitive look at the drive ahead or the view behind. With this new sensor, automotive manufacturers can design in camera functionality for side-view mirror replacement and assistance, or provide a reversing camera so the driver can clearly see what might be next to the car and behind it.

“Technology guided safety systems are a highly desirable feature for automobiles and CMOS imaging plays an integral role in advancing the vision assistance function,” said Bob Gove, vice president of Micron Technology, Inc.’s imaging group. “As a market leader in CMOS image sensors, Micron is committed to providing the best imaging technology for the automotive industry, ultimately improving a driver’s view of the road.”

Imaging technology is used in cars primarily for scene viewing and understanding applications. Micron has designed its line of complementary metal oxide semiconductor (CMOS) image sensors to increase drivers’ awareness of their surroundings. The sensors also capture information about environmental conditions and send information to the vehicle’s data systems to provide input for potential actions, such as safer deployment of a vehicle’s airbag. This new sensor (product number MT9V125) supplements Micron’s current portfolio of automotive CMOS image sensors and IT memory and is designed specifically for scene viewing applications, providing outstanding image quality.

“Imaging technology is enabling a multitude of potential applications that will benefit safety, security and convenience in automobiles,” said Jon Erensen, Senior Research Analyst with Gartner. “The best known use of image sensors in vehicles is for rear vision assist cameras. Key emerging applications for automotive manufacturers include accident avoidance, airbag passenger occupancy detection, lane departure warnings, and adaptive cruise control.”

Micron Continues Commitment to Automotive Industry

The MT9V125 complements Micron’s existing portfolio of automotive sensors and meets the requirements of the Automotive Electronics Council (AEC) Q-100. Designed to
fit a one-quarter inch lens aperture, the sensor provides a higher-level of integration, reducing camera cost and size. “With its intuitive design and flexible architecture, the MT9V125 meets the needs of automotive designers, regardless the vehicle model,” stated Curtis Stith, director of marketing for the Emerging Markets segment of Micron’s Imaging Group. The MT9V125 is available now for general customer sampling, with mass production expected in the first quarter of 2006.

**Integrating CMOS Sensors**

CMOS Imaging has actually undergone three major generational shifts in its short lifetime, and currently is starting to experience its fourth. The first three generations of CMOS imagers were very focused on improving image quality. The technology was chasing CCD performance and until it achieved levels of performance either on-par with CCDs or acceptable to the general public, little else mattered.

CMOS imagers have reached this point, and in addition to continuing their efforts to improve the photoplane’s performance they have also started to look at how they can better fit the imager into specific applications. This article will take a look at several of the existing and future markets automotive markets for this technology and discuss how the next generation of CMOS imagers will help to reduce the system cost.

It is projected that the 60 million cars made annually by the middle to end of the next decade will have on average between 4 and 16 cameras in them. Figure 3 shows just some of the applications that will use cameras. This market will be very slow to mature, but companies that are experiencing success in some of the current volume markets are starting to address this market.

One of the most significant issues with this market is the customers are looking for military qualified components at toy prices. This is not really achievable, unless you can come up with ways to reduce the overall system cost, which is exactly what is being done. The first step was to recognize that this market can not just use an existing imager designed for a consumer market. The requirements for temperature range, shock survivability, wide dynamic range, and to accurately image under high vibration situations for what in many cases will be directly related keeping the occupants safe within the vehicle, and the vehicle safely on the road require a completely new design and approach.

**Scene Viewing**
Currently there are two types of applications for cameras in vehicles. The first is scene viewing, the second is scene understanding. The scene viewing applications are those that will capture imagery and present it to a screen within the vehicle to help the driver, viewing the scene, to make decisions about the environment around them. These applications include rear vision assist, mirror replacement, blind spot, side view, rear passenger, and post accident status cameras.

You may think that these are just applications that are more style than substance. Realize that over the last 20 months no child in the front passenger seat of a car in the US has been accidentally killed by an airbag, whereas in that same time frame more than a thousand children have been reversed over, hundreds of these accidents have resulted in serious permanent damage to the child or death. Most times an immediate relative of the child was driving. The imagers for these applications are focused on presenting accurate, good looking images that the driver can understand without having to pause to study the image.

Figure 0 Potential imagers in Vehicles
Currently these cameras are being widely deployed in Japan, and are starting to be deployed in the US and Europe. The initial architecture has a wide angle field of view lens
CCD camera mounted in the trunk of the vehicle. This camera passes NTSC/PAL based video to an electronic control unit, ECU. The ECU takes the analog video and uses an analog to digital converter, ADC, chip to put the video into the digital domain, it then puts the image into a processing chip where the lens distortion is corrected, in doing this depth perspective can be altered, and so in many vehicles distance markers are overlaid onto the video.

The processed video stream is then put back into the analog domain and converted back into NTSC or PAL to be sent to the display in the front of the cabin. In keeping with the theme of the 4th generation CMOS imaging chip, a new imager was recently developed by Micron specifically for the automotive scene viewing applications. In addition to being designed to operate between -40°C to +105°C, not a trivial feat for an imager, this imager puts out both NTSC/PAL video as well as digital formatted video. The chip also has a digital video input port, and will let the user decide if they want to put the video coming from the photoplane, or the digital video input port to use the on-chip digital to analog converter, DAC and NTSC/PAL formatter. This is shown graphically with figure 4.

A. Digital video out to DSP
B. Post processed digital video
C. There is an on-chip mux between the image output or post DSP processed input, specifically between the imager and video in.
D. Post processed NTSC/PAL video

Figure 1 Gen 4 Rear Vision CMOS Imager Camera

This design enables the system designer to take the digital video directly from the imager and feed it into their processing chip that will correct the lens distortion and
add overlays. The post processed video can then be fed back into the imager use the on-chip DAC and NTSC/PAL encoder to send the now post processed NTSC/PAL formatted data to the front of the vehicle. By doing this the connectors on both ends of the ECU, the ADC, DAC and NTSC encoder are all not needed. This will reduce the system cost on the order of $5.00 to $10.00 without increasing the cost of the imager. This is how the automotive manufacturers can get military grade performance at effectively toy-like system prices.

**Scene Understanding**

The other set of applications for vehicles are based on scene understanding. In many of these applications the driver will never see the imagery. Instead the video is sent directly to a processor. The processor pulls out features from the scene and makes decisions based on those features. These decisions are then fed to various control devices within the vehicle. These applications include lane tracking, urban cruise control, collision warning, avoidance, or mitigation, rain sensing, headlamp dimming, drowsy driver, driver attention, occupant positioning for airbag deployment, gaze detection, mirror adjustment based on where your eyes are, and biometric ID.

In many cases the decisions are being made much faster than a person could react, or are being made as the person is trying to react to a crisis situation and needs assistance, not to be distracted. Here the need is to present as much information as possible and to present the imagery in a way that helps to reduce the processing needed to make decisions. The 4th generation features of this imager is to include a much wider dynamic range so as to be able to see lane markers while driving with the sun low on the horizon and in the scene. To also present the image with as little distortion as possible a global shutter design is

*Figure 1 Global vs. Rolling Shutter*
implemented rather than that the rolling shutter which is more typical for consumer grade CMOS imagers. Figure 5 shows the distortion effect of a rolling versus global shutter when capturing video of a spinning cube. With processing you can make the image on the right look like the image on the left, but since the imager was designed with the application in mind that entire processing burden has been resolved. This then can enable the system designer to do more processing to increase accuracy, add another application, or the designer can choose a less expensive processor.

A typical example of how imagers will be used in scene understanding applications is based on active cruise control systems. The US National Transportation and Safety Board estimates that more than 70% of rear end collisions could be avoided if the vehicle started braking 0.5 seconds sooner. Since it would be very difficult to make faster people, why shouldn’t the vehicle be able to assist the driver and start braking to avoid such a collision. Part of the reason why is trying to understand the difference between when someone in front of you is on a curve in the road, and starts braking versus when you are on a straight part of the road, but they are pulling onto an off ramp and braking. To do this you need to know both how their speed is changing relative to yours and where they are relative to the lane you are in. Numerous technologies can be used to determine the relative speed of the vehicle in front of you, but only imaging can determine what lane the braking vehicle is in.

While the occupants of the vehicle may never know the sensor suite used for an application is based on an imager the overall effect of adding imagers and cameras to cars will be to help better fit the driver to the vehicle, or the vehicle to the road.

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To learn more about the value of Micron’s CMOS image sensor portfolio for the automotive industry, please visit http://www.micron.com/products/imaging/applications/auto.html.