Harman to Outsource More Manufacturing

Over the next five years, roughly, Harman is planning to outsource at least half of its infotainment manufacturing. Today, just 10% is outsourced.

“In good times this industry can get you to build up a huge manufacturing footprint, a fixed cost that can really impact [earnings] when times are not so good,” said Sachin Lawande, president of Harman’s infotainment division. “A second issue we have to consider is that large OEMs are consolidating their infotainment systems into fewer architectures. Rather than slicing and dicing by car and brand as they used to, large OEMs are consolidating their infotainment systems into fewer architectures across their entire fleets. Unit volumes are now approaching a point where engaging an EMS [electronics manufacturing service] makes sense.

“In the past we’d produce 200,000 head units for this OEM and 300,000 for that one—you can’t go to an EMS with those volumes. But now, as volumes start to approach one million units plus, outsourcing absolutely becomes an opportunity we cannot ignore,” said Mr. Lawande.

According to a Bloomberg News article published last April, software accounts for approximately 75% of Harman’s infotainment revenue. “The money is actually in software. It’s in the software design and architecture and safety, which is what we’re spending our money on right now,” the article quotes Dinesh Paliwal, CEO of Harman. According to Mr. Paliwal, the new outsourcing business model will allow Harman to reduce its manufacturing workforce to roughly 3,000 from 6,000 today.

Harman will also continue to design hardware. “Design is integral to our whole value proposition,” said Mr. Lawande. “It requires intimate knowledge of vehicle architecture. The EMS guys are not set up for that. We are focused on design and development, not manufacturing.”

Despite Formidable Challenges, Progress on V2V

Last month at the ITS World Congress in Detroit, General Motors made the surprising announcement that it will make V2V communications standard equipment on the 2017 Cadillac CTS. The V2V community, which has yet to see a return on its investment in the technology, was encouraged, but CTS drivers will experience almost no benefit from driving the world’s first production vehicles equipped with V2V devices. At the end of 2017, there will be about 40,000 V2V-equipped CTS vehicles in the U.S. fleet of about 270 million vehicles. The chances that one V2V vehicle will find another to talk to will be just one in 46 million, about the odds of winning the lottery.

With its safety reputation badly tarnished by a decade-long failure to come clean over faulty ignition switches, GM is badly in need of some positive press. Its aggressive posture with V2V suggests to the public that GM is now getting out front with new safety technology. “We’re doing it because it’s what customers want,” said CEO Mary Barra in her keynote address at ITS World. “Through technology and innovation, we will make driving safer.”

Apart from its impact on GM’s public relations, the carmaker’s decision to put V2V devices on the road has heartened safety engineers who have been developing and advocating for the technology for more than a decade. “Ms. Barra’s announcement last week was GM saying we believe in V2V, knowing darn well that the first person who buys a Cadillac CTS isn’t going to have anybody to talk to,” said John Capp, GM’s director of electrical, controls and active safety research. “Given all the work that’s been done and all that was learned from the [Connected Vehicle] Safety Pilot in Ann Arbor and NHTSA’s recent announcement about moving toward rulemaking, there is enough momentum that we know it is going to happen, it is only a question of when.”

A V2V mandate almost certainly won’t be issued before 2018, and would likely be followed by a three- to four-year phase-in period. If V2V devices are mandated for 100% of new vehicles in 2022, the odds of any two vehicles engaging in V2V communications by year end is only about one in 34. “Our hope is that other carmakers will start deploying V2V [before the final rule] so our customers get more value,” said Mr. Capp.

Brian Daugherty is responsible for corporate advanced development and intellectual property at Visteon. He thinks drivers of equipped vehicles will begin to experience some safety benefits well before the phase-in reaches 100% of new vehicles. “Even at 5% [fleet] penetration, when an equipped vehicle receives a warning and slows down because of an icy bridge or stopped vehicles ahead, unequipped vehicles to the rear will see the brake lights and also slow down. That makes for a safer situation.” If phase-in begins in 2019, 5% of vehicles on the road could have V2V by year end. By the end of 2020, 10% of the fleet could be equipped.

The Difficult Issue of Security

Of all the unresolved issues requiring more research before V2V communications can be deployed, and there are many, most V2V experts agree that completing and verifying the design of the security credential management system is the most challenging. “There are ways we have to deal with authenticating the vehicles and making sure they are operating correctly,” said Roger Berg, vice president, Denso International America. “We have ways of doing it. We just have to validate that those methods are useful under all conditions.”

The system is hugely complicated by the need to protect privacy. A V2V message cannot carry data that can be used to identify the particular vehicle that sent it. Visteon’s Mr. Daugherty observed: “To assure
Implementing V2V security will require additional investment both on and off the vehicle. “Security is not a resolved issue,” said Jim Misener, a consultant who has been working on V2V standardization since the mid-1990s. “You will need over-the-air connectivity through yet unknown long-range media [to the security back end] to provide these certificates and/or large onboard memory to hold them.” The back end must also handle misbehavior reporting and the revocation of certificates from any bad actors, as well as any updates to the vehicle’s security software.

The Crash Avoidance Metrics Partnership (CAMP), a research consortium of carmakers including Ford, GM, Honda, Hyundai-Kia, Mercedes, Nissan and VW/Audi, will build and test a prototype V2V security system. Their work will have to be largely done before the end of the Obama administration in January 2017, which is when NHTSA hopes to issue its Notice of Proposed Rulemaking.

“CAMP has a little over a year to finish the work: defining the security system, how it needs to work, how frequently the certificates need to be updated, how they can be moved around and stored, how one vehicle recognizes another one and how they can be revoked,” said GM’s Mr. Capp.

Onboard V2V equipment, including a security management system, would cost carmakers $341 to $350 per vehicle in 2020.

Spectrum Sharing
Another of the tough issues that could confound V2V introduction is the possibility that the U.S. Federal Communications Commission will vote to force the Department of Transportation to share the 75 megahertz spectrum (in the 5.9 GHz band) allocated for DSRC (dedicated short range communications) with Wi-Fi enabled consumer devices. Consumer device makers have argued that the spectrum has lain fallow since 1999.

Even without sharing, the potential for radio congestion is already a concern, noted Mr. Misener. “These [V2V] messages are generated ten times a second. How do you carry all these messages without channel congestion when vehicle traffic on the highway is dense?”

CAMP participants are conducting research on ways to mitigate radio congestion. “If you are driving in traffic at a low speed, maybe you could be transmitting at one, two or five hertz instead of ten hertz,” said Mr. Daugherty.

There are plenty of other unresolved questions about V2V: Are performance standards needed so warnings look the same in every vehicle? Will some drivers ignore the safety warnings? Instead of warnings, should vehicles respond autonomously to avoid crashes? Is GPS sufficiently accurate to precisely establish each vehicle’s position? What will compel vehicle owners to maintain their V2V system to ensure proper operation?

With so much still unresolved there is a good chance that NHTSA will not meet its ambitious schedule to issue a Notice of Proposed Rulemaking by January 2016, which means 100% deployment on new vehicles cannot happen until after 2022.

THE HANSEN REPORT
ON AUTOMOTIVE ELECTRONICS
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Fuel Economy Matters

Electrified vehicles will continue to represent a small fraction of the global vehicle fleet for the foreseeable future. Navigant Research forecasts that penetration of HEVs, PHEVs and BEVs will reach 7% globally by 2020. To meet legislative mandates for reduced carbon emissions, carmakers continue to improve fuel economy in internal combustion engine vehicles, and most consumers continue to place a high degree of importance on fuel efficiency when deciding on a new car purchase.

According to a survey published by the National Automotive Dealers Association (NADA) in August 2014, car shoppers ranked fuel economy as the most important of a list of ten factors influencing their purchases, more for financial reasons than out of concern for the environment.

Fiat Chrysler is planning to install a 9-speed, stop-start capable transmission licensed from ZF in its front-wheel drive models as they are redesigned. Chrysler started with Jeep Cherokee last fall and will equip the 2015 Chrysler 200 with the 9-speed, as well as a new Jeep model, the 2015 Renegade, being manufactured by Fiat in Italy. According to ZF, its transmission can reduce fuel consumption by up to 16% compared with a 6-speed automatic. Both the 200 and Renegade will have stop-start available on some models.

More than 50% of new vehicles sold in the U.S. will be equipped with fuel-saving stop-start systems by 2022, according to WardsAuto, with penetration in small 4-cylinder-engine cars reaching 70%. Navigant Research predicts that globally stop-start penetration will reach 54.3% by 2022. Detroit carmakers have been slower than the Europeans in widely offering the feature, but the picture is changing. Ford announced plans to have stop-start on 70% of its models by 2017.

According to Honeywell, a leading developer of turbochargers, turbocharging downsized engines can improve fuel economy by 20% in gasoline engines and 40% in diesel engines. The company expects penetration of turbos to grow the fastest in China and North America in the next five years, reaching 41% and 38% in those regions respectively, by 2019. Europe leads the world in turbocharging, with the popularity of diesel engines. Turbo penetration in Europe is already 67% and will grow by 2% annually through 2019.

Valeo claims it has minimized turbo lag with its new turbocharger that is powered by an electric motor rather than by exhaust gas. Audi is expected to debut the unit, which requires a 48-volt electrical system, in its Q7 SUV, at the Paris Motor Show in November.

Ford offers a downsized, turbo-boosted engine and stop start along with an aluminum body on its 2015 F-150. Replacing the steel body with aluminum saved 700 pounds according to Ford.

Pravala Networks: Seamless Connectivity via Best Available Network

Carmakers, drivers and passengers are becoming increasingly reliant on embedded wireless connectivity to access cloud-based services and the Internet, deliver software updates, provide safety and security features, send and receive diagnostics data, and eventually, link the vehicle to a V2V security certification entity and vehicle-to-infrastructure components.

For many of these data transfers, dropped calls, failed calls and other connectivity issues will be intolerable. But new technology from Pravala Networks, a startup located in Kitchener, Ontario, Canada, promises seamless communications that can use whatever channel is available—Wi-Fi, DSRC (dedicated short range communications), 3G or 4G mobile networks—to provide a secure communications link to and from the car. “We provide a trusted, secure super-pipe to everything outside the car. We make sure the pipe is always on,” said Richard Wagner, president of Pravala Networks. “Like the light switch in your house, you hit the switch and the light comes on. We make sure that “light” is always on in the car.”

Mr. Wagner describes Pravala’s technology as agnostic, meaning that it would select the best network regardless of carrier, AT&T, T-Mobile, Verizon or Sprint. “In the future we would expect some middle-man to come forward who could handle the billing from multiple carriers,” Mr. Wagner said.

Part of the network appliance device that’s embedded in the vehicle, Pravala’s technology performs like a router: Pravala software in the car “talks” to Pravala software in the cloud. “Our technology determines which networks are good and which networks are bad and seamlessly accomplishes the handover from one network to the next. We know when a call is about to be dropped based on poor quality indicators and instantly switch networks before that happens,” explained Mr. Wagner.

One of many possible applications for Pravala technology is in vehicles equipped for vehicle-to-vehicle communications, which will rely on DSRC for short range messaging, but will almost certainly use a variety of other networks capable of Internet Protocol transport such as cellular networks for security credential management and other maintenance to ensure that communications between vehicles are trustworthy.

I first learned about Pravala technology from an engineering manager at the U.S. Department of Transportation, who has been working on a unified national architecture for connected intelligent transportation systems. The DOT official had just driven from Washington to Detroit with a Pravala router in the trunk of his vehicle to collect data about the availability of Internet Protocol transport radio services. Pravala has also been working with Continental to develop an automotive-grade implementation of its vehicle connectivity technology.

Pravala’s customers include carriers such as Hong Kong Broadband and various mobility companies who want seamless handover between Wi-Fi and 4G for VOIP (Voice over Internet Protocol) and video over IP.

Privately funded, Pravala Networks is currently negotiating with some potential strategic partners. The company has 15 employees.

For more information, contact Richard Wagner by email at rwagner@pravala.com or call 519-772-1116 extension 1.
The Company Profile... Mobileye

Background
When it comes to the elite automotive parts suppliers, those with especially high profit margins and sustainable competitive advantages, three companies come to mind: Gentex (auto dimming mirrors), Sensata (automotive pressure sensors) and Mobileye (camera-based image processing software). Among the three, Mobileye is likely to be the most profitable well into the future. Its primary product is being mandated. Its technology, which is years ahead of any competitor’s, is crucial to improved safety and to autonomous driving. Mobileye has no in-house manufacturing. Its biggest expense is R&D and therefore mostly fixed, so margins, already quite high by automotive standards at 24.5% net, will almost certainly improve with scale. Mobileye first showed a profit in 2013.

Amnon Shashua, now CTO and chairman, and Ziv Aviram, president and CEO, launched the company in 1999. Originally incorporated in Israel, the founders incorporated Mobileye B.V. in the Netherlands as a holding company in 2001, and later converted it to a Dutch limited liability company in 2003. Management and the company reside in Israel.

Mobileye’s initial public offering, which began trading on the New York Stock Exchange on August 1, 2014, resulted in a staggering valuation of the company, with market capitalization approaching $11 billion at the end of September. For the sake of comparison, Harman International, with $4.3 billion in sales in 2013, has a market cap in the range of $7 billion. Mobileye has no plans to issue dividends; it intends to invest all available funds into the business. The company carries almost no debt.

In 2013, Mobileye’s top three customers accounted for 63% of revenue. A tier-two supplier, Mobileye sells its products—mono-camera image processing software and its patented EyeQ processor for advanced driver assistance systems—to the tier-one ADAS suppliers. Mobileye’s technology first found application in production vehicles in 2007, on four Volvo models. Working with Delphi as the integrator of Mobileye’s EyeQ image processor, Volvo introduced Collision Warning with Auto Brake, using radar and camera fusion, and a lane-departure warning system combined with Volvo’s Driver Alert Control that assesses driver fatigue by monitoring the car’s movements. That year GM and BMW also launched lane-departure warning based on Mobileye technology.

Market Drivers
The biggest push for Mobileye’s products is regulation, starting with the European NCAP (New Car Assessment Program) safety ratings, and moving from there to anticipated NCAP regulations in the U.S., China, Japan and Korea. Euro NCAP ratings began including automatic emergency braking (AEB) systems, which detect an object ahead of the vehicle and if necessary brake the vehicle, in 2014. According to market researchers at SBD (U.K.), penetration of AEB in Europe was taking off even earlier. In 2013, 31% of vehicle models were offered with AEB either standard or optional. Euro NCAP communications manager, Marie Brasseur,
said the agency is certain that penetration increased this year and will continue to do so in the coming years. Euro NCAP plans call for AEB for pedestrians to be factored into its ratings beginning in 2016.

In the U.S., the National Highway Traffic Safety Administration (NHTSA) added forward collision warning and lane-departure warning to its NCAP evaluations in 2011. NHTSA is considering adding automatic emergency braking to the list of ADAS features needed for a five-star rating.

Mobileye believes a secondary market driver for its vision systems will come as more semi-automated driving features, starting with systems that can take over in traffic jams and on open highways, are deployed. The company does not expect fully autonomous vehicles any time in the near future but does see a positive impact on its OEM revenue as more carmakers offer features that can temporarily take over for the driver.

**Products**

Mobileye’s machine-vision algorithms and EyeQ chips interpret the visual field ahead of the vehicle to anticipate collisions with other vehicles, pedestrians, cyclists, animals, debris and other obstacles. The technology is also used to detect roadway markings and identify and read traffic signs and traffic lights, and to automatically control high beam headlights.

Bundled with an array of ADAS and convenience features, EyeQ1 was launched in 2007, and EyeQ2 in 2010. EyeQ3 will be launched in early 2015 by seven OEMs, with three additional OEM launches after 2015. EyeQ3, which will run on 40nm system on chip, supports full AEB, structure from motion functionalities, road profile reconstruction, debris detection, general object detection and traffic light detection. Set for production in early 2018, EyeQ4 will process outputs from multiple forward- and side-view sensors to support automated driving applications. Each generation of EyeQ SoC has six- to eight-times more capability than its predecessor. In Q2 2014, the average selling price for one of these processors was $44.60. Each chip can handle multiple functions; one chip per camera is required. All of Mobileye’s applications thus far involve a single forward-looking camera.

Mobileye’s EyeQ chips have been exclusively manufactured by STMicroelectronics, but Mobileye is presently negotiating with a second supplier as the company is expecting “exponential growth” in demand for its chips. ST recently licensed Samsung Electronics to manufacture 28nm FD-SOI (fully depleted silicon on insulator) devices, the technology on which Mobileye’s EyeQ4 processors will be built. The EyeQ central processing core is licensed from Imagination Technologies.

Lane-departure warning and forward-collision warning have provided the bulk of Mobileye’s sales in the U.S. In Europe, every Mobileye product comes with traffic-sign recognition. Starting in 2015, every customer will make automatic (full) emergency braking capability part of what they purchase from Mobileye. Some of those AEB systems will rely entirely on the camera; the rest will fuse the outputs of the camera and one or more radar sensor. A total of ten OEMs have booked orders for EyeQ3 – AEB.

**Technology**

In addition to its EyeQ family of chips, Mobileye’s most valued core technology is its software, especially its visual processing...
Mobileye

The price tier-one customers pay for Mobileye chips depends on the number of software applications that are bundled within. Supplied by Mobileye’s customer, the tier-one, the assembled camera including the EyeQ chip and other electronics, sells for under $200.

<table>
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<tr>
<th>Unit Sales</th>
<th>Average Selling Price</th>
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<tr>
<td>Q2 2013*</td>
<td>277,000</td>
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<tr>
<td>Q2 2014</td>
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*1.3 million EyeQ chips were shipped in 2013.

Mobileye says its technology functions as the eyes of the vehicle. The other sensor outputs, radar and eventually lidar and V2V, which can be integrated into ADAS systems, will complement the camera. As the resolution of cameras improves, Mobileye will be able to process images that are farther away and more capably interpret the scene ahead of the vehicle.

Not only does Mobileye design its own SoCs but it designs the electronics hardware that supports its chip. That hardware serves as a reference design for tier-one customers and is the basis for the company’s aftermarket product.

Competitive Strengths

“Mobileye’s competitors are way behind,” said an executive with one of Mobileye’s tier-one customers. “The company is running a freight train. As soon as one of its competitors comes up with traffic sign recognition for example, Mobileye is already on to the next application, traffic lights.”

- All of Mobileye’s applications are based on a single camera, a solution that is less expensive and takes up less room than stereo cameras. Systems can be updated with additional features by means of software updates.
- A huge barrier to entry for would-be competitors is Mobileye’s vast amount of validation data, collected from more than seven million kilometers (100,000 plus hours) of driving test-vehicles equipped with Mobileye’s image processing technology. The data are used to optimize and train Mobileye’s algorithms.
- As a tier-two supplier, Mobileye works with multiple tier-one suppliers giving it a greater chance of winning a production contract.
- Since the company outsources manufacturing of the chips it uses and the electronics hardware that comprises its aftermarket solution, Mobileye’s sales can grow significantly without major new investments. Capex in 2013 was just $1.5 million, mainly for data storage and other computer related equipment.
- The company’s algorithms run on its proprietary microprocessor chips, each one capable of running the full suite of ADAS and convenience applications. Mobileye’s third generation EyeQ chip, the EyeQ3, will find series production in 2015.
- Mobileye is narrowly focused on the automotive applications of its monocular image processing specialty.
- First and foremost an R&D company, Mobileye devoted 27.5% of its 2013 revenue to R&D. Of its 404 employees, 320 work in R&D.
- It took Mobileye eight years from its founding in 1999 to launch its first production program in 2007, giving it a head start over competing entities.
- According to Mobileye, the complexity of its algorithms is a big advantage, making it difficult for new entrants to participate in its market.

Mono vs. Stereo Cameras

Among forward-looking sensors applied to advanced driver assistance systems—cameras, radar and lidar—cameras have been...
the most essential because they gather much more data about the scene ahead than the other sensors. Until recently, almost every application required a single or stereo camera operating alone or in concert with radar. However, recent improvements in radar have made pedestrian detection possible without a camera.

Mobileye’s solutions rely entirely on the monocular camera in the belief that they are superior to solutions based on the stereo camera. A monocular camera is less expensive, requires less power and occupies less space behind the windshield. Further, according to Mobileye’s prospectus, “Monocular camera technology is not reliant on a depth map and avoids triangulation errors in the analysis.”

In written communication with the Hansen Report, Mobileye stated: “Stereo cameras will be phased out because we don’t believe there is justification for their added cost and complications of packaging. Testing done by the German ADAC and Japanese auto clubs has demonstrated that the performance of stereo camera systems is inferior to mono systems.”

Regardless of Mobileye’s assertions, a number of suppliers offer stereo vision systems, among them Continental, Bosch and Autoliv. Forward collision warning features offered by Subaru and Mercedes employ stereo camera systems.

According to Kay Stepper, head of the driver assistance and automated driving business unit for Robert Bosch LLC, one of the advantages of systems based on the stereo camera is robustness. “With stereo we have two independent ways of detecting objects. Relying on two cameras, we run both monocular and stereo algorithms and compare the two outputs to make detection and classification even more certain than mono could do by itself.” Later this year Bosch will launch a program with a carmaker that will rely entirely on the stereo camera, without a radar sensor. Relying on its own image processing software, Bosch produces both mono and stereo camera systems. (For more on Mobileye’s competitors, please see page 8.)

Multiple carmakers, including Audi, will offer ADAS features based only on Mobileye’s monocular camera technology, without benefit of radar, in 2015.

**Aftermarket**

Mobileye has been selling an aftermarket product, the Mobileye 5-Series, since 2007. As of July 2014, the product had been installed on more than 120,000 cars and trucks. Employing Mobileye’s machine-vision algorithms, the Mobileye 5-Series, which includes an EyeQ chip, a high dynamic range CMOS camera, related electronics and a display unit, is designed to be professionally mounted on the windshield. Features include forward-collision warning, pedestrian-collision warning, headway warning and lane-departure warning. In 2013 a smartphone app was added to serve as a display unit. The smartphone connects to the Mobileye hardware via Bluetooth.

Mobileye has been developing a new version of Mobileye 5 that won’t require installation by a certified installer. Once that is available, the company will offer the product through consumer distribution channels. The current version of Mobileye 5 is sold mainly to commercial and government fleets, telematics providers and insurance companies. It is also provided directly to customers in Israel through car dealers. The Israeli government gives a $400 tax benefit to vehicle importers for each car equipped with the Mobileye 5-Series ADAS features, roughly equal to its retail price.

The Mobileye 5-Series is produced by a contract manufacturer in China. Mobileye’s aftermarket segment grew by 44% in 2013, more slowly than its OEM segment, a trend that will continue for a few years at least. Aftermarket products will be transitioned to the EyeQ3 chip in 2015-2016.

**New Products**

- **Trifocal Camera**

Mobileye has already booked three production programs—Tesla in 2015 and two others in 2016—for its trifocal camera, which will be used in handsfree driving applications. Comprising three cameras and three EyeQ3 chips assembled in a compact 4- to 6-centimeter wide package, the trifocal camera will provide the redundancy needed for autonomous driving applications. Each camera assembly will provide three different fields of view. Basic ADAS functionality will be handled by the 50-degree monocular camera. The 150-degree field of view provides early detection of close objects, such as vehicles that cut in, pedestrians crossing and cyclists. The 30-degree camera is there to spot road debris (10-15 cm in height) and traffic lights.

Mobileye has been developing trifocal camera applications with six additional OEMs, which could launch production programs in 2018.

According to Mobileye, these initial applications coming in two years will support handsfree highway driving both at speed and in congested traffic. By 2018, handsfree driving will begin to extend to country roads and city roads, where there is traffic congestion. According to Mobileye, these applications will require significant algorithmic advances but only minor improvements to the sensing hardware.

- **Surround View**

In 2015, Mobileye will begin development of visual processing based on surround views from front-, side- and rear-facing cameras to support automated parking functions. These functions will include the detection of obstacles and pedestrians, including children.

- **Fusing Camera, Radar and Lidar**

As autonomous features advance in the next few years, Mobileye is anticipating the need to not only fuse the output of radar with the camera’s output, but also to integrate the output from side-facing lidar sensors. Mobileye believes that handsfree driving will eventually require the adoption of all three sensor types.  

**Product Offerings: Software and related technologies for camera-based ADAS**

**Safety**

Lane functions – Lane departure warning, lane keeping support
Vehicle detection – Forward collision warning, headway monitoring and warning, adaptive cruise control, traffic jam assist and automatic emergency braking
Pedestrian detection – Pedestrian collision warning and pedestrian automatic emergency braking

**Convenience and Driving Enhancement**

Intelligent high-beam control, traffic-sign recognition and speed-limit indicator

**Autonomous Driving Technologies**

Drivable path delimiter capabilities, including detection of curbs, barriers, construction zone obstructions, general obstacles, road bumps, potholes and debris
Mobileye’s Competitors in Catch-up Mode

With the ADAS market in a growth spurt, a number of tier-one and tier-two suppliers intend to challenge Mobileye’s present dominance of the market for image processing software. Bosch and Continental, two of the world’s biggest tier-one suppliers, have their own software that competes with Mobileye. Indeed, a number of competitors can compete head-to-head on lane-departure warning, traffic-sign recognition and high-beam assist. Other ADAS tier ones with in-house image processing software include Denso and Autoliv. Hopeful tier-two competitors include Neusoft, iOnRoad and Itseez.

Continental has a legacy camera-based system in production that relies on Mobileye technology, but for the last two-and-a-half years its mono- and stereo-vision solutions have employed only in-house image processing technology. Applications on the road include stereo and monocular solutions with Mercedes, and mono-camera systems for GM, Ford Europe and Mazda. Single-camera vision applications include high-beam assist, traffic-sign recognition, lane-departure warning and obstacle detection of motorcycles, but not pedestrian detection.

Continental is addressing the quickly emerging market for automatic emergency braking for pedestrians not with a camera but with 77–79 GHz radar-only systems. “We have a lot of high-volume series development based on radar in the works,” said Wolfgang Fey, head of Continental’s surround-view segment. “The resolution and sensitivity of radar is pretty high now. You can determine the size of object. You don’t see a visual picture of a person but you can very well detect that it is a person. You can even detect moving objects behind a car, which a camera can’t see. Radar can look underneath cars by reflection and see objects that are hidden.” Unlike camera solutions, radar systems work all the time, facing into bright sunlight, in rain, snow and fog. And the sensor can be hidden behind the bumper. Radar cannot read traffic signs or traffic lights.

Bosch is a promising tier-one competitor with its own image processing software for both mono and stereo cameras. Bosch is especially excited about a recent win involving its stereo vision solution, because it is a camera-only system that requires no radar backup. The system handles automatic emergency braking for vehicles and pedestrians, adaptive cruise control and traffic-sign recognition.

Bosch has been in production with its mono-camera-based solutions since 2009, and later this year will begin production of its second generation mono-vision solution. This one will be paired with radar. Thus far, Bosch has won forward-looking camera business with fewer than five carmakers. “We are working with every major carmaker around the world on forward-looking and near-range camera systems,” said Kay Stepper, head of Bosch’s U.S. regional ADAS and automated driving unit. “We see strong growth potential for both stereo and monocular vision systems.”

Neusoft, a Chinese software company with $1.2 billion in 2013 revenue, says its lane-departure warning, pedestrian detection and traffic-sign recognition algorithms will be ready for production applications in the 2015-2016 timeframe. Like Mobileye’s, Neusoft’s software is based on a single camera. Neusoft’s pedestrian-detection algorithms aren’t yet ready for autonomous emergency braking applications.

The company is collaborating with chipmaker Freescale, and development and runtime environment provider Green Hills Software to deliver an ADAS development platform that is compliant with ISO 26262. Neusoft hopes to be ready to demonstrate its software on Freescale hardware in the first or second quarter of 2015.

Not only does Neusoft expect to offer a price alternative to Mobileye, but it also offers flexibility. “Tier-one suppliers want to be free to choose the operating system and the chip supplier,” said Georg Müller head of sales for Neusoft’s automotive business, “something they can’t do with Mobileye.”

A key supplier of navigation and audio/video software to infotainment companies, Neusoft’s automotive division had about $120 million in revenue in 2013 and 2,400 employees, 200 of whom are located in Hamburg. The people in Germany were part of Harman until 2010. For more contact Georg.Mueller@de.neusoft.com.

iOnRoad says it is ready now to engage the market for embedded camera-based collision warning and lane-departure warning applications. “iOnRoad technology passed the NHTSA test in Q2 2014. That tells you our technology is now ready,” said Sachin Lawande, president of the infotainment division of Harman International. Harman acquired Israel-based iOnRoad in April 2013.

“We are in serious discussions with at least two OEMs. I’ll be disappointed if we don’t win something in six months,” said Mr. Lawande. Harman hopes to act as system integrator for the system, which includes computer vision algorithms and a camera module, though it isn’t ruling out a tier-two role as the supplier of only the image processing software.

iOnRoad’s main product has been an app that uses a smartphone camera to detect lanes and vehicles and alert drivers when they are driving too close to the car in front of them or when they are straying outside their lane. Downloads of the app are nearing one million.

iOnRoad is not yet ready with pedestrian detection. While acknowledging that it is playing catch-up with Mobileye, Harman believes that carmakers will be drawn to its image processing software because it is independent from any particular SoC solution. “Our solution is software based. It can be integrated with multiple systems in many ways,” said Mr. Lawande.

Twelve employees are assigned to iOnRoad with support from additional Harman employees working on visual advanced driver assistance systems and other complementary technologies.

Itseez, a 100-person computer vision firm based in Russia, has developed a traffic-sign recognition algorithm and is working on lane-departure and collision-warning algorithms. A pedestrian collision warning system is a few weeks away from completion. The company would like to license its software to a tier-one supplier.

Newly engaged with the auto industry, the company has been focused on the 3D scanner and face detection markets. Its first automotive deal is with a small OEM that uses the algorithm to work on an Android platform.

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