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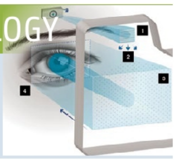

Plessey microLEDs set for AR glasses

- Optics firm Vuzix teams up with Plessey to develop augmented reality specs using microLEDs

STEVE BUSH

Plessey has tied up with Vuzix to develop augmented reality (AR) glasses, combining Plessey's Quanta-Brite microLED arrays and Vuzix's expertise and IP in smart glasses and optics.

"This development with Vuzix, a leading actor in the exploration of next-generation AR, is a significant endorsement of Plessey's GaN-on-silicon microLED approach,' said Plessey CEO Keith Strickland.

Quanta-Brite is a light source for illuminating DMD (digital micro-mirror device) or LCoS (liquid crystal-on-silicon) display engines, based on monolithic arrays of microLEDs, which Plessey claims will enable an optical system up to 50% smaller, lighter and simpler than incumbent solutions, and improve power-efficiency. It could be "a major enabler" of the future of AR, said Vuzix CEO Paul Travers.

"As well as delivering high-efficiency, low-power and small-size illumination capabilities, the high luminescence level of the light source can also enable the development of end products with a sleeker form factor, which is critical to mass market adoption," said Travers.

The microLED arrays use Plessey's GaN-on-Si technology, combined with its IC-building knowledge that allows inter-LED conductors to be formed on-die. The firm has also developed a way to deposit red and green phosphors on two-thirds of the inherently blue-emitting micron-scale LEDs to produce hundreds or thousands of RGB pixels.

"The Quanta-Brite illuminator comprises an array of switchable RGB pixels with integrated first level optical elements for optimised light extraction, simplified additional optical elements and uniform illumination," Plessey marketing director Myles Blake told *Electronics Weekly*. "All pixels of a single colour are addressed as one and phased with the DMD or LCoS requirements."

The package size for monolithic RGB array, near-die collimation and lenslet is below 5.5x5x2mm.

Vuzix has already developed smart glasses culminating in the Vuzix Blade, which uses proprietary waveguide optics formed from nano-structures on glass. The next generation, according to Plessey, will use Plessey microLED arrays. The announcement did not cover RGB microLED displays, intended to entirely replace DMDs and LCoSs, which some contend will be the ultimate image source for AR glasses.

RADAR BIDS FOR POLE POSITION OVER LIDAR

- Radar tech for driverless cars and ADAS is challenging Lidar's role in vehicle safety

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Head count pledge costs Arm a leg

Softbank has sold 51% of Arm's China operation for $775m to local investors, according to *Reuters*.

Arm gets about one fifth of its $1.4bn annual revenues from China.

Under the deal the 51% share will be owned by a consortium led by the Hou An Innovation Fund, which is jointly managed by Arm and Hopu Investments, with Hou An the controlling shareholder.

Hou An's backers include China Investment Corporation, Silk Road Fund, Temasek Holdings, Shum Yip Group and Hopu.

According to Rene Haas, president of Arm's IP products group, the plan is to IPO the unit on a Chinese stock market.

A quarter of Arm has already been transferred to Softbank's Vision Fund for a reputed $8bn. Softbank execs have said they may IPO the remainder of their Arm holding, while the Vision Fund may also IPO its 25% stake in Arm as an exit option.

Arm has been unprofitable for the last three quarters under Softbank control. This is due, in part, to Softbank's undertaking to increase Arm's head count.

Radar challenges lidar

Radar technology for autonomous vehicles and ADAS is challenging lidar's role in vehicle safety, writes **David Wheeler**

Automotive radar is in the ascendant again, with ever higher demands for data processing leading to a large number of tracked objects and a detailed point-cloud driving artificial intelligence (AI) autopilot decisions.

This radar imaging capability is challenging lidar to the extent that Level 5 autonomous driving systems may not need lidar at all.

When the first autonomous driving prototypes took part in the US Department of Defence's Darpa Challenge starting in 2004, they relied heavily on lidar sensors to provide the distance and high spatial resolution necessary to effectively image the terrain.

At first, the trend was firmly that the camera plus lidar could do it all. Over time, the capability of camera-based systems, due to the success of Mobileye, has grown considerably, whereby the latest systems are able to judge distance to objects from a multi-ocular camera. This has partly replaced any particular need for lidar and it has become just another sensor providing an alternate view of the terrain.

Both camera and lidar fall short in poor weather conditions, night-time driving, keeping a clean lens and providing accurate speed information. There radar will continue to rule unchallenged, to the extent that a combination of radar and cameras drive the Tesla ADAS, 'Autopilot'.

Radar has a long history in vehicle sensing and in recent systems like the Bosch mid-range radar sensor – a bi-static multimodal radar with four independent receive channels and digital beam forming – it is the sole sensor input into adaptive cruise control (ACC), autonomous emergency braking (AEB) and side impact protection.

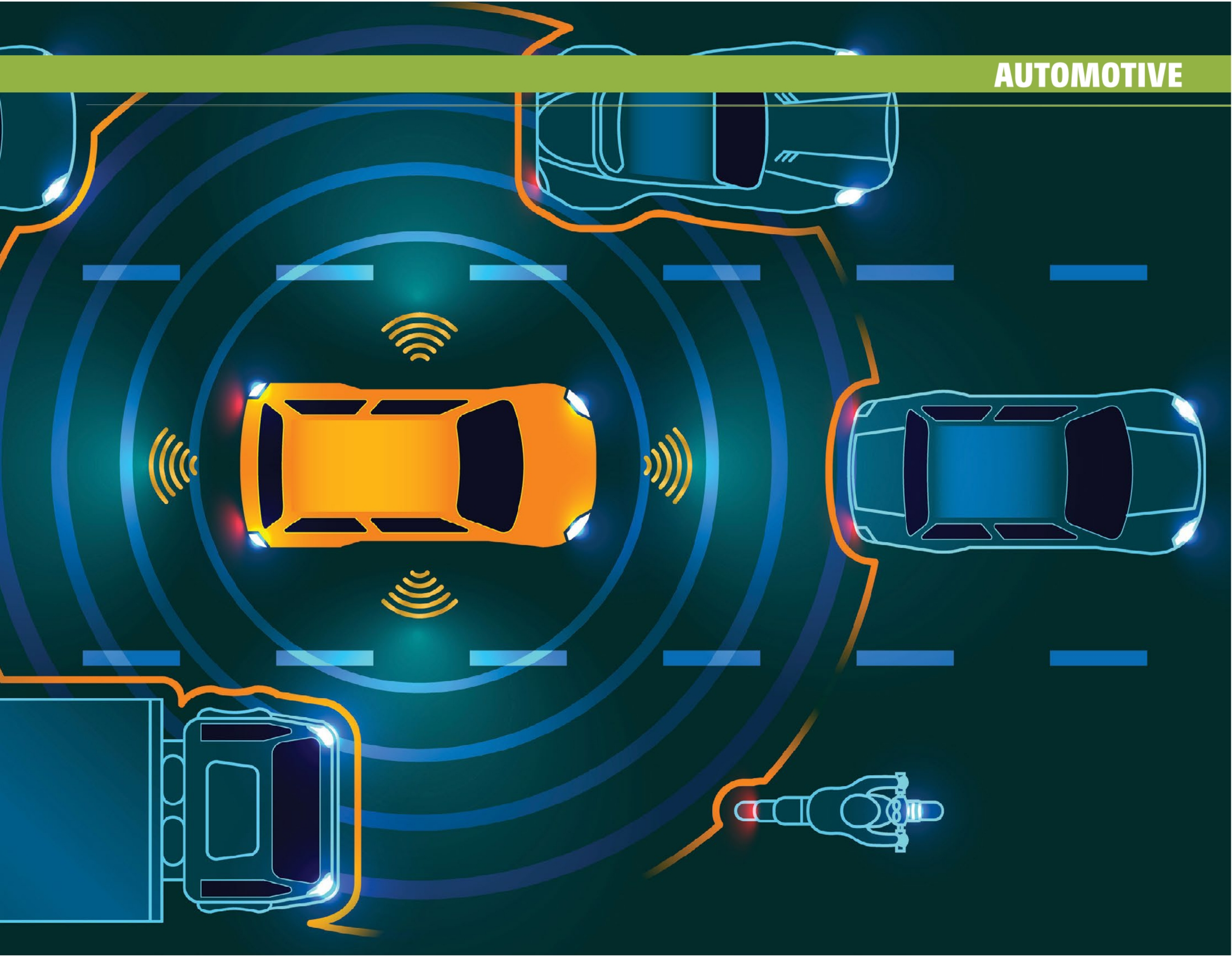
Change is coming

Looking forward, radar is undergoing a double step-change in specification.

The first is for an integrated, multi-sensor aggregation providing 360° vehicle coverage to address the limited sector, field of view (FOV) of an individual (non-rotating) radar. These have created challenges in forming the sensor array into the bodywork, transporting data and combining it in a central ECU

The second step-change is the level of detail that each RADAR sensor provides. By adding more transmit and receive antennas, a virtual array can be formed using MIMO signal processing techniques. The resulting spatial resolution available for a 256-antenna virtual array can be down to 0.1° – equivalent to the best lidar – but for a fraction of the cost.

Equally, new sawtooth frequency modulated continuous wave (FMCW) modulation techniques help to determine object range and speed unambiguously even in a very dense scattering scene. Furthermore, the RF modulation sample rates, after down conversion, are being pushed to greater than 40Msamples/s so that long fast fourier transforms (FFT) up to 4,000 points can divide the range span into ever smaller cells, revealing previously hidden detail.



Finally, radar has taken on 4D (range, speed, azimuth, elevation) as standard to further erode any advantages that lidar provided. Each of these dimensions involves calculating thousands of large FFTs and is computationally intensive.

Of course all this performance increase comes at a price. The amount of raw sensor sample data generated is on an exponential curve in proportion to the number of antennas multiplied by the sample rate.

Critically, the time allowed to process all this has not changed, at around 40ms; being related to camera frame rates for fusion alignment and the simple physics of how much time the car needs to break in reacting to a possible collision.

Also, when it comes to detection, the processing has to be on digitally formed beams to give the best performance – typically four to 16 are required – and uses adaptive thresholding for optimum discrimination, but all this requires a vast increase in computation rates.

> "The traditional radar processing that tracks extended objects is still essential to post-processing and forms an additional output to the imaging point-cloud

Of equal importance to computation rates is the amount of storage needed during processing.

Tackling storage density

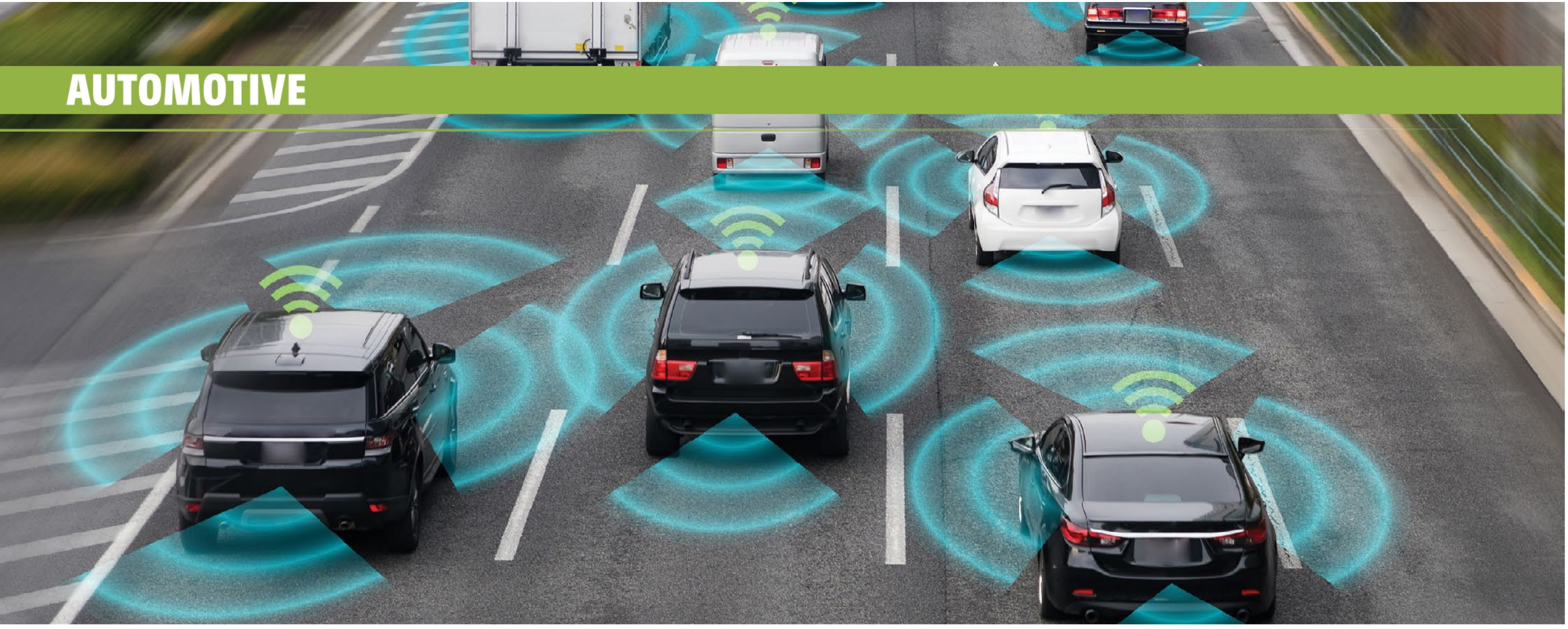
Techniques that can reduce the overall storage requirements include a multichannel, pipelined, hardware signal processing chain, early, but prudent detection, and data compression.

Even for the highest density point-clouds, extensive hardware pipelining and data compression mean a modest specification internal RAM can be achieved.

The 4D FFT data needs further processing to be called a radar image point-cloud. Operations such as extracting the return intensity (radar cross-section) by taking into account the distance and antenna beam-pattern are essential to normalise the raw energy in a 4D cell ready for analysis.

Other operations are common, for example removing background clutter unrelated to physical objects and co-ordinating conversion from polar to real-world Cartesian.

A radar image point-cloud is typically of the order of 100,000 points, which can be reduced to 30,000 points per 40ms after removing noise. This level of detail is akin to a lidar, where, for instance, the Velodyne HDL-32e



> “Advanced signal processing resolves objects that could remain hidden

produces 700,000points/s. However, point-cloud objects with strong return in the far field could be caused by two or more distinct objects, such as cars driving alongside one another in adjacent lanes that the detection has merged because of the limited virtual array beam-width.

Advanced signal processing techniques such as Capon or Music, known collectively as super-resolution, must be applied to test and resolve objects within a beam-width that would otherwise remain hidden.

These techniques require floating point, singular value decomposition on large dimension (≥ 16x16), complex valued matrices and have consequently only been applied sparingly, but the extra point-cloud detail now means this is necessary on 100+ range/Doppler bins.

The traditional radar processing that tracks extended objects is still an essential part of post-processing and forms an additional output to the imaging point-cloud. Indeed, an extended object becomes, in a simplified sense, a cluster of co-located points sharing the same speed.

The process of clustering objects into a centroid is highly computational and made all the more difficult by having a high density point-cloud.

The extended object measurements are finally associated with tracks maintained by a Kalman filter and the closest measurement to each track is used to update that track. The track association and Kalman filters must be implemented in floating point and both involve matrix operations, which includes inverting real valued state matrices of typical dimension 6x6.

In addition to all this, a new generation of radar needs to be multi-modal, which requires the ability to sequence and process a number of frames each designed to accomplish a different objective, such as short-range wide field of view, long-range narrow field of view, squint-view and frames designed to correct for Doppler ambiguity at a low sample rate.❑

Typical specification for radar imaging that eSi-ADAS addresses

Parameter	LRR mode	SRR mode
Receive antennas	16	16
Transmit antennas	16	16
Maximum virtual array antennas	256	256
Detection beams	16	16
Detection algorithms	CA, SO, GO, CASH	
	GOS-CA, GOS-SO, GOS-GO	CA, SO, GO, CASH
Multiple interleaved frame types	Yes	Yes
Maximum range	300m	50m
Range resolution	15cm	1.2 m
Range accuracy	10mm (up to 50m)	1mm
Doppler range	±340 km/h	±170 km/h
Doppler resolution	±2.65km/h	±1.35km/h
Doppler accuracy	0.02km/h	0.01km/h
Azimuth field of view	±10°	±65°
Azimuth resolution	±0.3° (conventional)	±0.3° (conventional)
	± 0.1° (super-resolution)	± 0.1° (super-resolution)
Azimuth accuracy	0.1°	0.1°
Elevation FOV	±8°	±8°
Elevation resolution	±10° (conventional)	±10° (conventional)
Elevation accuracy	0.1°	0.1°
Point cloud size	≥32K points	≥32K points
Objects tracked (6 state)	128	256
Super-resolution range-bins	128	128
Processing time	20ms	20ms
Update rate	40ms	80ms

EnSilica has a 10-year track record with radar, including defence, commercial roadside, and on-board automotive systems. Its radar signal processing chain addresses automotive imaging and will be able to complement or replace lidar in future autonomous vehicles to Level 5.

The company’s eSi-ADAS device is a highly configurable, MIMO virtual array imaging radar processor built around hardware acceleration of key algorithms for calibration, windowing, FFT, digital beam forming, power spectrum generation, CFAR detection, clustering, super-resolution, kinematics, co-ordinate conversion, measurement to track association and tracking filters. Its programming interface allows flexible sequencing and custom extensions to commercially available RF devices that can be repurposed for radar imaging.

The high density point-cloud over an Ethernet interface and tracked objects over both Ethernet and CAN can be formatted in standards including lidar LAS, LAZ, PCD.

About the author

David Wheeler is technical director at EnSilica