360° Surround View Systems for Automobiles - a study

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Abstract:
The document is a study report on camera based Surround View system. The system gives the driver a full 360° view around the vehicle as well as providing additional information for driver assistance functions such as fully automated parking, pedestrian detection, cross traffic. This feature will enable driver to perform sharp maneuvers in crowded traffic at low speed\textsuperscript{[1]}. The automobiles with this feature are in the market and more enhanced versions are expected to hit the market from 2014.
## Abbreviations:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Acronyms (Page No.)</th>
<th>Full form</th>
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<tbody>
<tr>
<td>1</td>
<td>ADAS (5, 12)</td>
<td>Advanced Driver Assistance System</td>
</tr>
<tr>
<td>2</td>
<td>LCD (5, 10)</td>
<td>Liquid-crystal Display</td>
</tr>
<tr>
<td>3</td>
<td>CID (5, 9, 10)</td>
<td>Central Information Display</td>
</tr>
<tr>
<td>4</td>
<td>CMOS (7)</td>
<td>Complementary Metal Oxide Semiconductor</td>
</tr>
<tr>
<td>5</td>
<td>OEM (6, 7, 8)</td>
<td>Original Equipment Manufactures</td>
</tr>
<tr>
<td>6</td>
<td>RADAR (11)</td>
<td>Radio Detection And Ranging</td>
</tr>
<tr>
<td>7</td>
<td>LiDAR (11)</td>
<td>Light Detection And Ranging</td>
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Background:

Visibility is the major constraint while driving any vehicles, that’s the reason research programs are being carried out to enhance the visibility, hence making the journey safe.

The active safety or advanced driver assistance systems (ADAS) is branched out as specialized domain to focus driver and occupant safety, these systems meant for pre-crash assessment it comprises of single or combination of multiple-sensors installed at various locations in the vehicle.

360° surround view camera system one of the ADAS shows the vehicle's direct surroundings from every angle to the driver on the LCD instrument cluster or the central information display (CID). The surroundings can be seen from different perspectives, including the top-down bird’s eye view perspective, which eliminates all blind spots during critical and precise maneuvers in crowded spaces.
Market Trends:
“The continuously improving cost efficiencies of automotive vision and sensing systems are now enabling the adoption of multi-camera surround view systems across a broader range of vehicles,” said Kevin Mak, automotive industry analyst for Strategy Analytics. “Despite the recession and delayed model cycles, reports are projecting up to 90 million parking and driver assist systems will be deployed by 2018.”[2]

Automotive industry has realized the growing importance of surround view system, many Tier1s and OEMs are actively investing in developing the technology by including advanced features to enrich their market proposition, and some examples are:

**Continental – Surround View**[1]

The system gives the driver a full 360° view around the vehicle as well as providing additional information for driver assistance functions, which then unlocks further options, such as fully automated parking.

Next generation surround view systems will be able to furnish 3D views. Several types of scalable systems are in development so that surround view can be offered in different vehicle segments. The basic version offers a pure 360-degree 3D image to assist in parking and maneuvering at low speeds. The Intelligent, active surround view systems will
also recognize pedestrians, warn the driver or even stop the vehicle in critical situations.

**Broadcom, Freescale Semiconductor and OmniVision – Ethernet-Based Parking Assistance System Delivers 360-Degree Surround View**\(^2\)

Presented as the world’s first Ethernet-based parking assistance solution. The collaboration, combining best-in-class semiconductor innovation and automotive electronics expertise, is an important step in the migration from a closed application to an open and scalable Ethernet-based driver assistance network in which several systems can easily access information. The cost advantages offered by Ethernet technology, combined with the high image resolution now available from affordable CMOS image sensors, dramatically expand the opportunity for OEMs to deploy 360-degree parking assistance camera systems across vehicle classes, bringing valuable assistance options to luxury and non-luxury markets alike.

**Harman – Surround View park Assistance**\(^3\)

HARMAN’s revolutionary new camera-based parking assistant goes beyond today’s single, rear-mounted view or multi-camera top view. With the help of 4 super-wide-angle cameras positioned around the car, computation of real camera data with virtual reality modeling to offer complete 360-degree surround views of the perimeter of the car from virtually any viewing angle. It improves overall parking safety
and accuracy by eliminating blind spots during critical maneuvers in crowded and narrow spaces.

Apart from the above mentioned Tier1s companies like Bosch\(^4\), Xylon\(^5\), Optronics\(^6\), Rydeen\(^7\), KDPOF\(^8\), ALVACON\(^9\) etc. are readying their prototypes, this effort is supported by semicon providers like Texas Instruments\(^{10}\), Renesas\(^{11}\), Fujitsu\(^{12}\), Xilinx\(^{13}\), Freescale\(^{14}\), Nvidia\(^{14}\), OmniVision(lens)\(^{12}\), Toshiba\(^{15}\) etc.

2014 is the year targeted by the major OEMs to launch their cars with 360\(^0\) surround view system, some of the models are: Volvo(XC Coupe)\(^{16}\), BMW(2014 X5)\(^{17}\), Audi(S8)\(^{18}\), Mercedes Benz(2014 E350 4matic) (2014 S Class)\(^{19}\), Nissan(2014 Rogue)(2013 Pathfinder)\(^{20}\), Infinity(JX)\(^{20}\), Hyundai(2014 Equus)\(^{21}\), Porche(2014 Panamera)\(^{22}\), Acura(2014 MDX)\(^{23}\) etc. and next year Ford(2015 F-150)\(^{24}\) and many more are expected.
Solution:

Vehicle’s surround view on CID

Vehicle with 4 cameras looking downwards for surround view

The 360° surround view system basically includes 4 down facing cameras:

- The traditional backup camera is mounted above the rear license plate
- One camera in the front grille
- Two ultra-wide-angle cameras are in the side mirrors.

There is considerable distortion on the sides because cameras are less than 4 feet off the ground and have to cover more
than 16 feet of car. If you roll past the other car, its wheels are oblongs that look a football rolling end to end. If the other car is parked more than 3-4 feet away, you may not see it; if you can, you’ll only see it from the wheel arches down. You can always see the parking lanes which may be all you need to steer out accurately.

The stitching software blends the four videos and wraps it around an illustration of the vehicle from overhead and displays it on LCD/CID. It’s like bird’s-eye view from 20 feet over the center of the car.$^{[20]}$

The important components of surround view system are:

- Cameras used 4 to 8
- LCD on instruments cluster
- Use at low speed only
  i) Parking assistance
  ii) Autonomous parking
  iii) Manoeuvring in crowded street
- Technology used
  i) Image stitching
  ii) Distortion correction
  iii) Obstacle detection
- Other application support
  i) Pedestrian detection
  ii) Cross traffic
  iii) Lane departure/Lane Keep(in parking bay)
Common Issues:
The present generation four-camera system is targeted to luxury car segment as a value added feature which is expected to add an estimated $500-$1,000 costs to the buyer, more than twice what a backup camera costs\textsuperscript{[20]}. The next-gen systems with addition of more cameras, other sensors (RADAR/LiDAR) and intelligence like Auto parking, Pedestrian detection and Cross traffic detection is expected to create even deeper hole in buyers pocket.
Conclusion:

The ADAS are meant for the developed markets/countries where the standard road conditions are maintained all over, and it’s assumed in all other geographies the ADAS may not deliver proper performance because of non-standardization of road and traffic conditions.

The 360° surround view system is probably the only ADAS which is having a global appeal because of its uniform performance in all geographies. Also, it goes far beyond the pending federal mandate that cars manufactured in 2014 have a backup camera system to protect children walking behind the car when it’s reversing.[20]

Once the market for this system starts picking the price can be expected to come down significantly because of increase in production that will make car owners from all categories to enjoy its benefits.
Reference:


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