Camera Module Industry 2017
 ABOUT THE AUTHORS OF THIS REPORT

Biography & contact

**Pierre Cambou**

Pierre Cambou joined the imaging industry in 1999. Following an engineering degree from Université de Technologie de Compiègne and a master of science from Virginia Tech in 1998. He did graduate as well from Grenoble Ecole de Management’s MBA in 2010. Cambou took several positions at Thomson TCS, which became Atmel Grenoble in 2001 and e2v Semiconductors in 2006. In 2012 he founded Vence Innovation, now called Irlynx, in order to bring to market a disruptive man-to-machine interaction technology. He joined market research and strategy consulting company Yole Développement as imaging activity leader in 2014.

**Jean-Luc Jaffard**

From 1966 Jean-Luc Jaffard paved the way of imaging activity at STMicroelectronics being at the forefront of the emergence and growth of this business. At STMicroelectronics Imaging Division he was successively appointed as Research Development and Innovation Director managing a large multidisciplinary and multicultural team and later on promoted to Deputy General Manager and Advanced Technology Director in charge of identifying and developing breakthrough Imaging Technologies and to transform them into innovative and profitable products. In 2010 he was appointed STMicroelectronics Intellectual Property Business Unit Director. In January 2014 he created the Technology and Innovation branch of Red Belt Conseil.
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WHAT WE GOT RIGHT, WHAT WE GOT WRONG

CCM forecast over the years

Yole has lowered its forecast for CMOS camera modules due to cost reductions and delayed introduction of new technologies such as OIS.

Mostly driven by dual-camera approaches and the introduction of advanced sensor technologies in smartphones, growth potential is maintained at a high level for the 2016-2022 period.

Our goal is a +/-10% market prediction in five years’ time.
HOW IS MADE A MOBILE CAMERA MODULE?

Structure of a Mobile camera module

Once a relatively basic component, CCM has evolved in a complex micro-electro-mechanical device.

- Connector
- Flex-rigid substrate
- CMOS Image Sensor (CIS)
- Metal Shield
- Voice Coil Motor (VCM)
- Lenses & Spacers
- Lens Mount

Courtesy of Oppo
HOW IS MADE AN AUTOMOTIVE CAMERA MODULE?

Structure of the automotive CCM

- Lens Mount
- CMOS Image Sensor (CIS)
- Flex rigids substrate
- No voice coil motor
- Connector

The automotive CCM has duplicated the formula from Mobile

Complete ADAS camera system

Automotive camera module

Courtesy of TRW
Combined revenues in the CCM business reached $23.4B in 2016.

Revenues are captured by four types of players:
- CCM Assembly
- CIS Supplier
- Lens Supplier
- AF&OIS Supplier

The industry is the reunion of different sub-part manufacturing.
Combined revenues in the CCM business has reached $23.4B in 2015 and should reach $46.8B in 2022.

The stacked sensor effect temporarily froze module size & price.

Growth is picking up again in 2017 due to full effect of OIS and Dual camera demand.

A $23B industry with double digit growth rate.
ANALYSIS OF THE MOBILE MARKET TREND

Present & Future

• On the rear of the phone the effort is still to match high end digital photography cameras. Use of dual (computational) approach allowed for x2 zoom capability (Apple) and/or enhanced resolution black and white pictures (Huawei). OIS once thought to be the new Grail has in fact penetrated more slowly than expected due to unstructured supply chain, lack of market recognition and cost. Next steps are most probably incremental innovations with dual OIS, Laser rangers, and 3D computational capability.

• On the front side of the phone, a race toward high resolution sensors for selfies has been observed. The new trend from Apple is transforming the front optical hub into a touchless user interface with 3D sensing capability. Next steps are therefore more disruptive on this side of the phone, with possible variations in technology choices.

• 3D mapping: dedicated dual sensors or structured light sensors or time of flight sensors
• LED Illuminator: probably a more complex device than current LED, possibly with MEMS mirror
• Motion sensor: global shutter sensor (VGA, pixel 3.5µm to 5µm)
• Iris recognition: could improve current biometric sensors approach
• Far Infrared: interaction with humans
• Hyperspectral: spectroscopic insights in the nature of objects
MOBILE MARKET TREND

3D Sensing camera is the fifth phase of smartphone camera evolution

The majority of demand is for 10mm x 10mm x 5mm modules

Smartphones:
The main camera’s size stops shrinking and a front-facing camera is added

Camera phones:
Innovation from Sharp in June 2000

Selfies:
Front-facing camera size increases

Dual rear cameras:
Improved photography thanks to a dual-camera approach

Event #1
Event #2
Event #3
Event #4
Event #5

Rear smartphone camera modules
Front smartphone camera module
3D sensing module


Module size and cost
20mm x 10mm
$20
10mm x 10mm
$10
5mm x 5mm
$5
1mm x 1mm
$1

Market size
$20B
$10B
$5B
$1B

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Main players market share analysis
CONSUMER APPLICATIONS

VR/AR/MR are applications, not a specific hardware device

<table>
<thead>
<tr>
<th>Applications</th>
<th>Hardware</th>
<th>VR headset</th>
<th>AR headset</th>
<th>Notebook and tablet</th>
<th>Smartphone</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR</td>
<td>Sensors</td>
<td>[Image of VR headset]</td>
<td>[Image of AR headset]</td>
<td>[Image of notebook and tablet]</td>
<td>[Image of smartphone]</td>
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<tr>
<td>AR</td>
<td></td>
<td>[Image of position sensor]</td>
<td>[Image of 2D camera]</td>
<td>[Image of smartphone with Pokémon Go]</td>
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<tr>
<td>MR</td>
<td></td>
<td>[Image of 3D camera]</td>
<td>[Image of smartphone with Pokémon Go]</td>
<td>[Image of smartphone with virtual character]</td>
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CMOS IMAGE SENSOR TECHNOLOGY TREND

FSI

TSV Hole to replace shell case approach Wafer Level Packaging Interconnection

BSI

Trench TSV BEOL Interconnection

Stacked BSI

TSV BEOL and DSP Interconnection

Triple Stack BSI
Additional optical sensor technologies in mobile devices
(Source: Yole Développement, 2017)

<table>
<thead>
<tr>
<th>Players</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth sensing</td>
<td>accelerated development of 3D sensors pixel shrinks opens door to integration</td>
</tr>
<tr>
<td>3D mapping</td>
<td></td>
</tr>
<tr>
<td>3D Structured Light</td>
<td>Structured light is one approach to 3D sensing, effort mainly on the illuminator</td>
</tr>
<tr>
<td>NIR sensors</td>
<td>NIR sensors is also part of the 3D story</td>
</tr>
<tr>
<td>Iris or face recognition</td>
<td>Surfing on the wave of enhanced biometrics and ergonomics</td>
</tr>
<tr>
<td>Far Infrared sensors</td>
<td>FIR sensors have the size for mobile integration, the application is still missing</td>
</tr>
<tr>
<td>Hyperspectral sensors</td>
<td>Plasmonic or Fabry Perrot filters could bring hyperspectral capability to mobile</td>
</tr>
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