CEVA

CEVA TECHNOLOGY
SYMPOSIUM SERIES

12th YEAR

Enabling Intelligent Vision Processing at the Edge

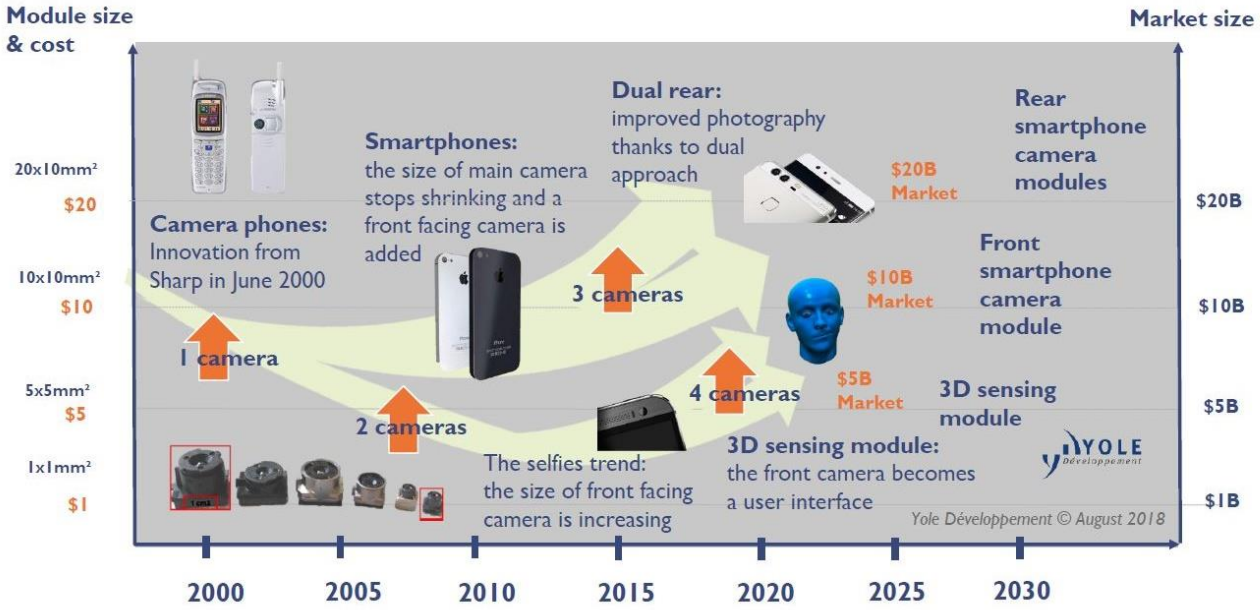
Liran Bar, Director of Product Marketing, CEVA

CV Market Trends

Mobile Market Trend

3D brings the fourth camera embedded in smartphones!

Most of the business is for 10x10x5mm³ camera modules



Smartphone with Four Rear Cameras !

- Computational photography features:
  - 2x optical zoom
  - Scene optimizer (19 modes)
  - Manual depth of field adjusting
  - Flaw detection (e.g. Eye Blink, Facial Blur, and backlight issues)
  - And much more…

✓ The camera is still the main highlighted feature
✓ There is a need for a better image/video quality

Samsung Galaxy A9

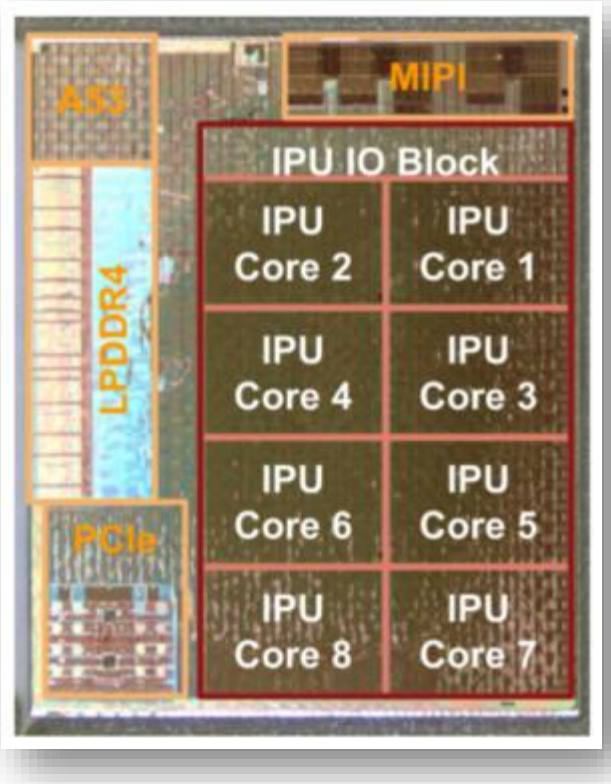
Google Pixel 3 (&2) - Pixel Visual Core

- Computational photography features:
  - HDR+, 5 images with 1/10th the power consumption
  - Complex imaging and machine learning tasks
  - Super resolution zoom
  - Night sight

With a single rear camera !

A foreground and background mask created by Google's neural network.

Depth Map data captured using a PDAF camera and the resulting blur map for the final image.



Google Pixel 3 – Night Sight

Allows for incredibly detailed pictures to be captured in low-light situations (without the aid of a flash)

OPPO Find-X - 3D Structured Light Technology

- Global shipments of smartphones featuring 3D sensing technology are expected to top over 100 million units in 2018*
- Apple serving as the primary vendor and following by Xiaomi, Oppo and Vivo

(*) according to an estimate of China-based Sigmaintell

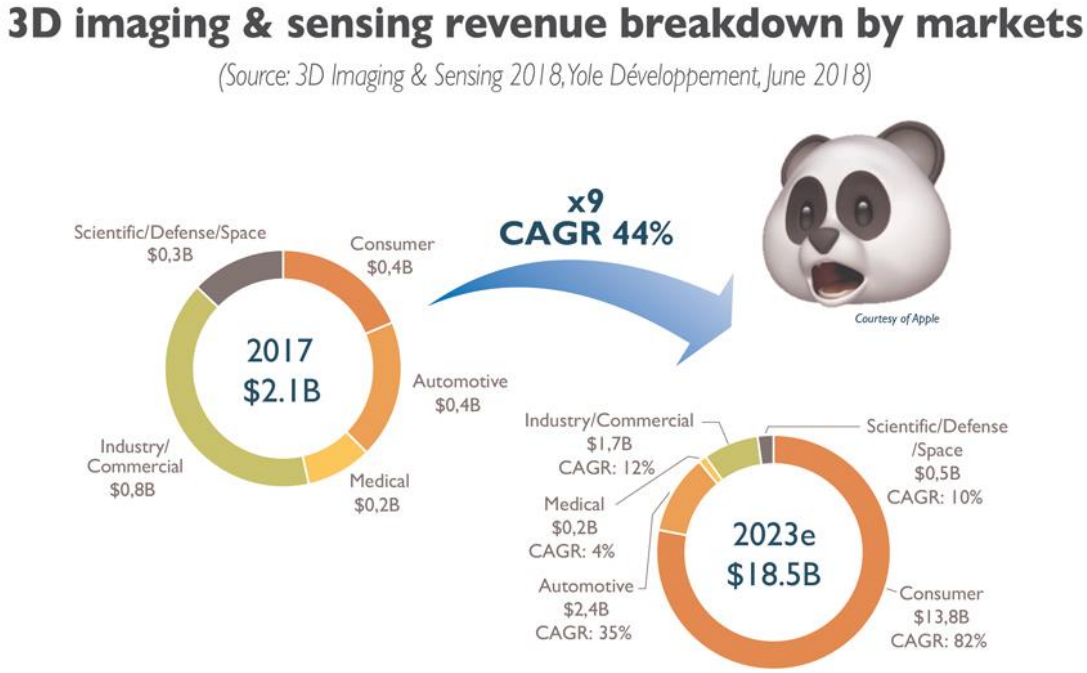
Creates a millimeter-scale 3D face depth map for safer unlock

Creates 3D stereo model of the face to perform 3D personality beauty

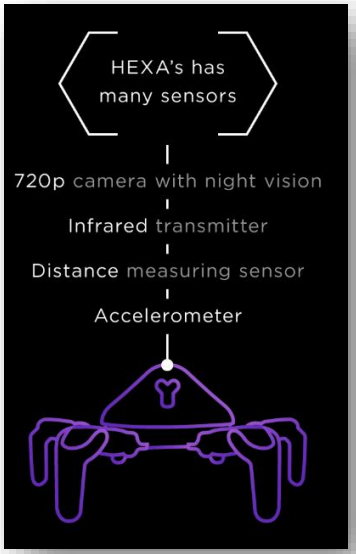
3D Vision Technology

3D vision is a key technology in the fields of human-computer interaction, face recognition, AR/VR, assisted driving, etc.

Automotive	Healthcare
Robotics	3D Scanning/Printing
3D Metrology	Gaming
Retail	AR/VR
Security	Smart Home



SLAM* (combined with AI)



https://www.vincross.com/hexa

(*) Simultaneous **L**ocalization **A**nd **M**apping

High Immersion

Cardboard

View-Master

Google Daydream

Samsung Gear

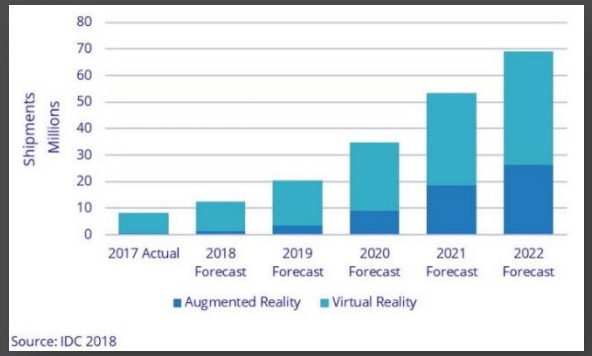
Sony Morpheus

Facebook Oculus

HTC Vive

Inexpensive

Expensive



Low Immersion

Oculus Quest

Magic Leap One

What do we Need to Make it Happen?

- VR market faces many challenges
- What do we need to “cross the chasm”?

Mobile VR Challenges

- Strong Computing Power
  - Connected to a PC
  - Latency issues
- Easy of use
  - Inside-out tracking
  - Power consumption
- Quality content

CEVA Imaging & Vision

Industry Recognition

Linley Group

- CEVA-XM4 awarded Linley's "Best Processor IP" in 2015

CEVA-XM4™

THE LINLEY GROUP ANALYSTS' CHOICE 2015 BEST PROCESSOR IP

Vision System Design

- CEVA-XM6 awarded “Innovator Gold Awards" in 2018

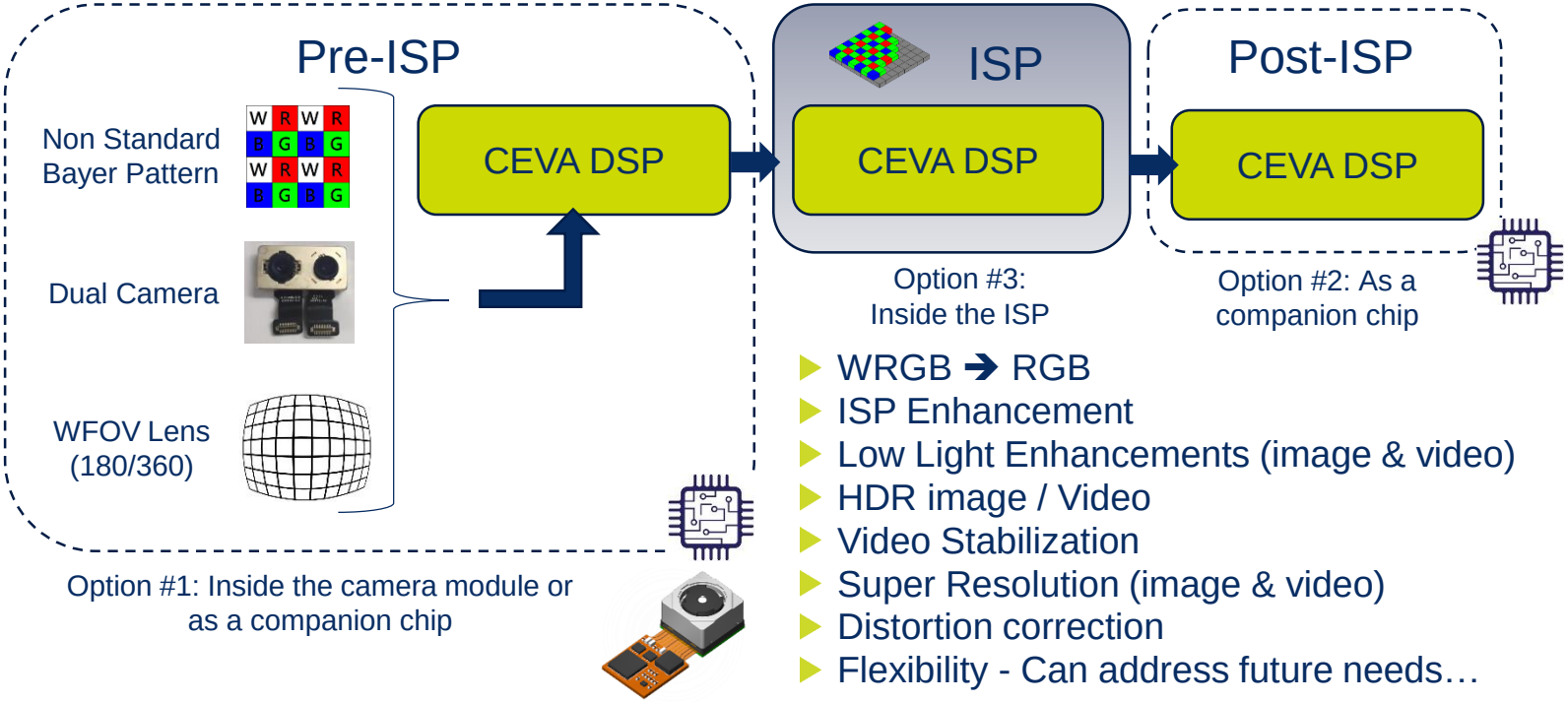
CEVA-XM6™

Vision Systems DESIGN 2018 Innovators Awards GOLD

Enable Comprehensive Vision and AI Solutions

- Computational photography and computer vision applications, delivering a human-like visual perception
- Intelligent processing applications, delivering a human-like smart devices
- Enabling power-efficient, intelligent devices for a range of end markets, including mobile, consumer, automotive, industrial and IoT

CEVA Vision and Imaging DSP as ‘Enabler’ for Better Image and Video Quality



- WRGB ➔ RGB
- ISP Enhancement
- Low Light Enhancements (image & video)
- HDR image / Video
- Video Stabilization
- Super Resolution (image & video)
- Distortion correction
- Flexibility - Can address future needs…

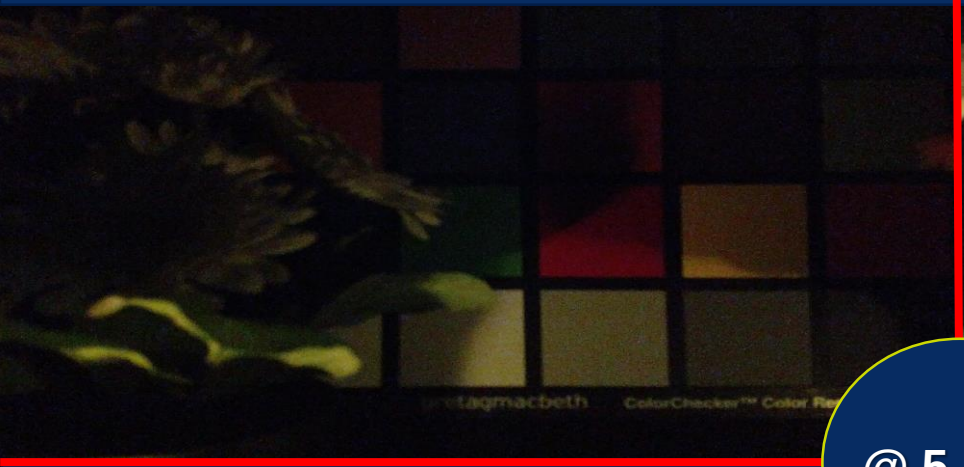
Rockchip RK1608

Technology Features

- Dual CEVA-XM4 @ 600MHz
- Frame based process, rather than line based in ISP
- Multi frame process, RAW domain, better quality than YUV domain
- Faster than AP process, 200ms process Multi frame de-noise
- No impact AF/AWB, just fine tune AE of ISP

http://www.rock-chips.com/a/en/News/Press_Releases/2017/0227/836.html

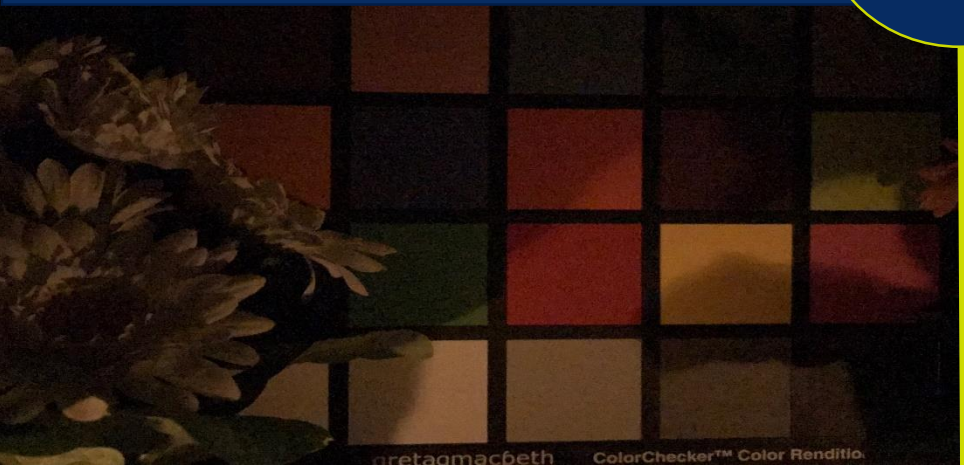
Motorola X



Galaxy S7

@ 5 LUX

iPhone 7 Plus

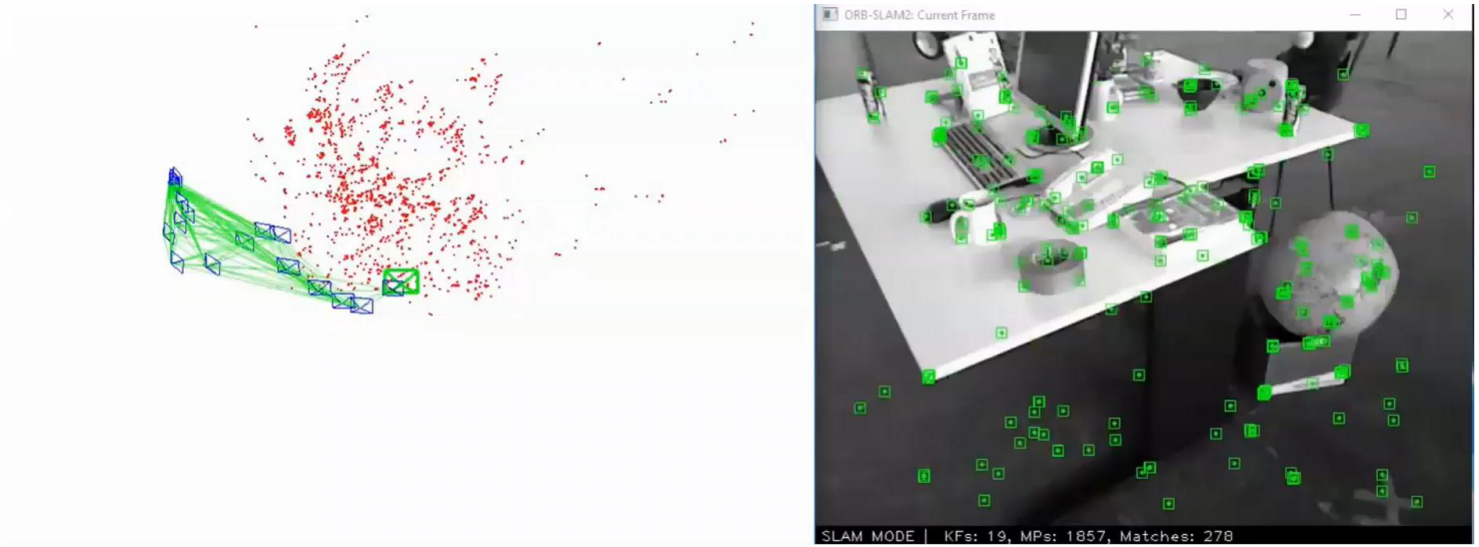


ASUS Zenfone 3 Zoom

SLAM Technology

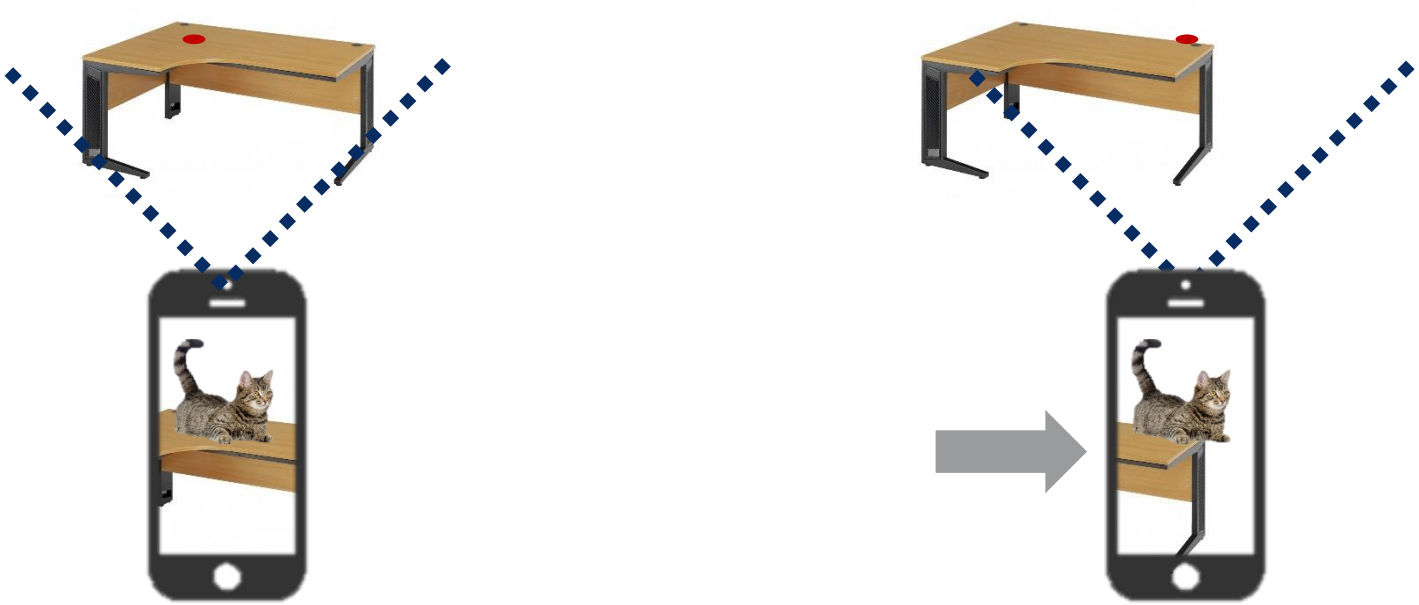
What is SLAM?

- **S**imultaneous **L**ocalization **A**nd **M**apping
- Find sensor position in space (6DoF) while mapping the environment



SLAM Technology

- In order for computer vision application to relate to the real environment the device must find it’s position in space accurately



Industry Using SLAM

- Mobile device localization
- Automotive
- Drones
- Enabler for AR/VR application
  - Apple's ARKit 
  - Google's ARCore 

SLAM is an essential technology for AR to accurately position virtual objects in tracked scenes

SLAM Solutions

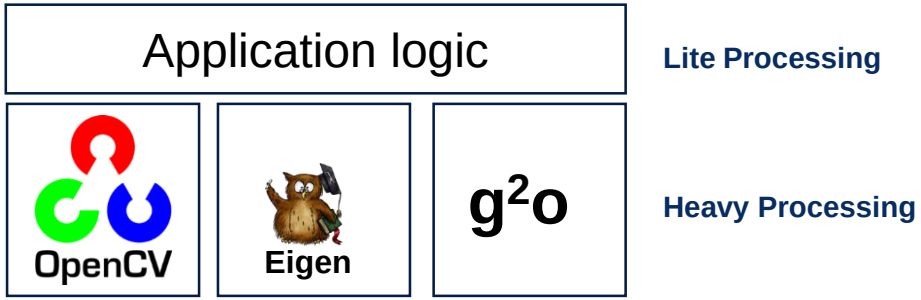
- Various visual SLAM solution vendors

AUGMENTED PIXELS

uSens Inc

VanGogh Imaging

- All share similar building blocks when it comes heavy processing
- Each vendor have it’s own propriety high level logic and tuning

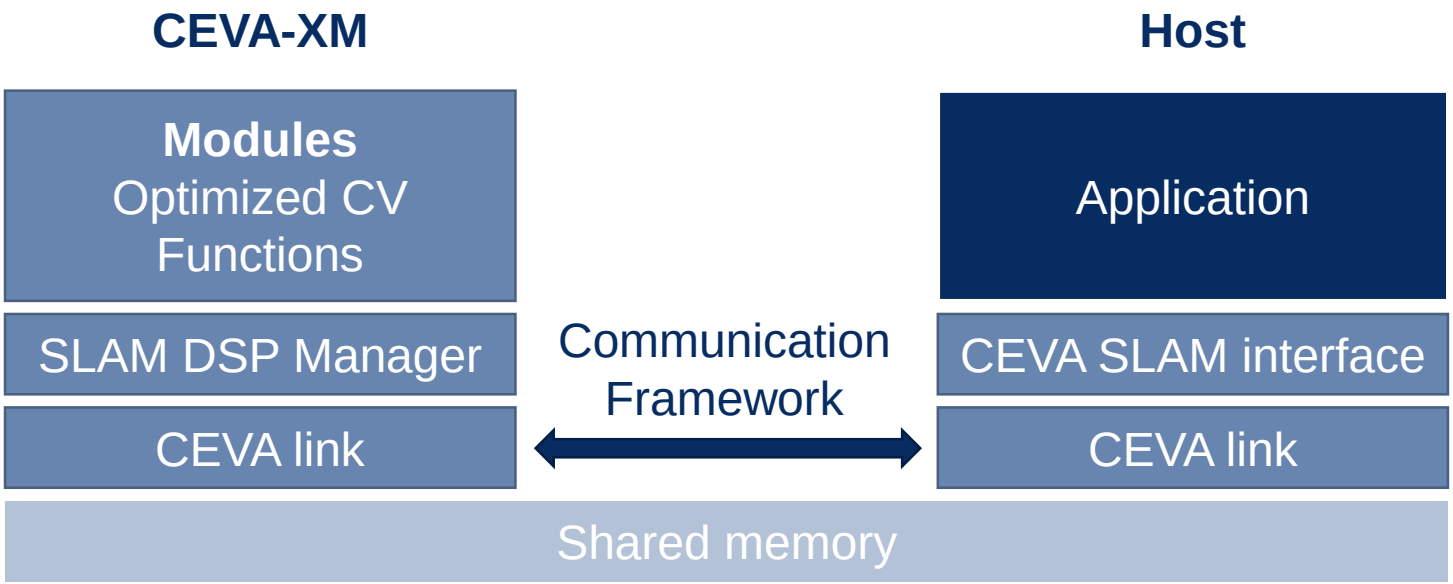


CEVA's SLAM SDK

- Accelerate heavy processing using efficient vector DSP
- Easy seamless integration with standard APIs
- Generic modules supports various sensors
  - Mono, Stereo, TOF
- Feature set
  - Image processing
  - Feature detection, extraction and matching
  - 3D point processing
  - Complex math operation

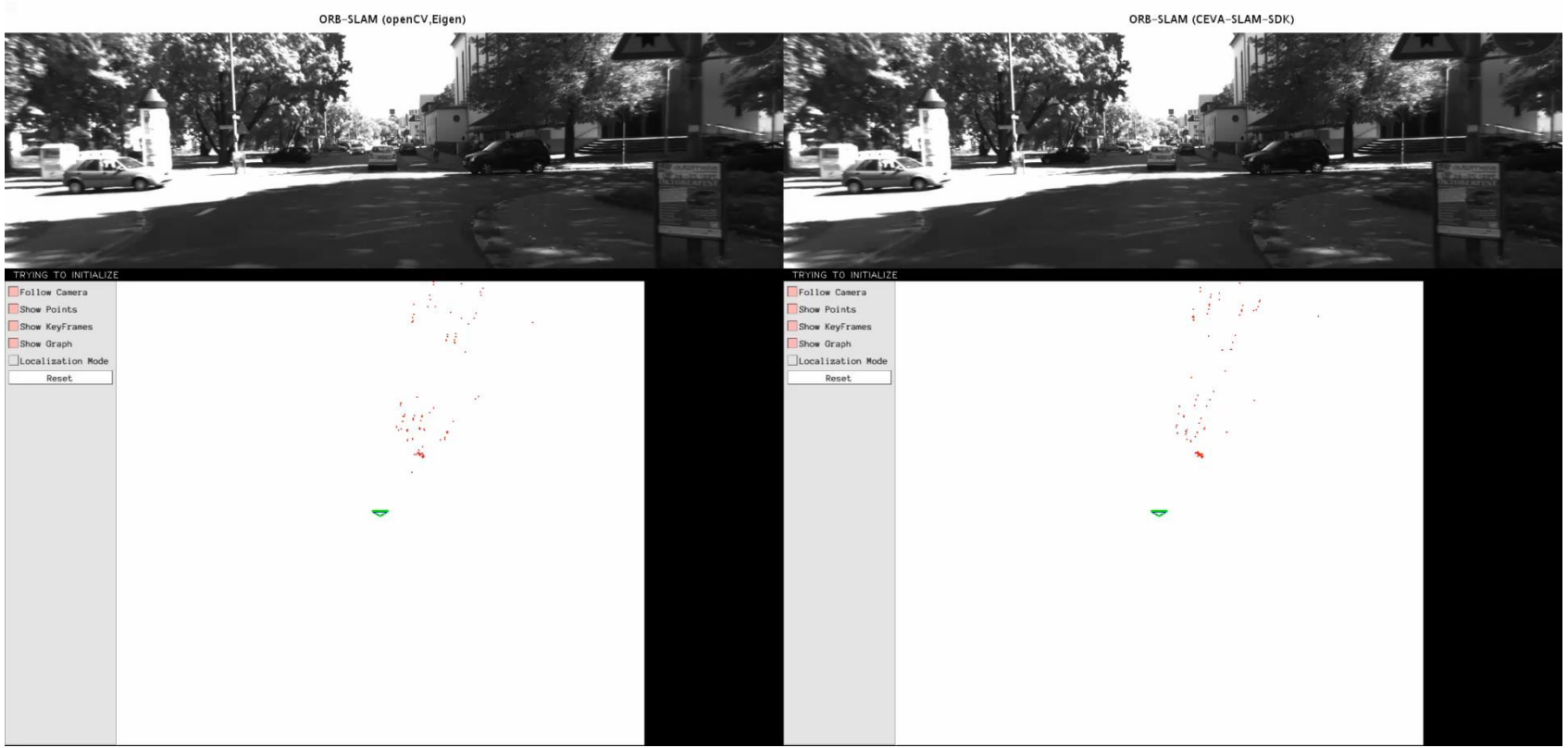
CEVA's SLAM SDK - Integration

- Two main deign goals:
  - Optimized CV functions
  - Easy integration with existing solutions – **Offload framework**



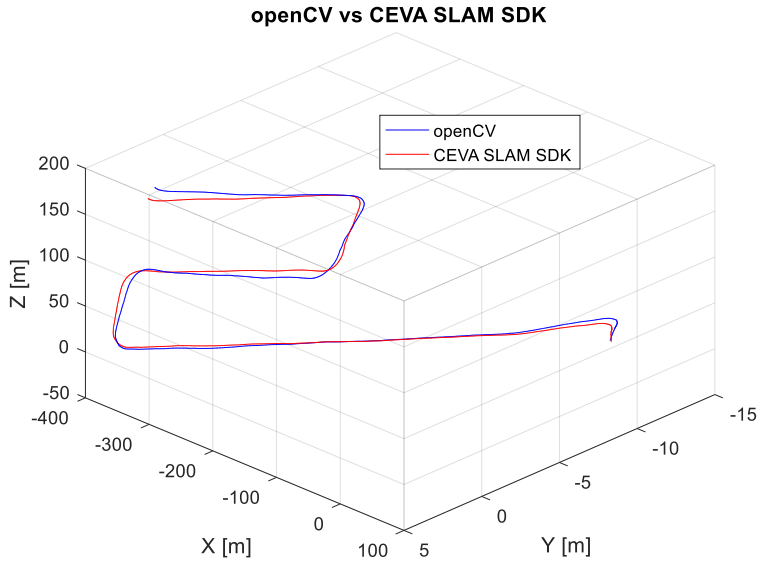
* Supplied by CEVA

Example – ORB SLAM2



Example – ORB SLAM2

- Accuracy Analysis
  - Trajectory



  - Error Statistics Analysis

Relative Error (% Of Range)	Open Source	CEVA SLAM-SDK
Mean	0.6	0.5
Median 50%	0.65	0.5
Median 90%	0.9	0.8

CEVA-XM is a Technology Enabler

CEVA

eyeSight™ core photonics KeyLemon

NVISO SENSETIME 商汤科技

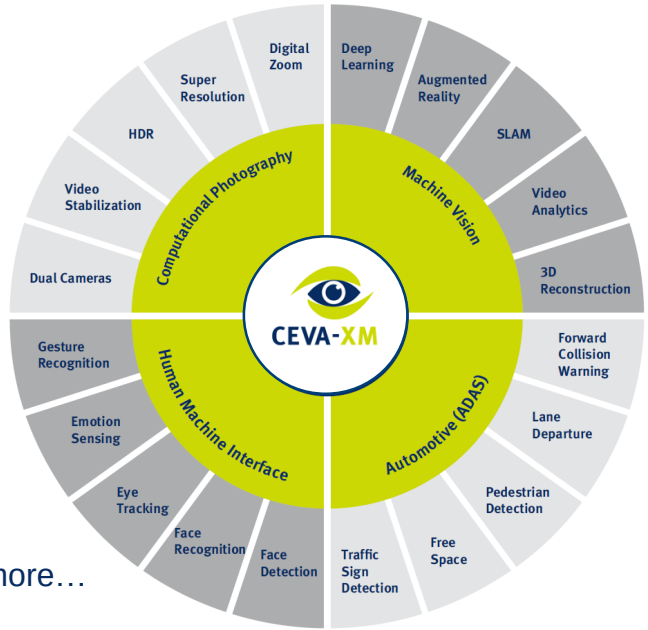
ArcSoft SoftKinetic The Interface is You

IntelliVision

STRADVISION DEEPGLINT 格灵深瞳 Brodmann

Morpho MMSolutions pilot.ai Pisofttech

Almalence 3DiVi VisionLabs MACHINES CAN SEE eyetech DIGITAL SYSTEMS



And much more…

CEVA's Software Ecosystem Enable Fast Time-to-Market

Thank You

Liran Bar, Director of Product Marketing,
CEVA

Email: liran.bar@ceva-dsp.com

www.ceva-dsp.com