



Compute + Sensing in robotics

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Robotics and AI Inflection Point

Market Drivers

- Labor Shortage
- Raising cost of labor
- Nationalized programs
- Population growth and aging
- Food scarcity
- Climate change
- Deglobalization
- VC funding

Robotics

Technological Advancements

- Confluence of four superpowers: **AI, Edge, Connectivity, Cloud**
- Advancements in XPU, CAD, Batteries
- Sensor market explosion
- Exponential progress in Machine Vision & AI
- Digital Twin

Growing investments in Robotics



\$775M acquisition of Kivas

[Link](#)



Expands enterprise solutions for drones and ground robotics

[Link](#)



Launched robotics firm Intrinsic

[Link](#)



\$1B acquisition of Boston Dynamics

[Link](#)



Partner with Symbiotic to bring robotics to 25 regional Walmart distribution centers.

[Link](#)



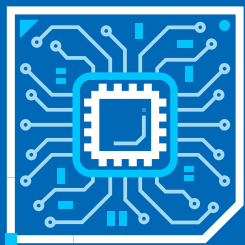
ABB to acquire ASTI mobile robotics

[Link](#)

We create world-changing technology that improves the life of every human on the planet.

Robotics embodies Intel's purpose and strategy

Powering Digital Disruption



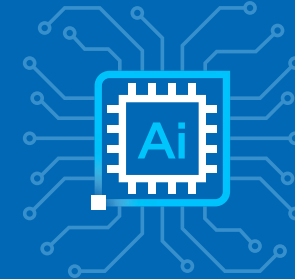
Ubiquitous Compute



Pervasive Connectivity



Cloud to Edge Infrastructure



Artificial Intelligence

What is a Robot?



Industrial robot* is defined to be an “automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications.”



“Service robot” is a robot “that performs useful tasks for humans or equipment excluding industrial automation applications”.



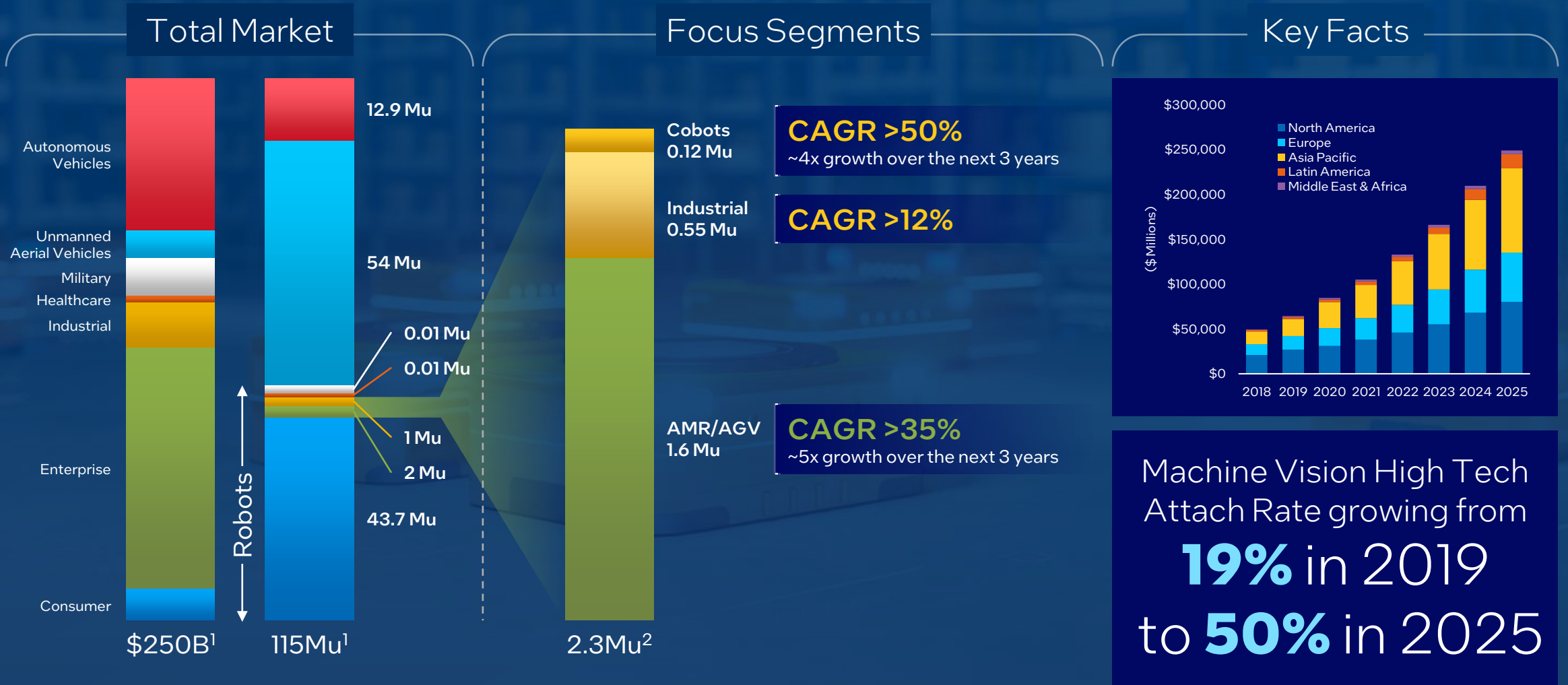
What is *not* a Robot:

Software (bots, AI, Robotic Process Automation RPA) | Remote-controlled drones, UAV, UGV, UUV | Autonomous cars

www.intel.com/robotics

*As defined by the International Federation of Robotics, ISO 8373

Market Perspective in 2025



Source: 1. Robotics and autonomous machines market forecast, OMDIA Q3'20; 2. Commercial and Industrial Robotics, ABI, Q3'20

Robotics Categories and Industry applications



Industrial Robot

No human interaction
Fenced/Caged
Programmable



Fixed Articulated Robots



Pick/Place

Assembly, Cutting, Drilling,
Sealing, Welding, Polishing



Cobot

Work beside human worker
May require guarding
Programmable



Assembly, Dispensing
Machine tending, Labeling
Pick and place, Packaging



Autonomous Mobile Robots (AMR)

Mobile
Semi or fully autonomous
No guarding



Wayfinding



Palletize &
depalletize



Pick & place



Security patrol



Cleaning/
Disinfecting



Indoor delivery



Outdoor
delivery



Tele-presence



Mobile kiosk



Data
collection

Industrial | Warehouse | Logistics | Retail | Hospitality | Healthcare | Smart Cities

Robotics Industry Challenges

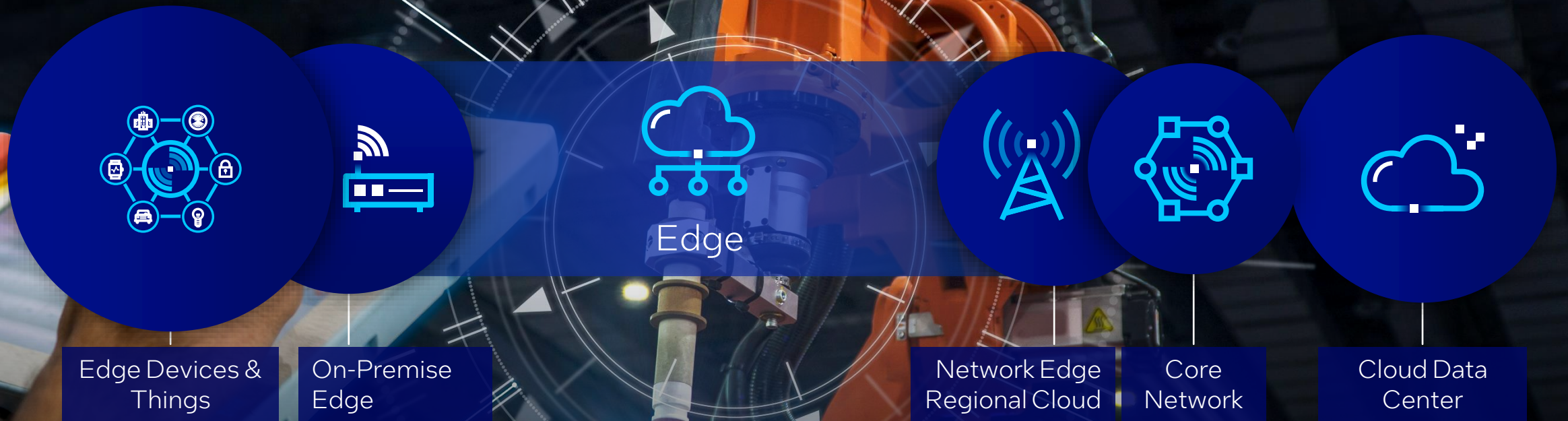
Business

- Efficient operations at enterprise level
- CAPEX/TCO
- Business intelligence/systems integration
- Democratize robotics application development
- Robotics skills/expertise
- Ecosystems at scale

Technical



- E2E unified SW environment
- Building scalable manageable and secure systems
- Interoperability
- Flexibility and choice
- Continuous integration of new capabilities into existing workflows
- Configurability: robot settings->applications
- Vendor agnostic open standards
- Repeatable solutions

End-to-end Vision for Robotics



End-to-End Solution:
Robot, Edge to Cloud Including SW, Integration, and Service Opportunities!











Intel Value Proposition for Robotics Partners

<p>Account management</p> 	<p>Ecosystem</p> <p>Ecosystem Partners for IoT</p>  <ul style="list-style-type: none"> ▪ ODM ▪ ISV ▪ GSI ▪ End Customer ▪ OEM ▪ OTSI ▪ CSP <p>Marketplace</p> <p>MRS RRK Sol Agr</p>	<p>Vertical expertise and engagements</p> <ul style="list-style-type: none"> ▪ Industrial ▪ Manufacturing ▪ Retail ▪ Hospitality ▪ Banking ▪ Education ▪ Health and Life Sciences ▪ Smart Cities and Transportation 	<p>Investments and mentorship</p> <p>intel capital intel ignite</p> <p>Research</p> <p>intel labs</p>	<p>Events</p> <p>intel innovation</p> <p>intel VISION</p> <p>Consortia</p> <p>IFR International Federation of Robotics</p>
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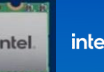



Intel® Developer Catalog

	<p>1</p> <p>oneAPI</p>	<p>Edge Insights for Industrial (EII)</p> <p>Edge Insights for Autonomous Mobile Robots (EI for AMR)</p>	<p>Edge Controls for Industrial (ECI)</p>	<p>Intel® DevCloud</p> 	<p>FPGA Design Tools Including Intel® Quartus® Prime Software</p>
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Capabilities

 <p>Use Conditions</p>	 <p>RealTime</p>	 <p>Functional Safety</p>	 <p>Industrial Networks</p>	 <p>Long Product Lifecycle</p>	 <p>HW Security</p>	 <p>HW Assisted Virtualization</p>	 <p>Remote Manageability</p>	 <p>AI Inference</p>	 <p>AI Training</p>
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SCALABLE COMPUTE (Intel® XPU)

											 
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Intel Robotics Solutions

Robot Reference Controller



Highly integrated robot controller design combining Real Time Motion Control, HMI and Functional Safety

Robot Vision & Control Platform



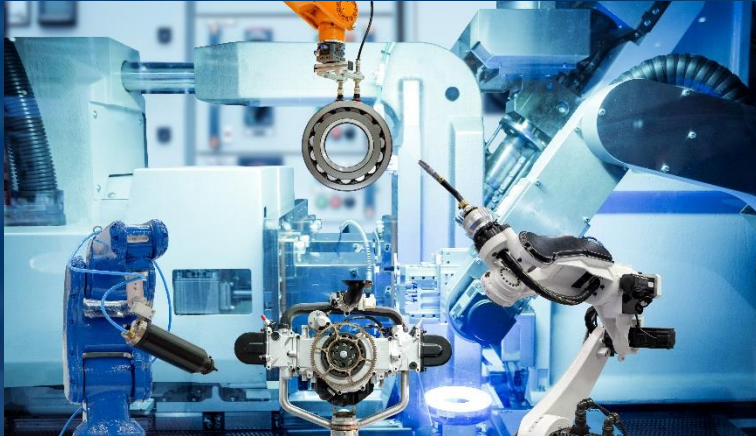
Unified Platform that combines Vision/AI, Real Time Control and Functional Safety

Autonomous Mobile Robot Reference Platform



Reference design and open, modular SW platform for autonomous mobile robot applications

Current Intel Key Software Offerings for Robotics



Edge Insights for Industrial

Support advanced AI workloads for product quality, predictive analytics + industrial automation



Edge Controls for Industrial

Accelerate the transition from fixed-function industrial control systems to SW-defined solutions



Edge Insights for Autonomous Mobile Robots

Accelerate robotics solutions development + microservices from Robot to Edge Server to Cloud

Get a head start with our free, open reference implementations

www.intel.com/robotics

Sensing in Robotics using Real Sense

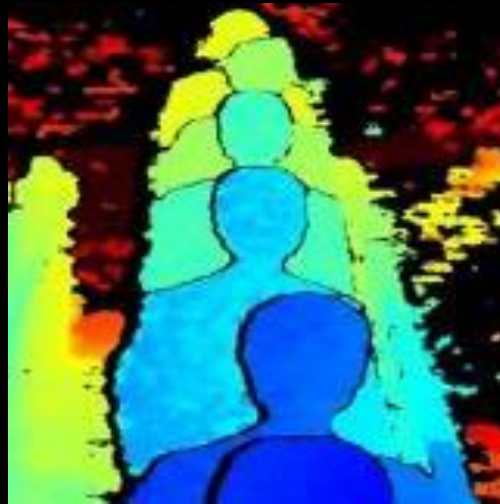
Intel Robotics Innovations

- Overview of Compute Platforms for Robotics
- Vision and Depth Cameras
- Key Market Segments
- Retail Innovation Uses Cases
- Intel RealSense Portfolio
- Q & A

Why 3D and Depth Are Important



2D Color image showing an optical illusion



Depth Image shows individual objects and their position

Faux color represents range to object (red=far, blue=near)

3D depth cameras provide information that 2D cameras are unable to deliver without extensive AI and modeling support.

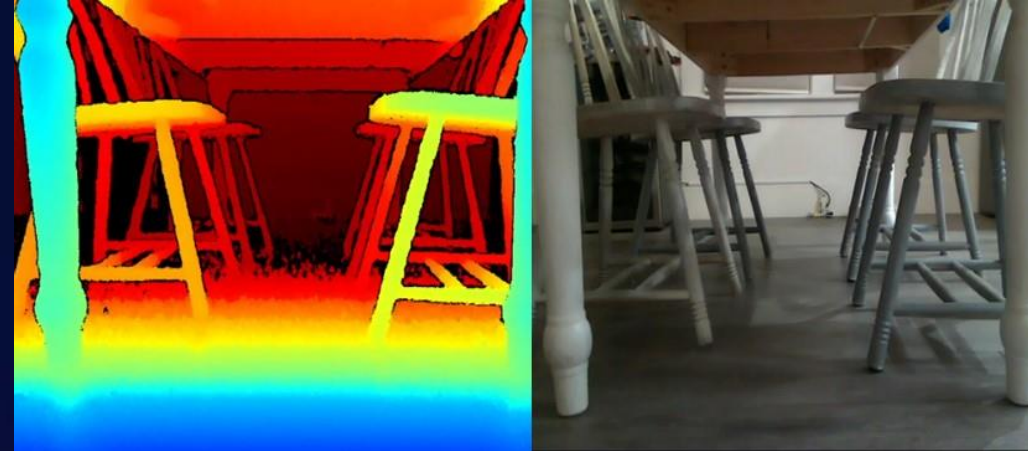
Depth cameras provide real-time depth and RGB information about every point or pixel.

This provides a device with human-like vision, enabling movement or scene understanding in any environment.

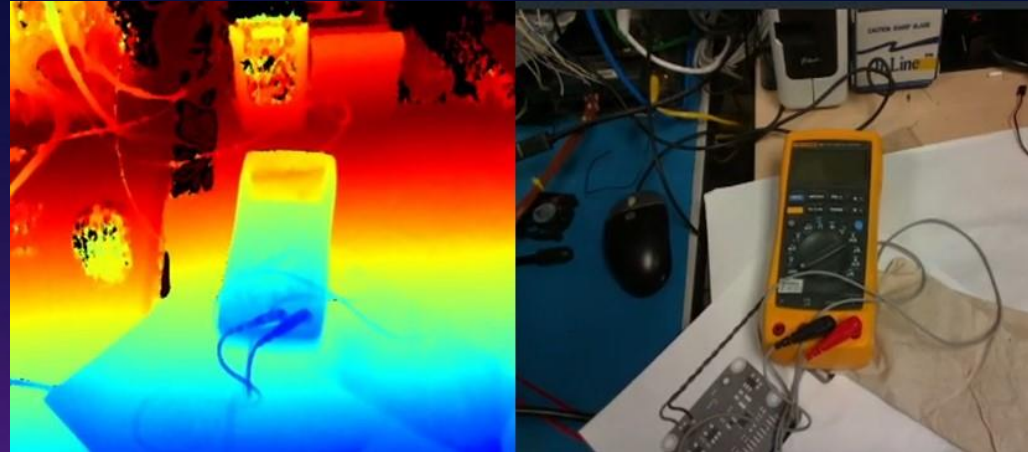
Where Depth Data Provides Advantage

Depth data communicates distance, enabling:

- Better collision avoidance for robots
- Multiple cameras increase accuracy without interference
- Better inference data improves machine learning
- Reduced compute time with on board vision processor
- IMU synchronized with depth for VSLAM
- Enables Tracking of Customer Flow or Robots
- Training applications for object recognition



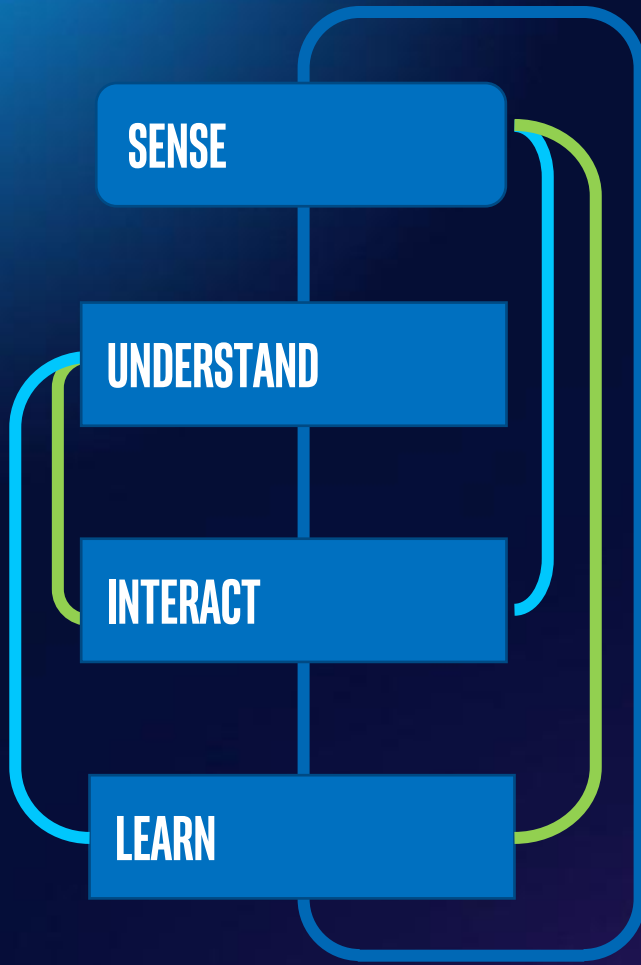
Obstacle Detection & Collision Avoidance



Object Recognition

Faux color represents range to object (red=far, blue=near)

"Mimicking" the Human Perceptual System



intel
REALSENSE™
3D VISION SENSORS



VISION & AI
PROCESSING
UNIT

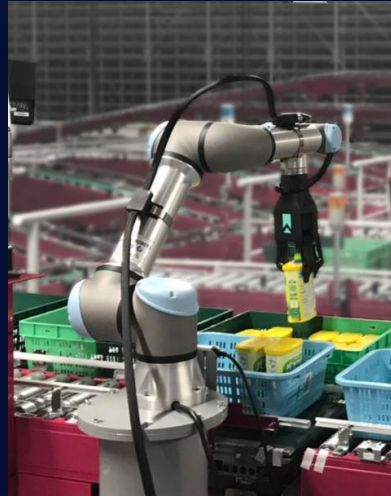
Market Segment Use Cases



3D Sensing Brings Value to Variety of Market Segments



Facial Authentication



Robotics AMRs

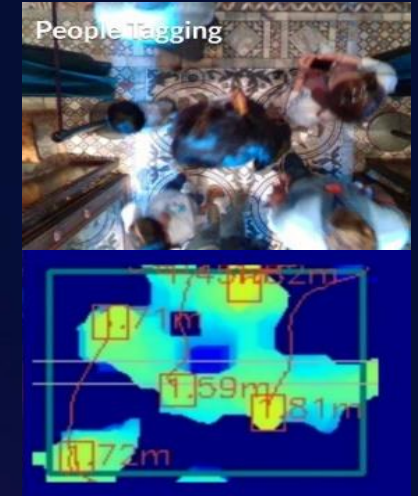


Scanning



Identifying Measurements
306 x 256 x 208 mm
Measuring Container

Measurement and Logistics



Recognition and Interaction

Intel RealSense enables a wide range of retail applications in these Market Segments

Retail Store Applications

Instore Inventory Robots



Autonomous Mobile Robots (AMRs) navigate and scan aisles to order replenishment inventory

Interactive Video Walls



Intel RealSense Depth Cameras enable gesture recognition for video wall interaction with customers

Retail Logistics Applications

Warehouse Logistics



AMRs move inventory in fulfillment centers to improve efficiency, reduce cost and minimize mistakes

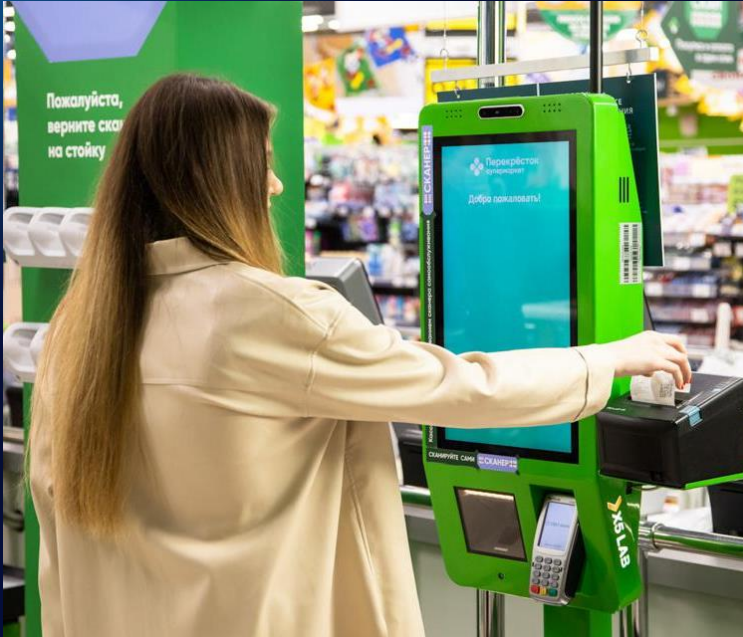
Pick & Place Fulfillment



Robotics arms enable a single fulfillment center worker to manage multiple pick and place packaging stations

Retail Payment Applications.

Self Checkout



Depth Cameras are used in Customer Facial Authentication for payment authorization and Object Detection for Self Checkout

Cashierless Stores



Ceiling mounted depth cameras enable customer tracking and shelf mounted cameras can detect products for frictionless purchases

Hospitality and Retail Tracking

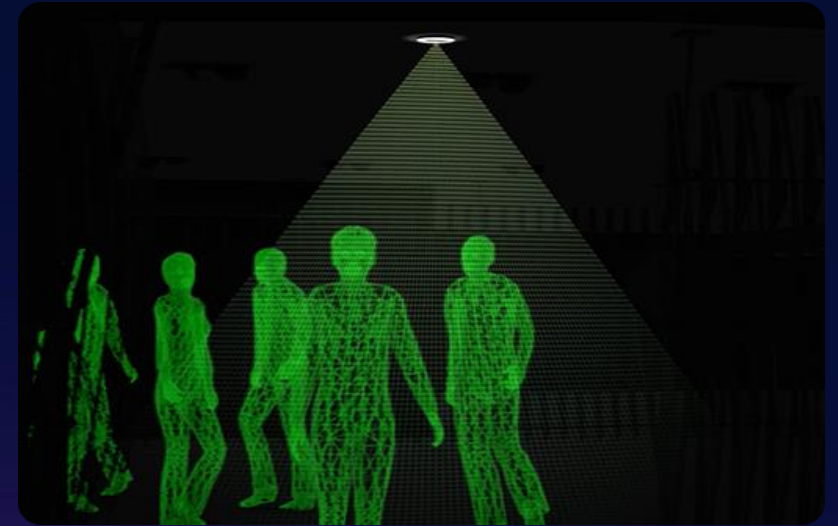
Restaurant / Hospital Delivery



AMRs can replace food runners or delivery people in Restaurants, Hotels and Hospitals



Shopper Tracker / Traffic Flow



Ceiling mounted depth cameras enable a wide range of retail analytics applications in real time traffic flow, monitoring dwell time, customer tracking and can estimate age/gender of customers

Cleaning Robots

Disinfecting Robots



UV-C Disinfecting AMRs can move through Hospital rooms, Hotel Rooms, Retail Stores and Restaurants to eliminate pathogens quickly and safely

Floor Robots



AMRs can vacuum or scrub and wax floors in Shopping Malls, Retail Stores, Airports and Restaurants

Intel® RealSense™ Portfolio



New Intel® RealSense™ Portfolio

Stereo Product Line

Indoor/Outdoor/Multiple Devices
USB Peripherals and Module

Peripherals

“Plug and Play”



D455

.6m-6m (Ideal Range)



D415

.5m-3m (Ideal Range)



D435

.3m-3m (Ideal Range)



D435i (IMU)

.3m-3m (Ideal Range)

Modules

“Embedded”



D450

ASIC Board V1, V3



D410

D415



D430

New Stereo – D405

Indoor/Outdoor/Multiple Devices
USB Short Range

Close-in, wrist-
mountable
small stereo
camera



D405

7cm-50cm*



D401

Module

Intel® RealSense™ SDK 2.0

Open-source
cross-platform
Software
Developer’s Kit
library
for all Intel®
RealSense™
cameras and
modules

Download from
github



Why Intel® RealSense™ Technology?

Industry-leading Depth-sensing Technology

12+
years

developing and
selling vision
processing
technology

3M+
units

shipped and
designed
into working
solutions

Intel® RealSense™ Technology

- Multiple stereo-based products to align to your specific needs
- On-board vision processor for calculation of depth
- High quality, competitively priced depth cameras
- Designed into a wide range of retail applications worldwide

Intel® RealSense™ Software

- **Intel® RealSense™ SDK 2.0** is open-source software supporting all our cameras in many OS, ROS, and languages
- Easy integration with 3rd party software providers

Partner with
Intel® to create
robotics
solutions of
tomorrow.



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Thank you

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