FlightSense™

Applications Enabled by ST's Time-of-Flight Technology

Imaging Division

John Kvam – john.kvam@st.com

life.augmented

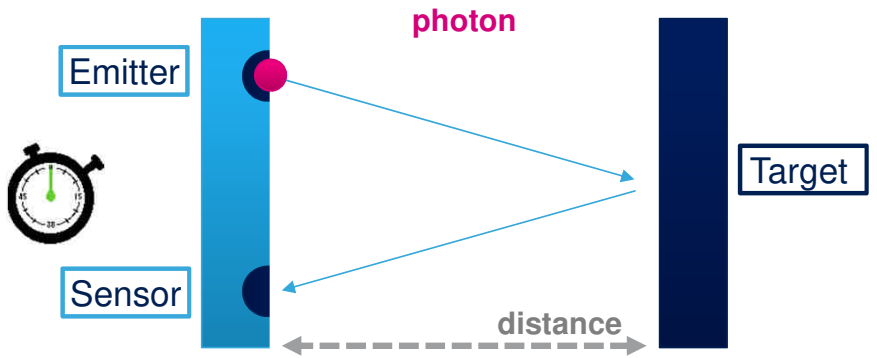
Technology Tour 2019

Minneapolis, MN | October 24

Flightsense™ Breakthrough Technology

Measurement at the speed of light!

FlightSense™ Principle



Measured distance = Photon travel time / 2 x Speed of light

Key benefits:

Direct distance measurement
Independent of target size, color & reflectance

Fully Integrated Time of Flight Module
ST #1 World Wide Supplier

Very fast (few ms)

Low power

Light is 1 million times faster than sound!

life.augmented

Flightsense™

Optical Time-of-Flight Product Family

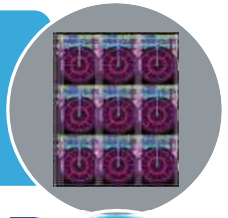
ST is Worldwide
#1 ToF supplier

Proven track record in manufacturing

>800Mu products shipped

300% AAGR

Single Photon Avalanche Diode
Ultra fast time resolution enabling Direct ToF processed in ST CMOS SPAD process



ST Proprietary Time-of-Flight IP
Best compromise of cost, complexity & power vs performance

All-in-one system
Sensor, filters, optics, VCSEL and driver integrated
Fully calibrated system

Optimized and reliable supply chain
High volume & low cost

life.augmented

FlightSense™ Product Longevity

7-years Commitment Extended

FlightSense™ benefits from ST Longevity Program

- 7-years **MORE** longevity starting from Jan 1, 2019
  - VL6180
  - VL53L0X
  - VL53L1X

life.augmented

F**light**Sense™ Product Descriptions

life.augmented

FlightSense™ Mass-Market Products

VL6180X

- 1st Gen FlightSense™ Sensor
- Proximity/ALS sensor up to **60cm**

VL53L0X

- 2nd Gen FlightSense™ Sensor
- Ranging sensor up to **2m**

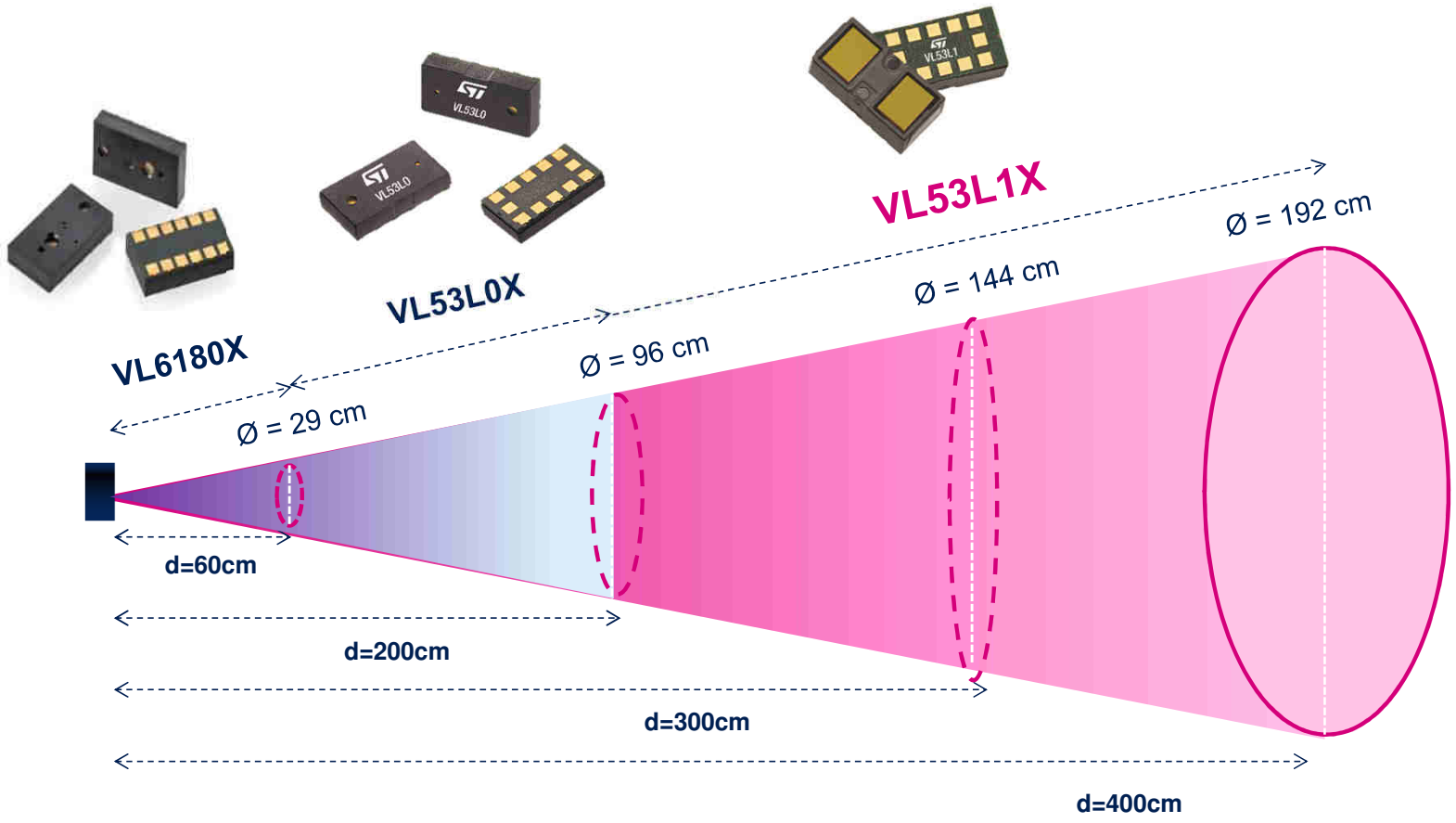
VL53L1X

- 3rd Gen FlightSense™ Sensor,
- Ranging sensor up to **4m**, with programmable **FoV**

Main use-cases: **proximity, distance measurement, user / object detection, robotics, lighting control, basic gesture…**

life.augmented

Detection Cone

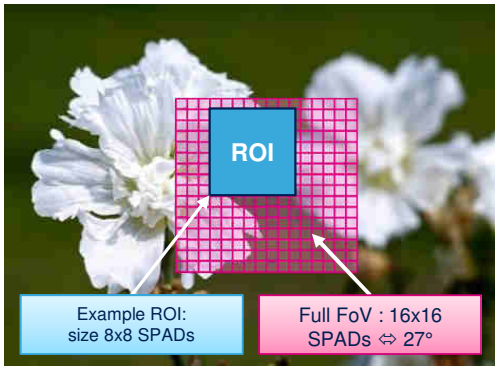


life.augmented

VL53L1X

Custom Field-OF-View (FOV) aka Custom ROI

- No fixed pre-defined size for the sensing array (Region of Interest)
  Unlike other sensors on the market or VL53L0X
- Sensing array is composed by 16x16 SPADs (Single Photon Avalanche Diodes) that **can be selected by customer**
- VL53L1X returns the distance to object covered by the ROI FoV
- **User defines the 2 corners of the array**, through SW driver (API) or the Eval Kit GUI.
  It could even be rectangular. Only condition is to have a minimum of 4x4 SPADs array.
- The change of ROI can be done “on the fly” by the host



Changing the ROI by software allows to virtually reduce the FoV

Please come at our demo stand,
you can see SmartShelves application based on custom ROI

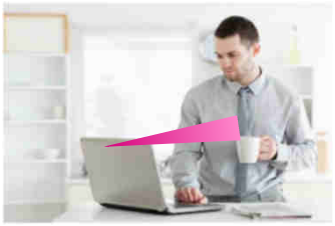
life.augmented

VL53L1X

Autonomous Low-Power User Detection

Save Power When No User Detected, and Easily Wake-up Your Device for <1mW

- The ToF sensor must consume as little as possible, just to detect if someone is approaching the device in sleep mode
- VL53L1X includes an Autonomous low-power mode, specially defined for this application



Embedded low-power MCU

- **Programmable** thresholds and repetition rate
- **Autonomous** state machine in VL53L1X
- Once target detected, an interrupt is sent on GPIO1 pin to wake-up the host (no need of i2C)

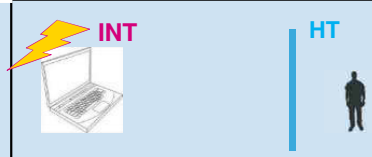
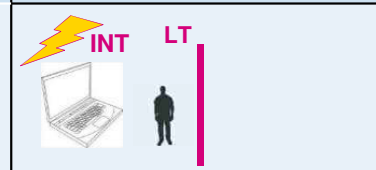
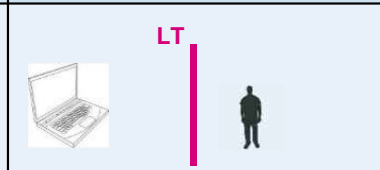
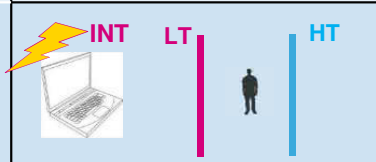
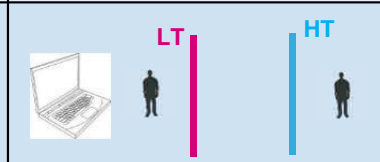
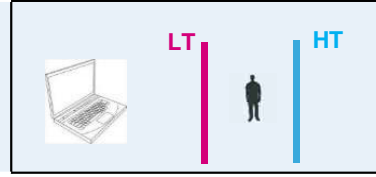
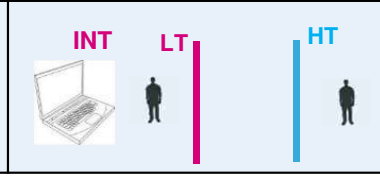
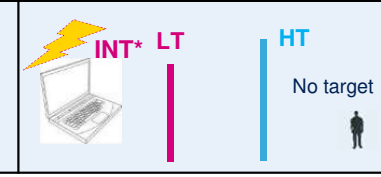
Example of Energy Saving:

- **VL53L1X in low-power autonomous mode: 0.9mW** (1Hz, 20ms ranging operation)
- Tablet (iPAD3): Active: 40W, Sleep Mode: 0.4W
- Laptop (iMAC 27”inch): Active: 80W, Display off: 20W, Sleep mode: 1W

life.augmented

VL53L1X

Autonomous Mode & Thresholding

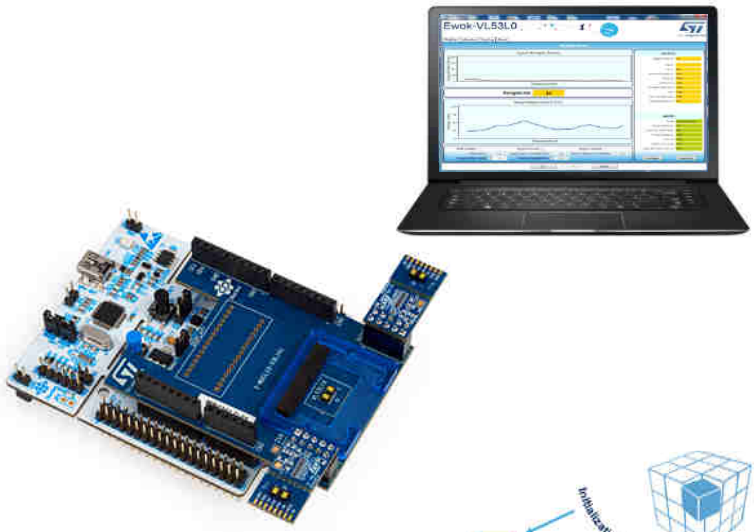
Threshold condition	Human & device situation and Interrupt raised by VL53L1X		
“Above HIGH” (> High)			
“Below LOW” (< Low)			
“In Window” (>= Low AND <= High)			
“Out of Window” (> High OR < Low)			

INT* (optional interrupt), customer choice

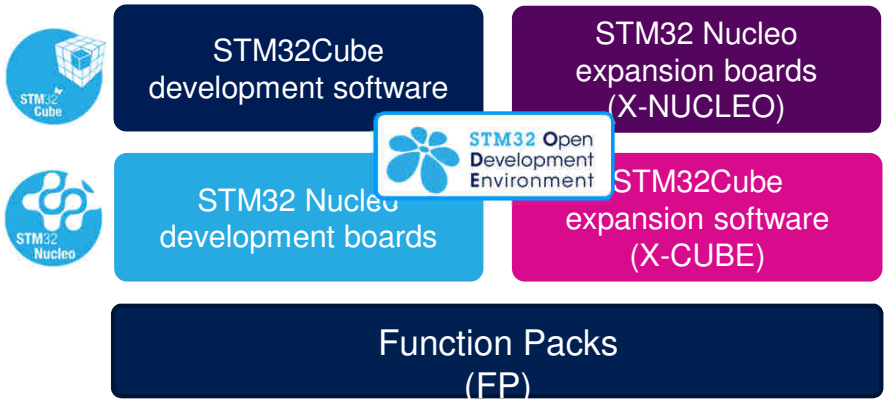
life.augmented

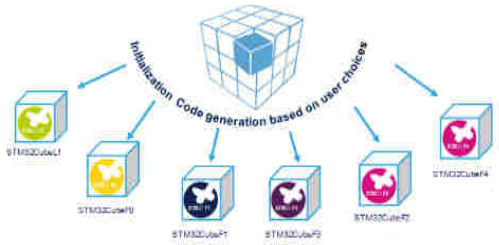
Complete Development Tools

- STM32 NUCLEO boards and GUI



- STM32 Open Development Environment





CUBE-MX SW Package

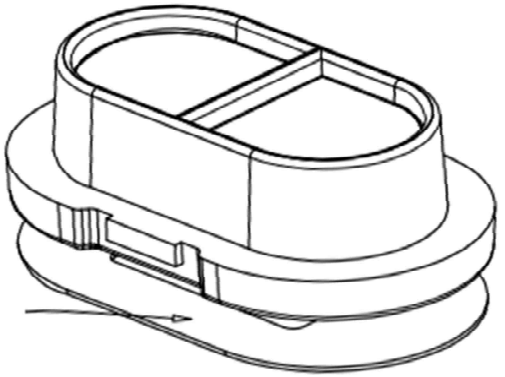
life.augmented

Accessories Updates

- Hornix Announces a new coverglass optimized for dusty environments.
- This completes its coverglass portfolio for FlightSenseTM products

www.hornix.com.tw

Coverglass designs for VL6180, VL53L0X & VL53L1X



life.augmented

Endless New Applications

Drones

PC & Tablet

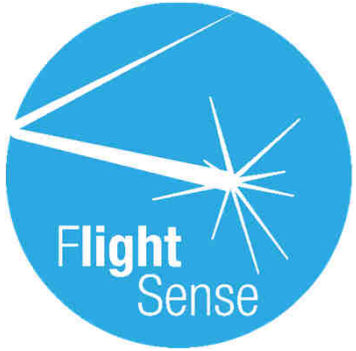
Vacuum cleaners

Sanitary

Smart home

Printers

Medical



Service Robots

White Goods

AR/VR

Industrial

Wearable & IoT

life.augmented

FlightSense™

… making light work

Camera Assist

- Instant focus
- Scene understanding
- AWB & light flicker rejection

Face Identification Assist

- Face anti-spoofing
- Cost, power, size optimized
- All-in-one depth sensing

Presence, User Detect

- Security
- Comfort
- Power saving
- Eye protection
- Wellness

Ranging & Proximity

- True distance
- Up-to 4m
- Robotics
- Storage load
- Vending machines
- Lighting control
- Sanitary

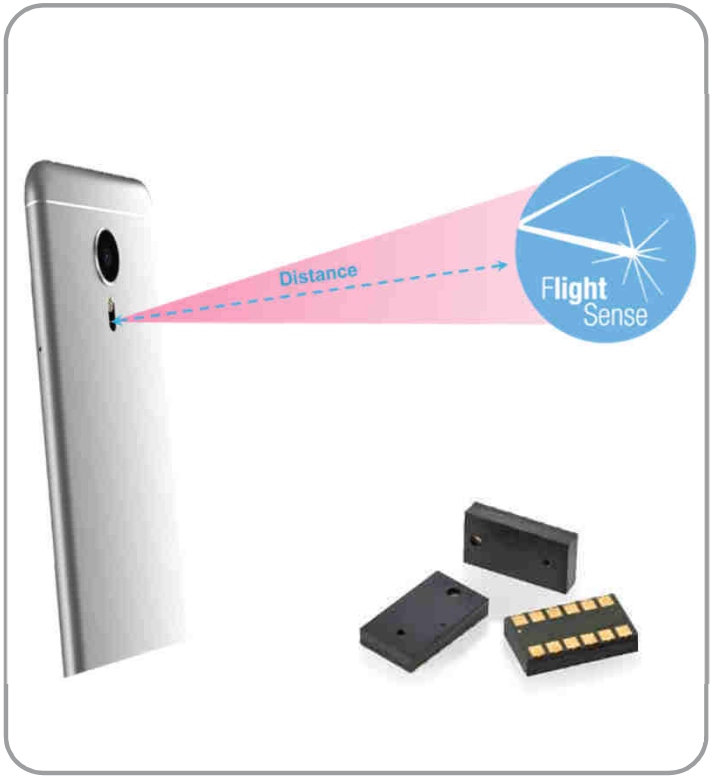
Gesture

- Power, size & performance
- New ways to interact
- White Goods
- Home appliances

life.augmented

Auto Focus Camera Assist

Smartphones



Typical functions

Almost “instant focus” over full focus range

Most of our 800M units go into this market

Cheek detect
Immediate screen on/off disable hang-up

Auto focus assist
Fastest solution for low light & low contrast scenes

life.augmented

FlightSense™ Use-cases

Presence Detection

A rising use-case in Personal Electronics & Industrial

Typical functions

Security
Immediate log-off or lock, log-in assist

Power saving
Immediate screen on/off

Eye protection
Warning when user is too close from screen

Audio/User interface enhanced control
Adjust mic/speaker mode based on distance

Simple and robust gesture
Tap & Swipe

Human vs Object

life.augmented

Presence Detect

Typical use

While in shutdown, the Sensor pings once or twice a second looking for a user.
When the user shows up, the Sensor sends the PC a wake-up
When the user goes away, the Sensor sends a sleep command to the PC
And so ends <cntl><alt><delete>

Key Tech Advantage

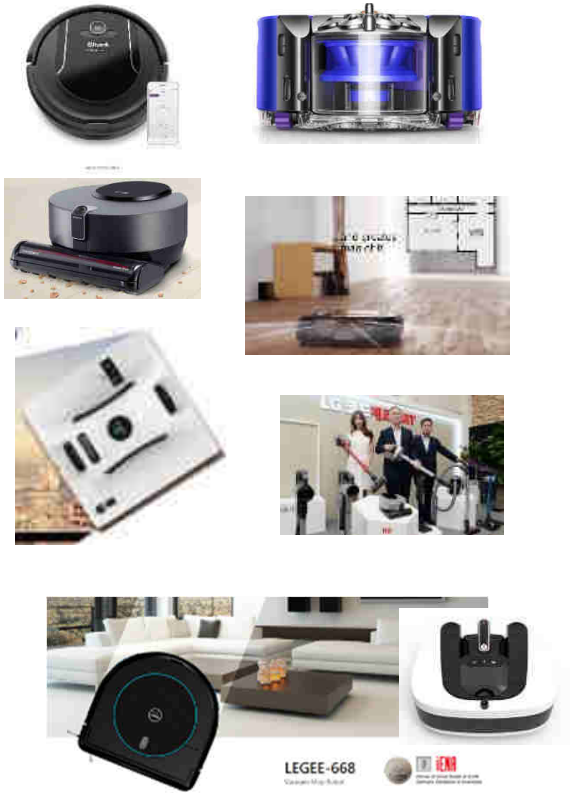
What happens if someone puts a chair in front of the sensor?
Chairs don't breathe! And we can tell.

life.augmented

FlightSense™ Use-cases

Robotics

Service Robots



Vacuum Cleaners

Typical functions

Security
Cliff detection

Detection
Wall tracker
Obstacle & object detection

life.augmented

Robotics - continued

Mistyrobotics.com

Typical use

Robots need sensors

- Forward looking to avoid walls and chair legs
- Backward looking to locate the charger
- Drop sensors to keep from falling down the stairs

But the big deal is how cheap the sensors are

- Cameras cost money, and need big CPUs to interpret the data.
- A ToF sensor, delivers distances and an alert. No programming required.

Key technical Advantage – Small enough to put anywhere.

life.augmented

FlightSense™ Use-cases

Drop Sensor

Typical use

Safety

All those robotic vacuum cleaners have trouble with stairs.
To keep the robot from falling, a ToF sensor is used to insure there is still a floor in front of the wheels.
The faster the sensor goes, the faster the vacuum can go.
And with a little help from a coverglass, we are not affected by dust – much.
Key Technical Advantage

speed

life.augmented

FlightSense™ Use-case

Smart Home - Sanitary - White Goods











Typical functions

Touchless operation
Presence or action detection

Power saving
Timely operation/ display on/off

Light adjustment
User convenience and comfort

User interface enhanced control
Objects detection

Simple and robust gesture
Tap & Swipe

life.augmented

Completely Automatic Bathroom

Things you know about
auto-flush toilets
automatic faucets
automatic towel dispensers

New ideas
Mirrors that light up when you look into them
Auto opening garbage cans
Shower heads that cut down the flow when you step away to soap up.

Key technical advantage
Battery life

One really cannot connect 110v to a faucet

life.augmented

Consoles and Thermostats

Typical Use

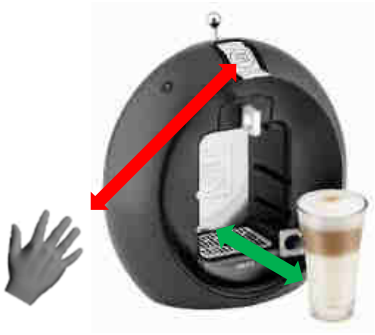
There are a whole class of things that should remain off until someone wants to interact with them.
A thermostat in a bedroom should really be dark, unless one wants to change something.
But how to find it in the dark?
Just wave at it or come close, and it automatically comes alive!

Key Technical Advantage

Field of View.
You don't have to know exactly where it is, just get close - near.

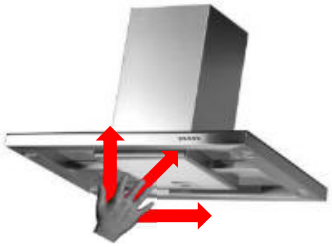
White goods

Basic gesture control & proximity sensing



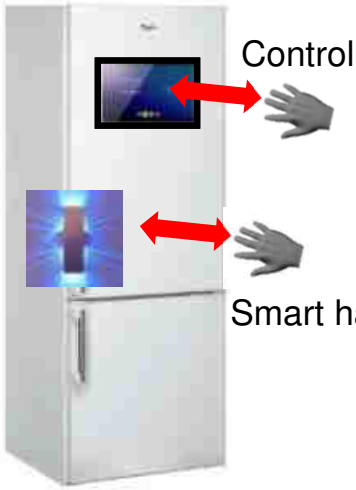
Coffee machine

- Filling level
- Positioning of cups
- Water tank level



Vent hood

Cooking machine



Control panel

Smart handles

Typical functions

Innovative Human Interface
No physical touch necessary
No touch panel needed
Special button application
No transfer of dirt, dust, liquids, eggs or dough to the user interface

Key Tech Advantage

No touch

life.augmented

FlightSense™ Use-cases

Drones - Toys










Typical functions

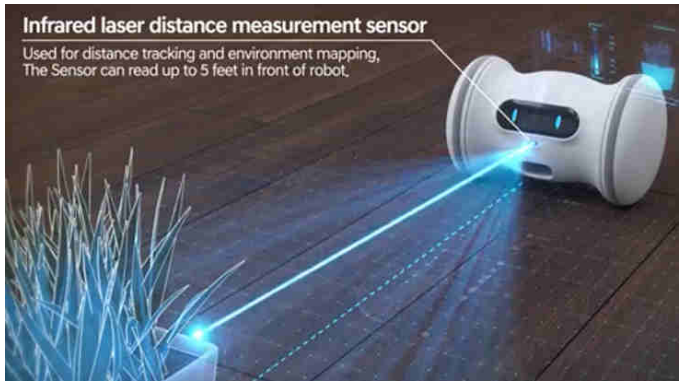
Detection

Obstacle & object detection

Floor/Ceiling detection

Sensing

Environment Mapping



life.augmented

Drones

FlightSense™ makes drones easier and safer to pilot

Typical functions

Landing / take-off assistance
Ceiling detection
Short distance measurement to the floor:
More accurate than ultrasonic, barometer sensor or GPS
Not affected by air turbulences
Lighter than ultrasonic

Key Tech Advantage
Small and relatively low power

life.augmented

FlightSense™ Use-cases

Level Measurement

Saltco.com

Typical functions

Remote Sensing
Liquid Level

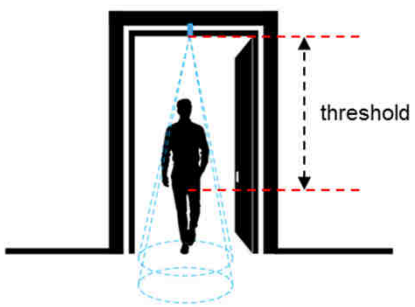
Health
Not intrusive level measurement
Measurement of
Corrosive liquid
Sterilized liquid or
no liquid at all

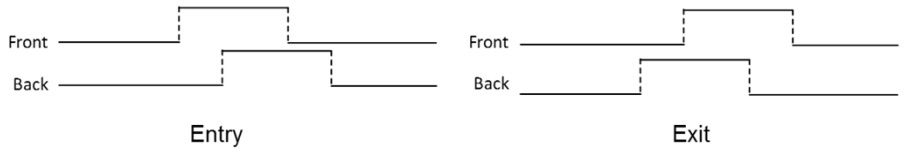
Key Tech Advantage
Black oil and bright reflective salt both work.

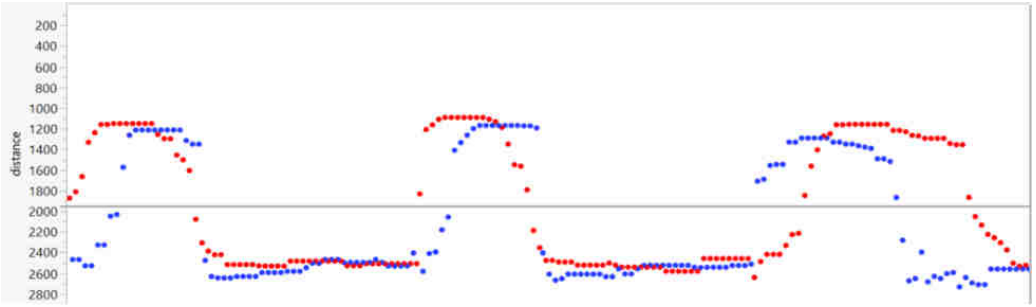
life.augmented

FlightSense™ Use-cases

Building Management System







Typical functions

People Counting
Room occupancy
AC adjustment

Presence Detection
Smart Display
Smart Appliances

Key Tech Advantage
Small and unobtrusive

life.augmented

FlightSense™ Use-cases

Smart Shelves - Industrial - Medical

Typical functions

Detection

Objects detection & counting

User Presence

Power saving

Timely operation/ display on/off

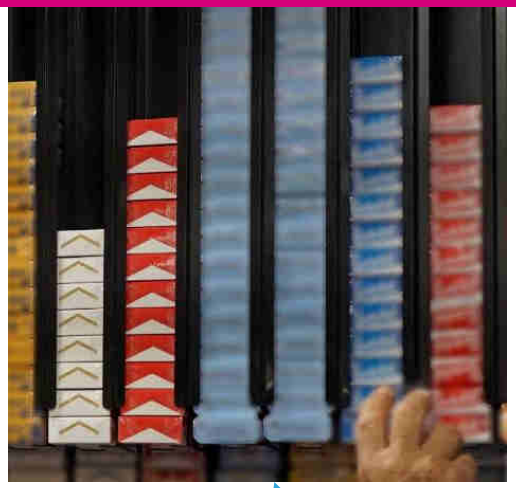
Touchless User interface

Basic Gesture recognition

life.augmented

Shelving topologies

Two ways to get products always available in front until empty



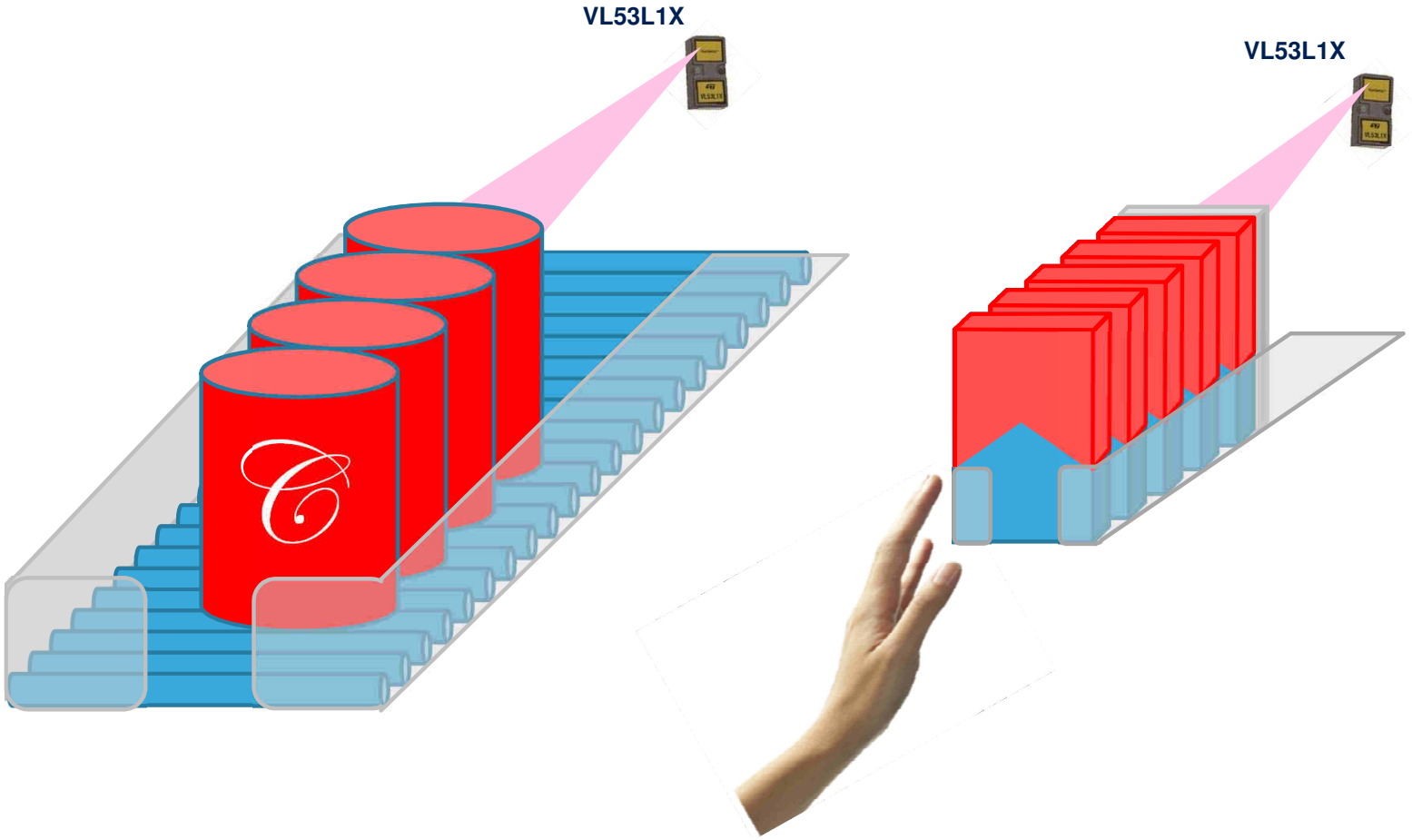
Gravity feed

Pusher tray

« Automatic » Content monitoring

VL53L1X ToF sensor solution

A key to reduce out-of-stock loss



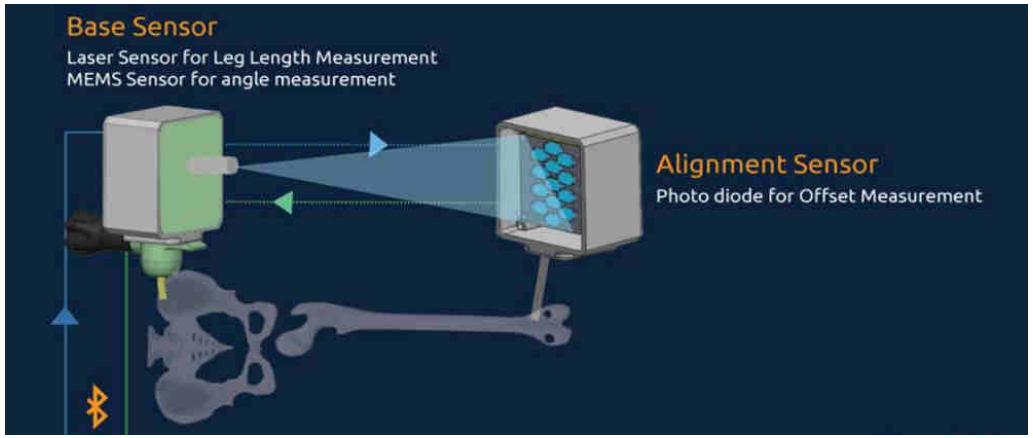
life.augmented

Smart Shelf

By ranging the empty space, one can know how many items are left Simple.

Key technical Advantage – Field of View, battery life.

Come at our Demo Stand to see SmartShelves application at work



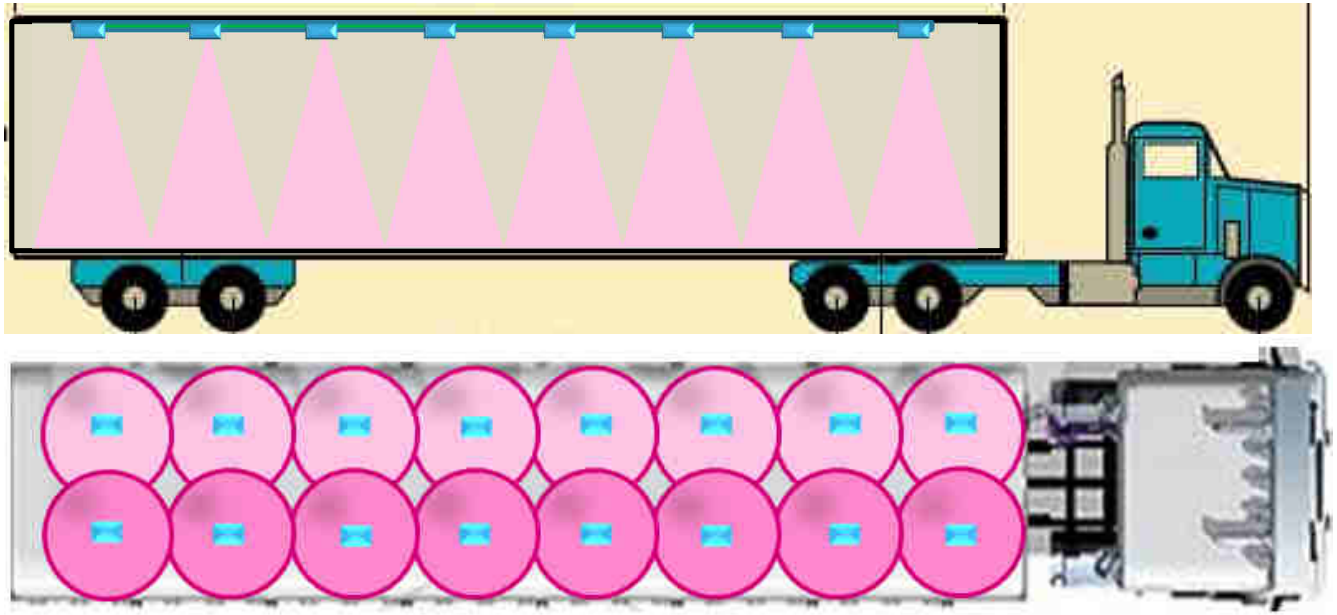
PathPartner.com

X-ray positioning sensor

Key technical Advantage: Accuracy

life.augmented

Truck Loading



With a number of sensors looking down, one can tell how well a truck is loaded.

Cameras are too expensive, too data intensive, and don't give distance data.
By ranging the empty space, one can know how many items are left Simple.

Key technical Advantage – Field of view

life.augmented

Taking out the garbage

Abmbed.com

KS Technologies 3300

This is one of a class of sensors where distance is combined with Bluetooth or Sigfox.

Attach it to a dumpster, and one can know a fullness level. Only roll the truck when you need it.

Key technical Advantages –
Dust Immunity
Low power

life.augmented

Watching the grass grow

Farmote.com

By aiming down and only taking measurements at night, a farmer can know if the cows have lots of grass left, or if it's time to move them to a different pasture.

Allows the farmer to adjust fertilizer depending on the growth of each field corner

Farmote chose to add a lot more sensors, giving complete weather data, delivered via cell phone technology.

Key technical advantages
Field of view, accuracy

Application Ideas

*Drop sensor – Neato,
*Bathroom – Urnal / faucet / soap / paper towel / garbage can / Mirror?
*Robots - Anki and Misty
Toys - spinmaster
*PC's Presence detect - Dell Latitude /
*Grass grow - Farmote
*Tank application – Tank Clarity
Car shock -
* Console – thermostats,
* People counting
Lidar
*Autofocus / cell phones
Printer tray full -
*Smart shelves - Demo
*Medical
*Truck Loading

life.augmented