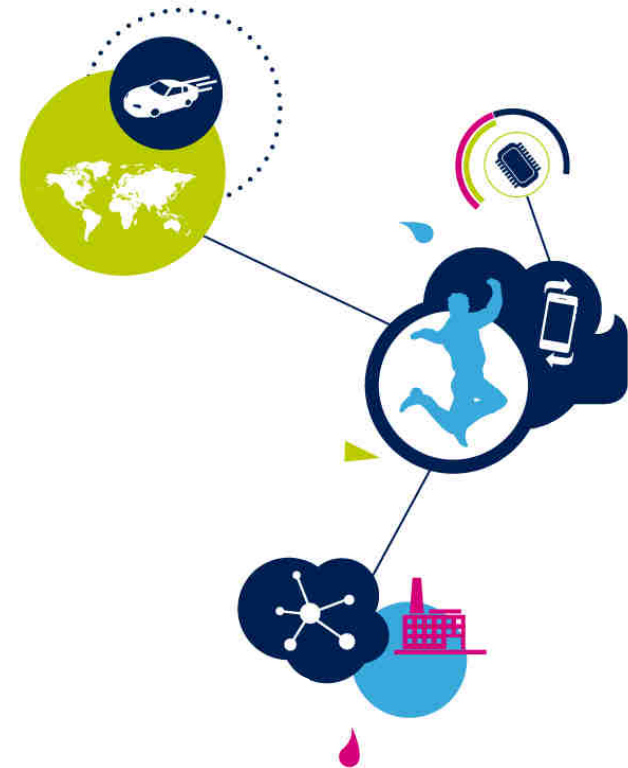


FlightSense™ Applications Enabled by ST's Time-of-Flight

Imaging Division

John Kvam – john.kvam@st.com



Technology Tour 2019

Vancouver, BC | September 24



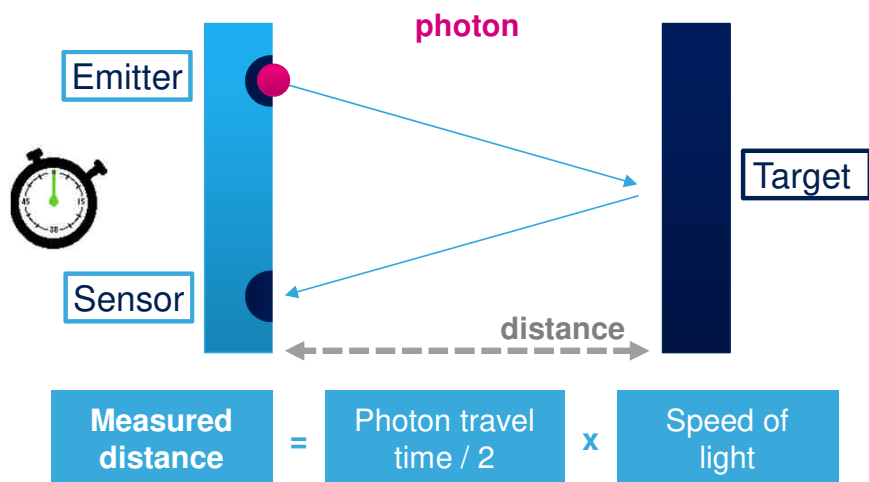


FlightSense™ Breakthrough Technology

2

Measurement at the speed of light!

FlightSense™ Principle



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

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



FlightSense™ Product Longevity

7-years Commitment Extended

4



FlightSense™ benefits from ST Longevity Program

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



FlightSense™ Product Descriptions

FlightSense™ Mass-Market Products

6

VL6180X



VL53L0X



VL53L1X

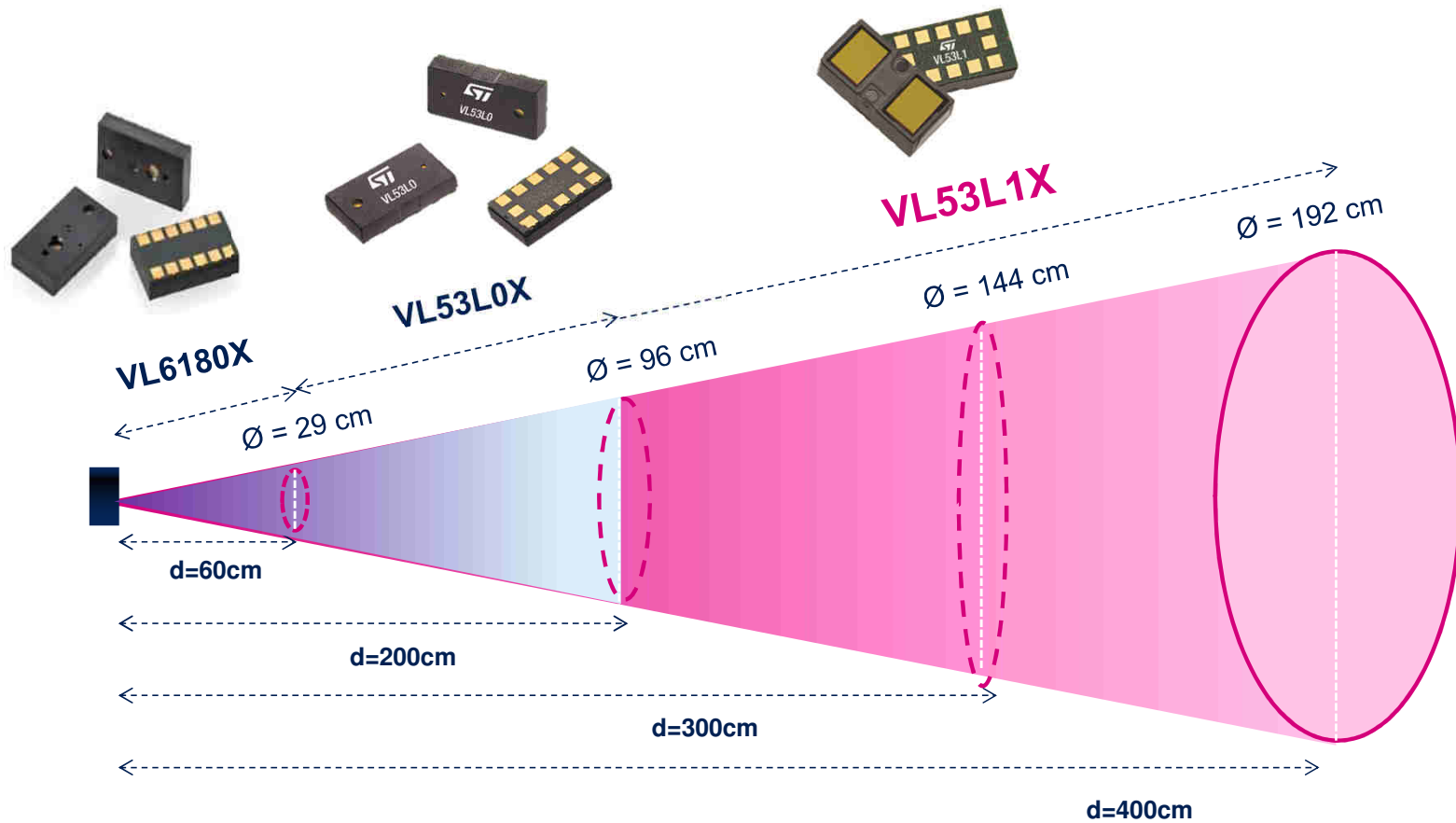


- 1st Gen **FlightSense™** Sensor
- Proximity/ALS sensor up to **60cm**
- 2nd Gen **FlightSense™** Sensor
- Ranging sensor up to **2m**
- 3rd Gen **FlightSense™** Sensor,
- Ranging sensor up to **4m**, with programmable **FoV**

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

Detection Cone

7

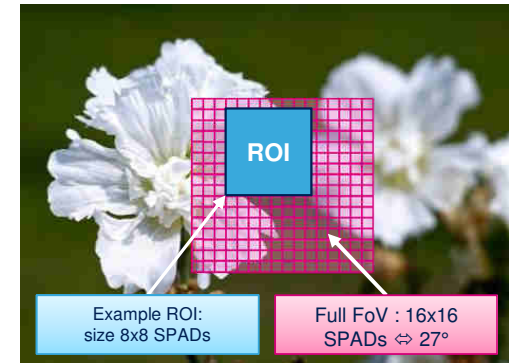


VL53L1X

8

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**

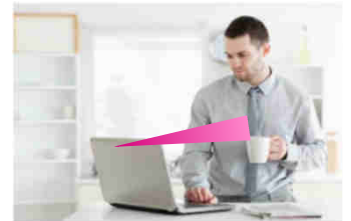
VL53L1X

9

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)

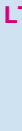
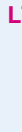
Example of Energy Saving:

- **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

VL53L1X

Autonomous Mode & Thresholding

10

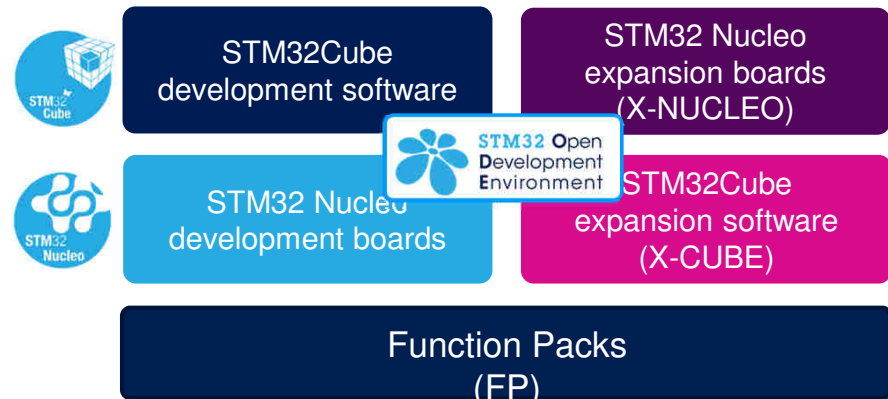
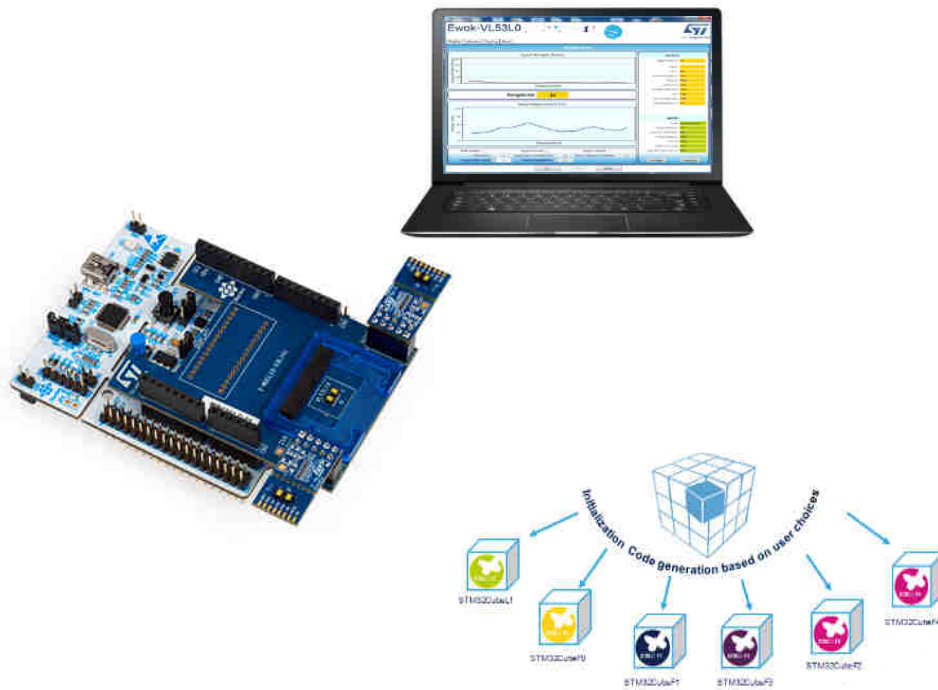
Threshold condition	Human & device situation and Interrupt raised by VL53L1X		
“Above HIGH” (> High)	  	  	  No target 
“Below LOW” (< Low)	  	  	  No target 
“In Window” (>= Low AND <= High)	   	   	   No target 
“Out of Window” (> High OR < Low)	   	   	   No target 

INT* (optional interrupt), customer choice

Complete Development Tools

11

- STM32 NUCLEO boards and GUI
- STM32 Open Development Environment



CUBE-MX SW Package

Accessories Updates

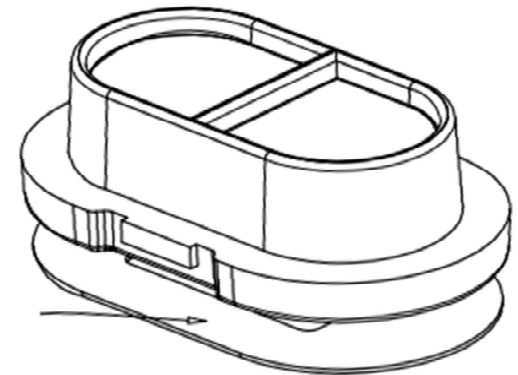
12



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

www.hornix.com.tw

Coverglass designs for VL6180, VL53L0X & VL53L1X



Endless New Applications

13



Drones



PC & Tablet



Vacuum cleaners



Sanitary



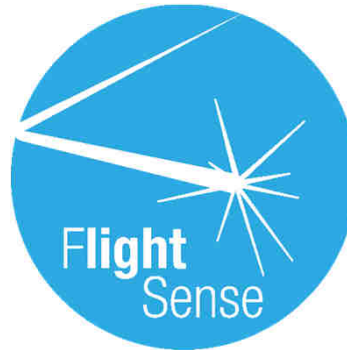
Smart home



Printers



Medical



Service Robots



White Goods



AR/VR



Industrial



Wearable & IoT



FlightSense™

... making light work

14



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



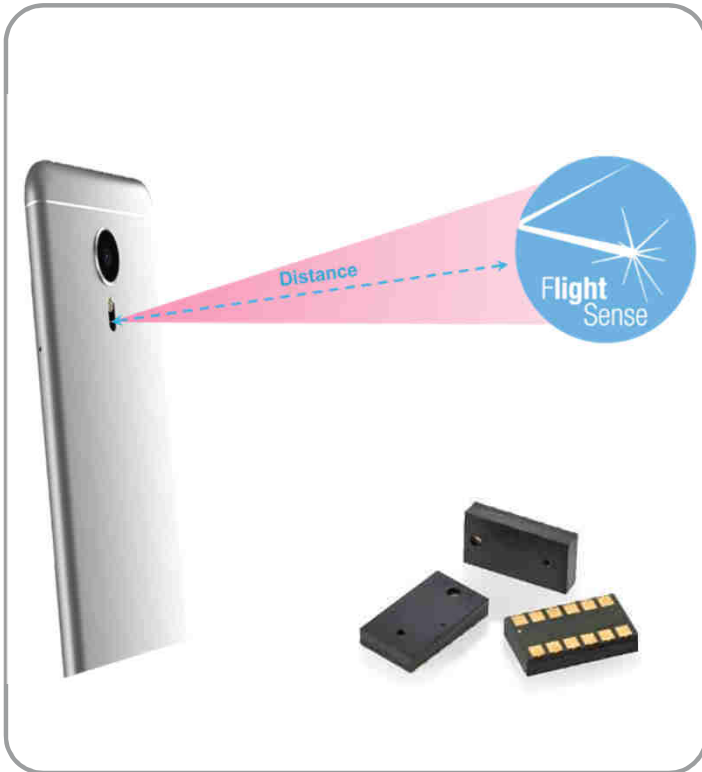
Gesture

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

Auto Focus Camera Assist

Smartphones

15



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



FlightSense™ Use-cases

Presence Detection

16

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

Presence Detect

17



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

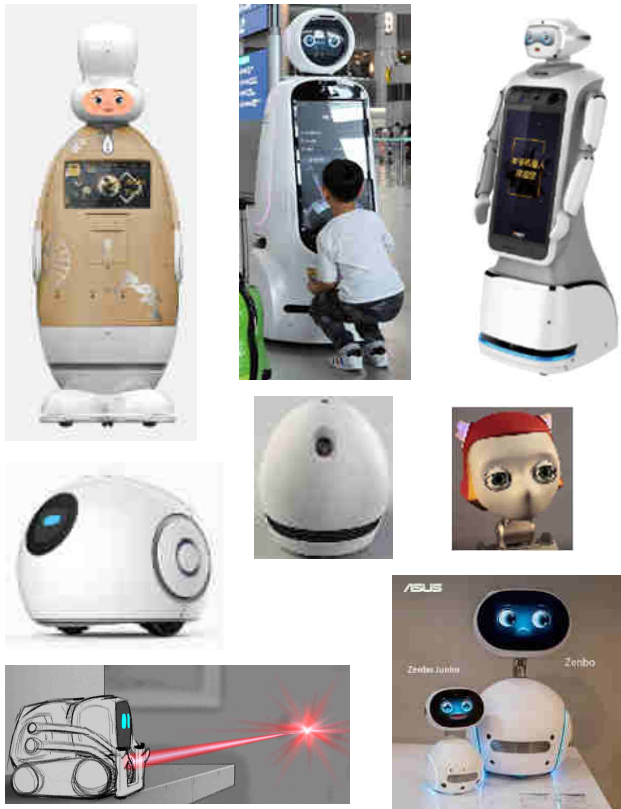
What happens if someone puts a chair in front of the sensor?

Chairs don't breathe! And we can tell.

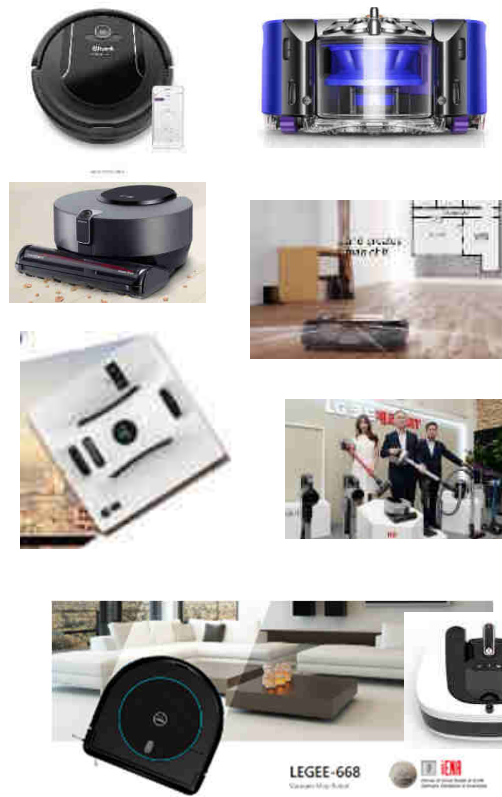
FlightSense™ Use-cases

Robotics

18



Service Robots



Vacuum Cleaners

Typical functions

Security

Cliff detection

Detection

Wall tracker

Obstacle & object detection



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.

FlightSense™ Use-cases

Drop Sensor

Typical use

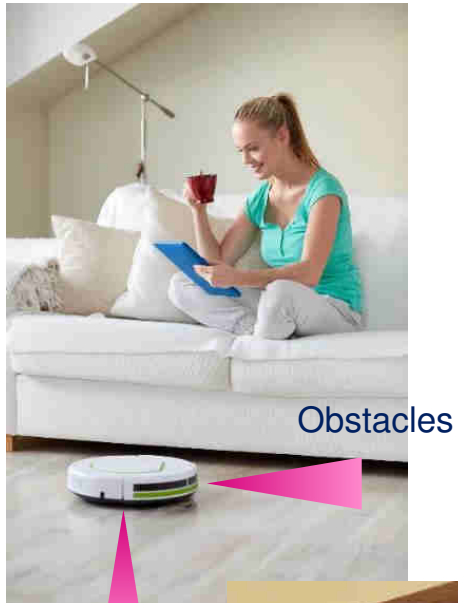
Safety

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



Obstacles

Anti-cliff



FlightSense™ Use-case

Smart Home - Sanitary - White Goods

21



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

Completely Automatic Bathroom

22



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



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.

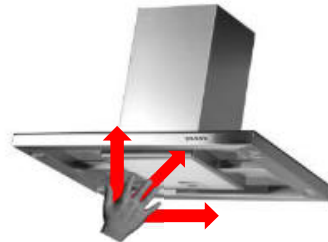
White goods

Basic gesture control & proximity sensing



Coffee machine

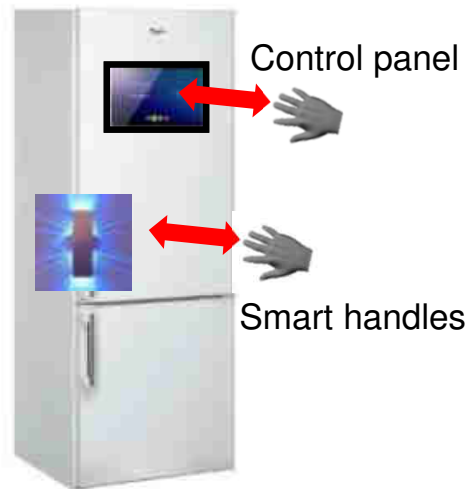
- Filling level
- Positioning of cups
- Water tank level



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

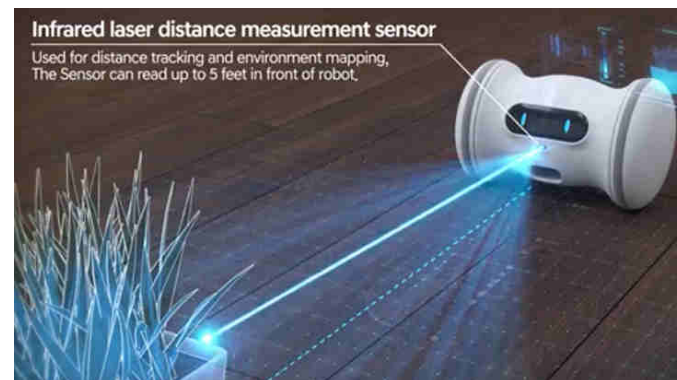
Key Tech Advantage

No touch

Detection

Sensing

Environment Mapping



Drones

26

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

FlightSense™ Use-cases

Level Measurement

27



Typical functions

Remote Sensing

Liquid Level

Health

Not intrusive level measurement

Measurement of

Corrosive liquid

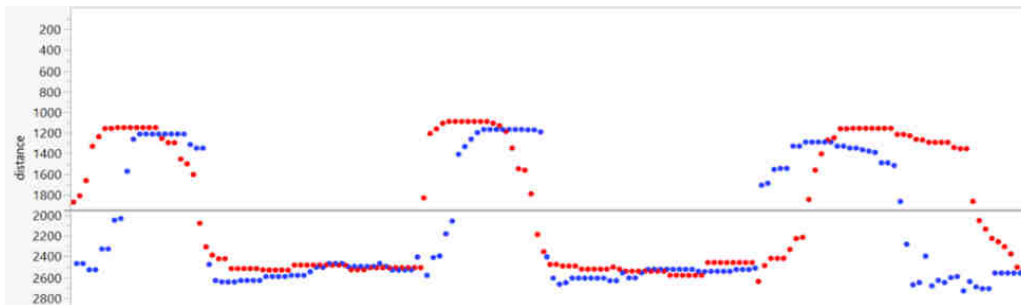
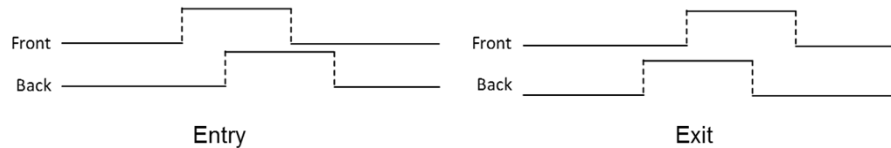
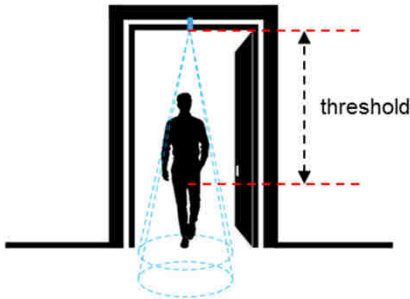
Sterilized liquid or
no liquid at all

Key Tech Advantage

Black oil and bright reflective salt
both work.

FlightSense™ Use-cases

Building Management System



Typical functions

People Counting

Room occupancy
AC adjustment

Presence Detection

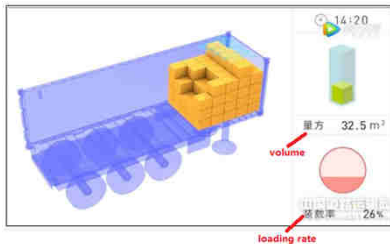
Smart Display
Smart Appliances

Key Tech Advantage

Small and unobtrusive

FlightSense™ Use-cases

Smart Shelves - Industrial - Medical



Typical functions

Detection

Objects detection & counting
User Presence

Power saving

Timely operation/ display on/off

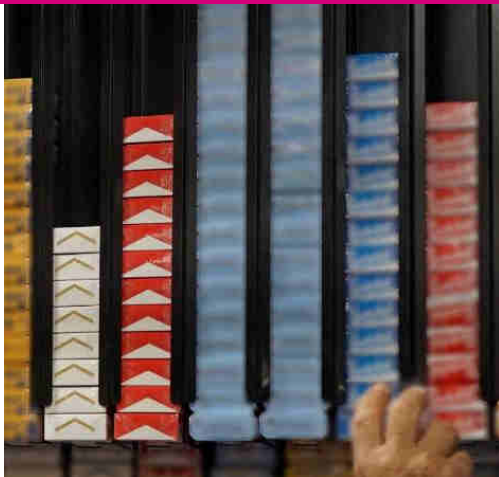
Touchless User interface

Basic Gesture recognition

Shelving topologies

30

Two ways to get products always available in front until empty



Gravity feed

Pusher tray

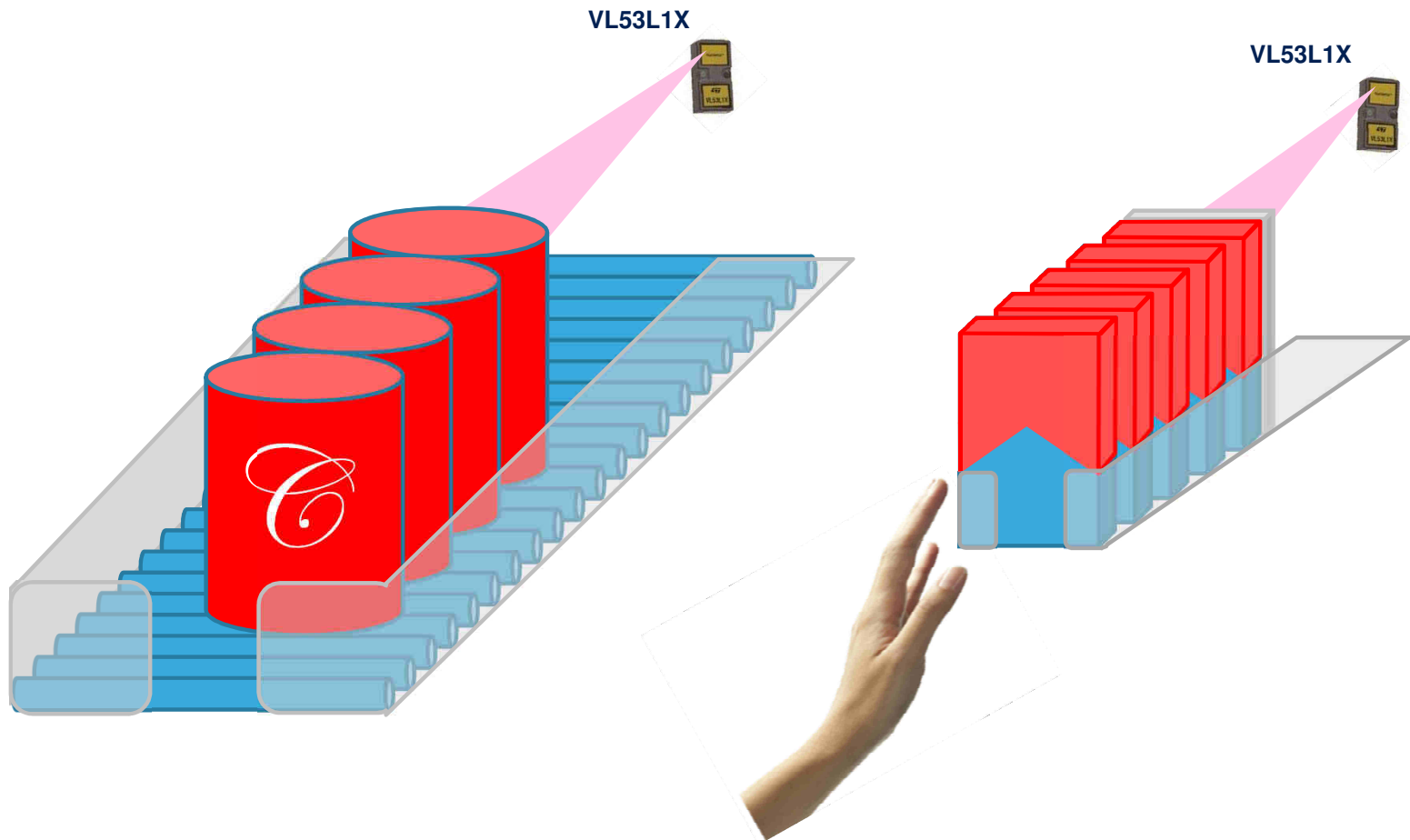


« Automatic » Content monitoring

VL53L1X ToF sensor solution

31

A key to reduce out-of-stock loss





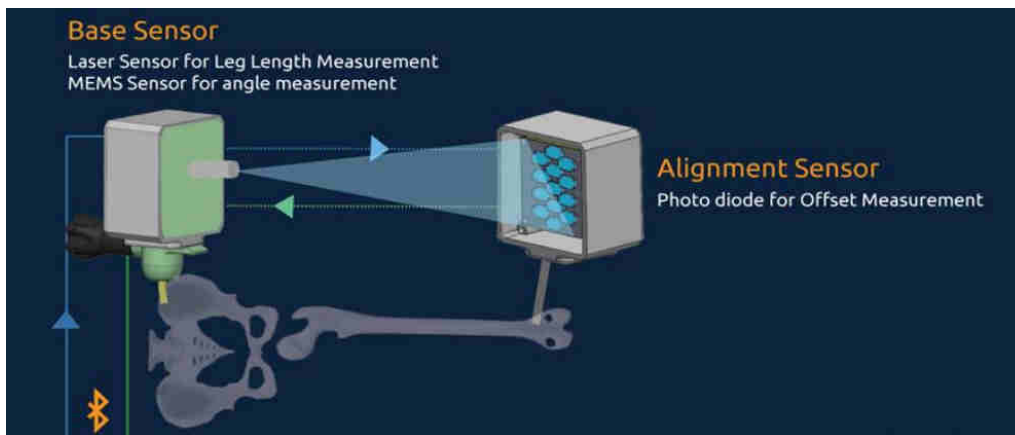
Smart Shelf

32

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

Key technical Advantage —
Field of View, battery life.





PathPartner.com

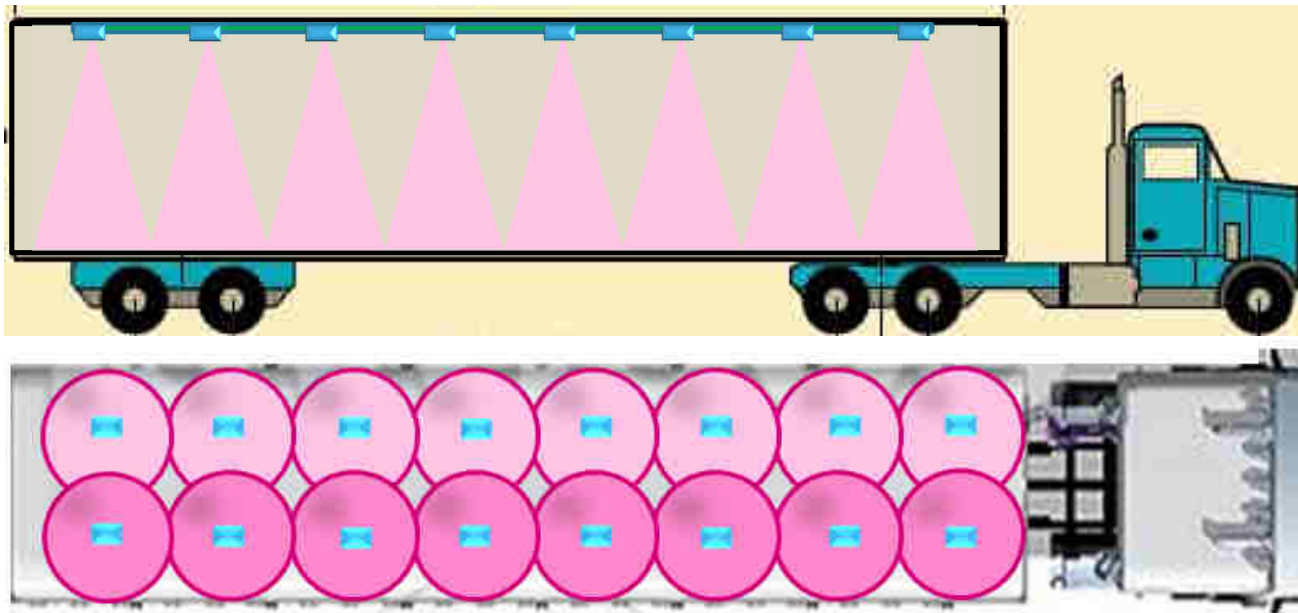


X-ray positioning sensor

Key technical Advantage: Accuracy

Truck Loading

34



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

Taking out the garbage

35



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.

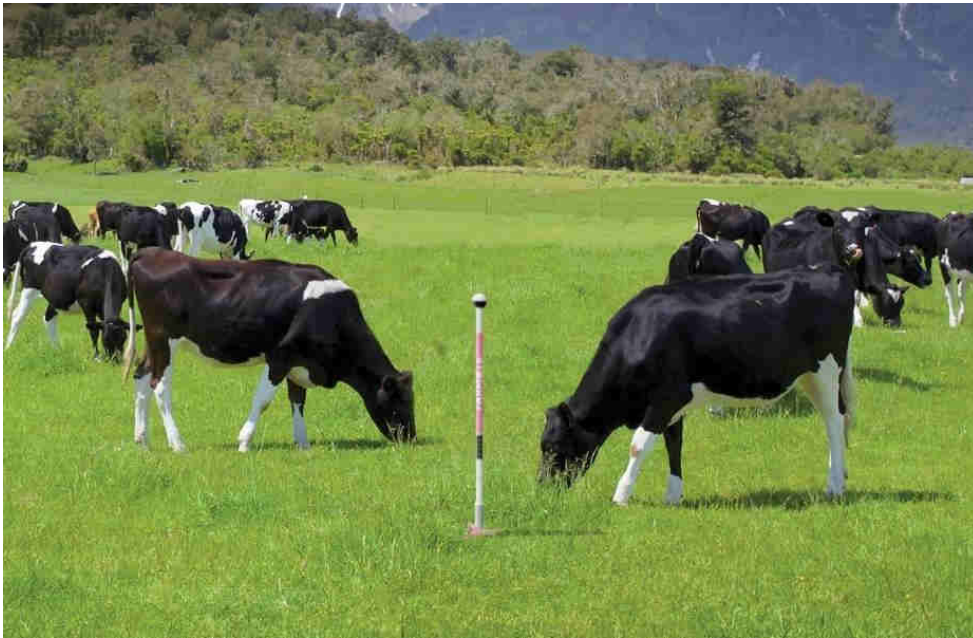
Key technical Advantages —

Dust Immunity

Low power

Watching the grass grow

36



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