# Intel RealSense Technology

*Bringing Human Senses to Your Devices*

*September 2014*

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Intel Confidential — Do Not Forward

# Introduction

What's the Intel RealSense Technology?

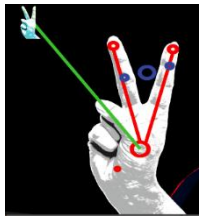
# Interaction with Computing Devices

## What's the Next?

Local Speech Recognition

Facial Tracking

Finger/Gesture Tracking



Augmented Reality

Background Subtraction

# Intel® RealSense ?

Eyes, Ears, Voice, Touch, Emotion and Context for experiences that are….

## Natural

## Intuitive

## Immersive

For Every App Category: Games, Productivity, Retail, Enterprise, Health, and More

# Intel® RealSense Mission

Adding “Human-like Senses” to Computing Devices

Natural, Intuitive and Immersive Experience

# 3D Camera for Every Form Factor

All-in-One | Notebook | Convertible | Detachable | Tablet | Phablet | Phone

FRONT Camera

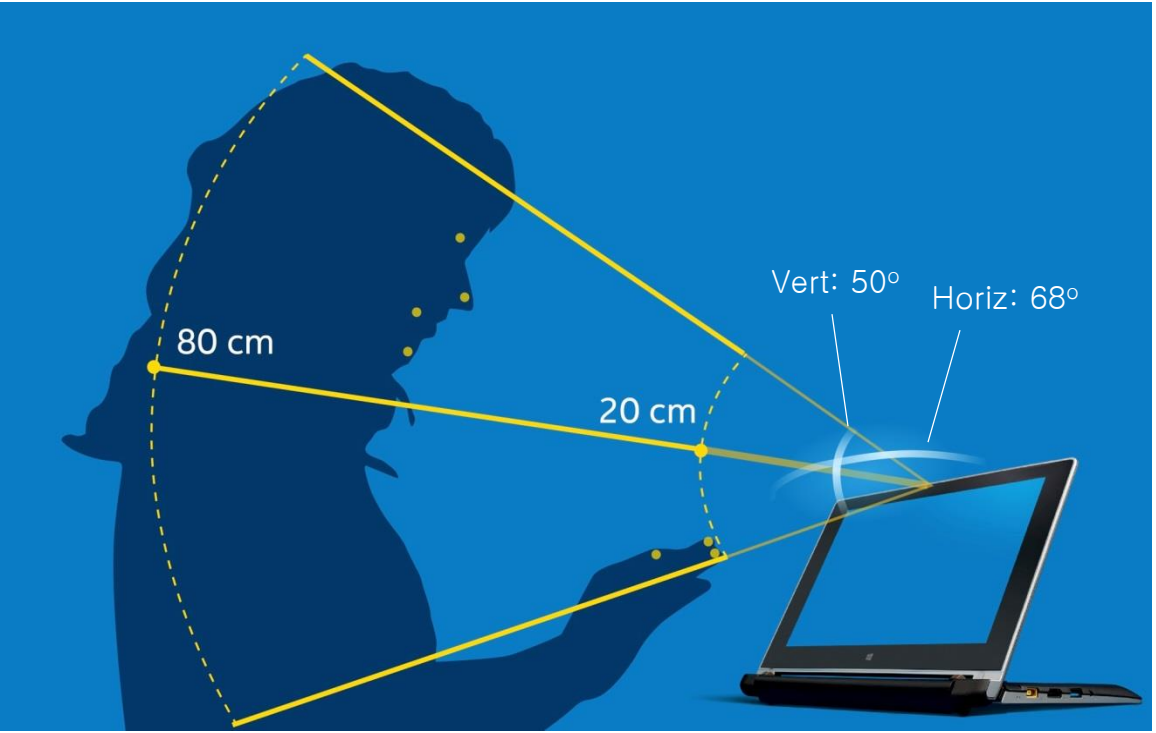
Intel® RealSense™ 3D Camera F200 (aka Bell Cliffs 60fp

REAR Camera

Intel® RealSense™ 3D Camera R200 (aka Double Spring 60fps)

Intel® RealSense™ Snapshot R100 (Photography) (aka Davis Reef)

# Intel® RealSense™ 3D Camera Module




The Intel® RealSense™ 3D camera depth module is integrated into the bezel of Ultrabook™, All-in-One PC, Notebook, Ultrabook™ 2 in 1, and Convertible / Detachable OEM partner devices. It is optimized for depth perception and can track 22 joints of the hands and 78 facial landmarks for face orientation and tracking.

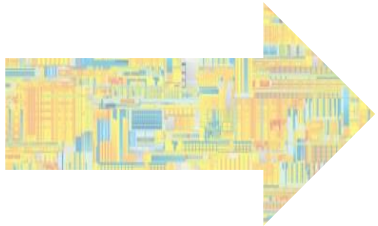
- Thin form factor – integration!
- Improved performance, accuracy/depth quality
  - VGA depth camera
  - HD 1080p RGB camera
- Reduced power
- RGB: 1080p30
- Depth: VGA@60

## Use Intel® RealSense™ 3D Camera for Face, Hand Tracking and Orientation

# Intel RealSense SDK 2014

Transition from Perceptual Computing SDK 2013 to RealSense SDK 2014

# 2014 Depth Camera Module



- Portable, USB 2.0 powered peripheral
- QVGA depth camera
- HD 720p RGB camera
- Dual microphones
- Bundled SW
- RGB: 720p
- Depth: QVGA@60

- Thin form factor – integration!
- Improved performance, accuracy/depth quality
  - VGA depth camera
  - HD 1080p RGB camera
- Reduced power
- RGB: 1080p30
- Depth: VGA@60

User-facing module placed on the same plane as the display for Ultrabook, AIO, Notebook and Convertible/Detachable designs

# What's New with the 2014 SDK?

## New Modalities

3D Scanning

Depth-enabled Augmented Reality

Grammar for Speech

## Enhanced Algorithms

Enhanced Hand/Finger tracking

3D Facial Analysis

**Intel® RealSense™ SDK for Windows 2014**

## Extended Reach

Next Generation Integrated Depth Camera

Windows* 8.1 Desktop

## Developer Tools

Unity* ToolKit

Productivity Extensions

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# What's New in the Intel® RealSense™ SDK 2014?

## New Features and Responding to Developer Feedback

| | SDK 2013 | SDK 2014 | Benefits |
|---|---|---|---|
| Camera Support | Creative* Senz 3D* | Bell Cliffs* Integrated Camera | Smaller, lighter, lower power, increased installed base |
| Camera Specs | RGB: 720p<br>Depth: QVGA@60<br>FOV: 53 deg<br>USB2.0 Peripheral | RGB: 1080p30<br>Depth: VGA@60<br>FOV: 85 deg<br>USB3.0 integrated | Higher resolution and accuracy |
| OS Support | Windows* 7/8 DT | Windows* 8.1 DT | New Windows* version |

Developers asked for

- Increased camera resolution and quality
- Increased finger/hand/face tracking quality
- Face and head orientation with depth

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# What's New in the Intel® RealSense™ SDK 2014?

| | SDK 2013 | SDK 2014 | Benefit |
|---|---|---|---|
| Modality | Hand / finger tracking | + Hand/finger joint tracking<br>+ Enhancements | Track all 22 joints in hand for more complex interactions<br>Greater accuracy, more robust tracking |
| | Facial Analysis (RGB) | + Head orientation<br>+ Depth | Head orientation tracking and greater accuracy and resolution. |
| | Voice Recognition | + Custom grammar | Developers can add customized commands to their apps. |
| | Augmented Reality(RGB) | + 3D object tracking<br>+ 3D environment tracking | Track 3D objects more accurately using depth data. Track 3D environments for accurate 3D augmentation |
| | Background Subtraction | + Enhancements | Remove background for 'green screen' effect OR define a z-depth plane of interest to specify the interaction range |
| | -- | +3D Scanning | Easily capture a complete, fully textured 3D model of objects for exciting new possibilities. |

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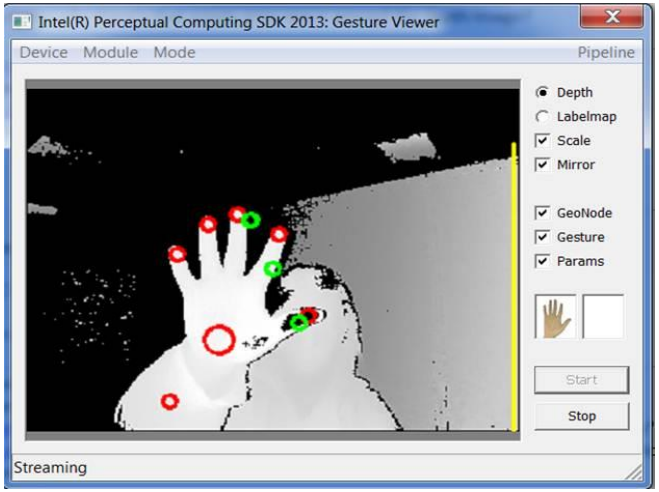
# Advanced Finger & Hand Tracking

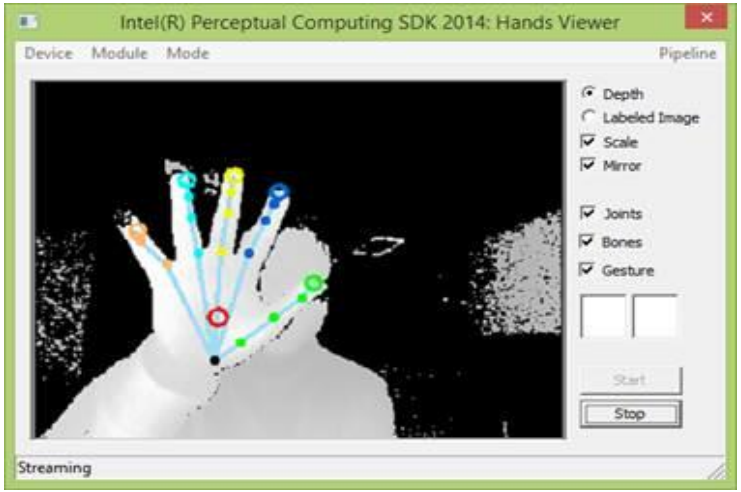
## 2013:

Fingertips, Palm Center, Grasp Point, Forearm




## 2014:

22 Joints




Greater Accuracy and Resolution

3D Hand Skeleton enables new usages

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# Advanced Finger & Hand Tracking

| Feature | SDK 2013 | SDK 2014 | 2014 Developer Benefit |
|---|---|---|---|
| Ten finger tip tracking | ✔ | ✔ | Enable end-user interaction with single or multiple fingers. |
| Palm center tracking | ✔ | ✔ | Discern orientation of hand. |
| Left & Right Hand Tracking | ✔ | + Two of the same hands and hand labeling | Track two of the same hand for multiplayer gaming |
| Tracking/Occlusion Data | -- | Occlusion prediction and back-of-hand recognition | Improved performance when users' hands are partially occluded |
| Finger label assignment | -- | Thumb, pointer, middle, ring, pinky | More granular GUI control (don't mistake a pinky for thumbs up) |
| 3D hand skeleton | -- | 22 joints<br>User adaptation<br>Output orientation<br>Hand detection<br>Normalized Skeleton | Account for different hand sizes with the same code, contextually choose which hand to track |
| Accelerated Performance | -- | DirectX* support | Increases performance and extends battery life by utilizing GPU for interpretation of depth data. |

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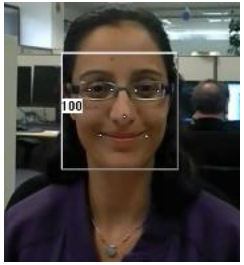
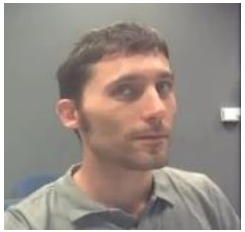
# Facial Analysis Improvements

2013:





2014:

- Greater Accuracy
- Identify More Landmarks
- Pose Detection

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# Facial Analysis Improvements

| Feature | SDK 2013 | SDK 2014 | 2014 Developer Benefit |
|---|---|---|---|
| Face Detection/Tracking | ✔ Frontal, 2D | + increased accuracy<br>+ depth<br>+ maintains tracking with much greater head movement<br>+ recognizes more faces (final number tbd) | • Works in wider lighting conditions<br>• Enhanced multiple user scenarios<br>• More precise head-oriented command-and-control<br>• More security features and greater accuracy + fewer false detections |
| Landmark Detection | ✔ 7 points | + depth<br>+ 78 points | • Supports avatar creation and facial animation<br>• Recognize more facial attributes |
| Optimization | ✔ Intel® IPP (CPU) | ✔ | Higher performance, lower power |
| Head Orientation | -- | + roll, yaw, pitch | • Use for basic gaze-tracking<br>• Head-coupled perspective with 3D orientation |

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# Augmented Reality

AR enhanced with depth

## 3D Object Tracking w/ depth data

## Map 3D environments

Track 3D objects more accurately using depth data.
Map 3D environments to realistically augment the real world with computer generated graphics.

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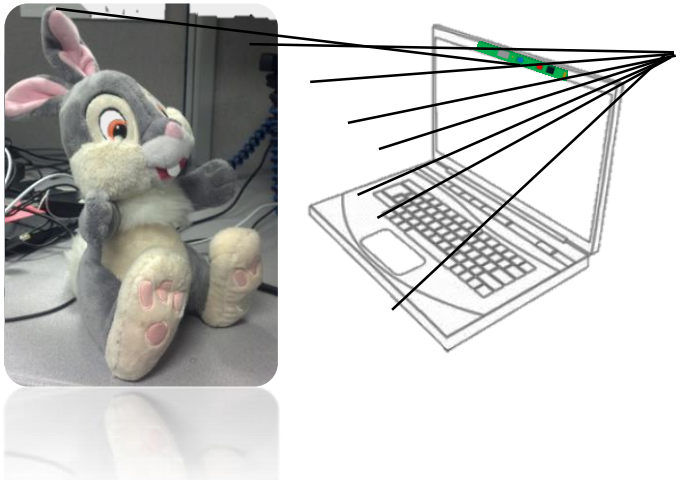
# 3D Scanning

1



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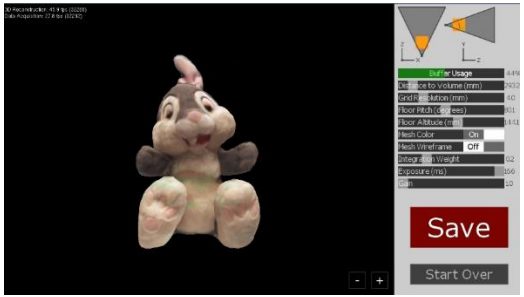


Capture objects and faces in 3D
Share and print 3D scans

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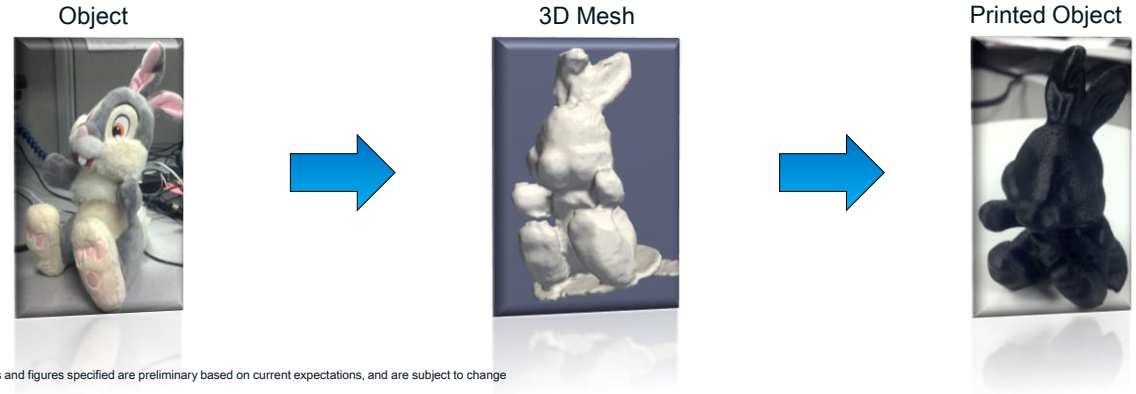
# 3D Scanning

| Feature | 2013 | 2014 | 2014 Developer Benefit |
|---|---|---|---|
| Object Scanning | N/A | Scan objects 18in and smaller, create object mesh with texture | Turn real-world objects into 3D models to be printed, uploaded to online marketplaces, or used in-application |
| Facial Scanning | N/A | Scan faces, create high-polygon facial mesh with texture | Use for analysis, avatar creation, identification, biometrics |

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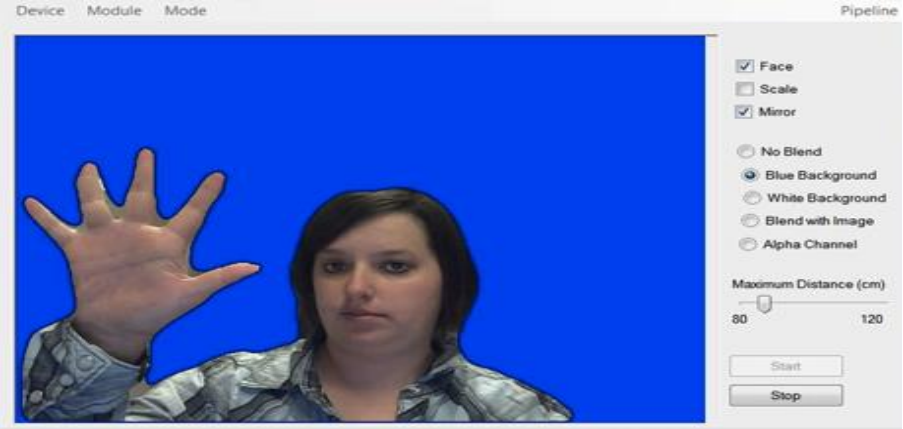
# Background Subtraction

| Feature | 2013 | 2014 | 2014 Developer Benefit |
|---|---|---|---|
| Isolate object of interest | ✔ | ✔ | Exclude irrelevant information from your applications. For immersive collaboration, remove the background. For gesture interfaces, highlight the hands when in range |
| Smoothing | ✔ | ✔ | Smoother output, especially for difficult areas like hair and in-between fingers |

Remove the Background for:

- Immersive collaboration
- Content creation via green screen

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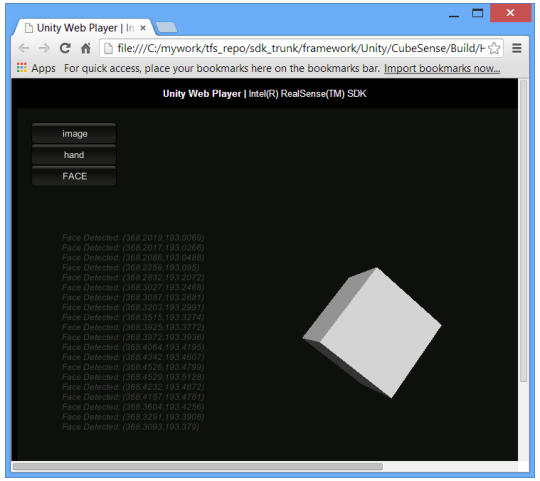
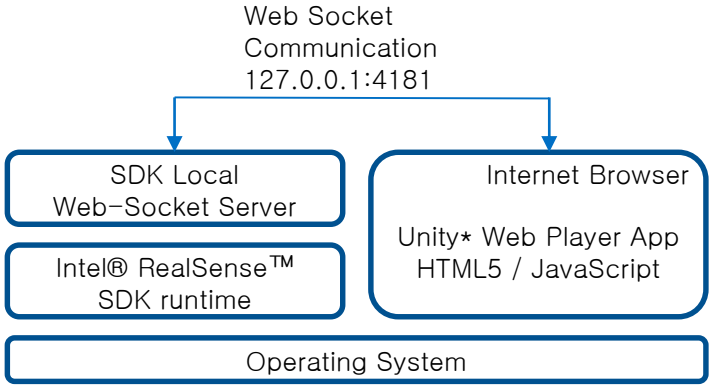
# Web / HTML5




Develop based on PC/standalone, trigger gesture and face events
Switch to the webplayer platform for deployment

Gestures and Facial Analysis
Unity* Web Player games
HTML5 / JavaScript (interactive websites)

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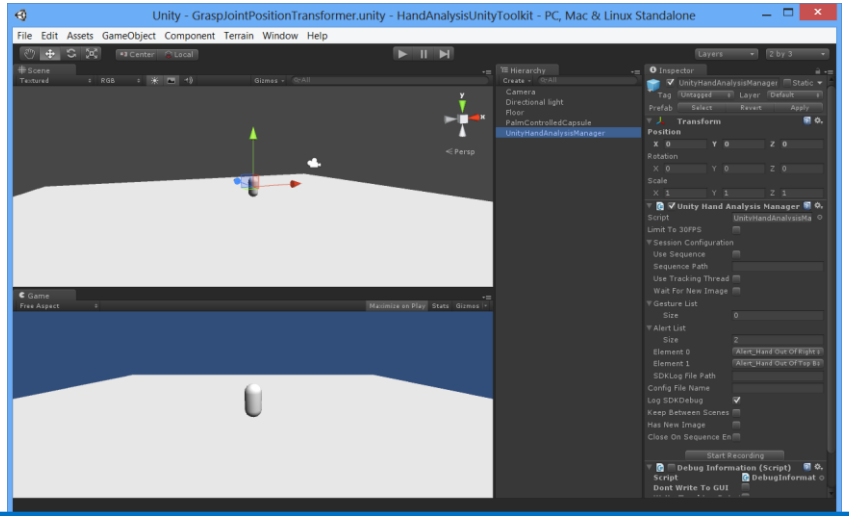
# Unity Productivity Extension

A set of scripts that provides configurable actions/rules based on the senses provided by the SDK.

- Programming: Associate your game objects with the action scripts.
- Programming: Create rules. Associate your game objects with rules.




Drag and drop programming

Write less code!

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# Intel RealSense™ SDK 2014 Features

| | |
|---|---|
| Modalities | Hand/Finger Tracking<br>Gesture Recognition<br>Facial Analysis<br>3D Scanning<br>Background Removal<br>Augmented Reality<br>Speech Recognition |
| Processors | Intel® Core™ Processors (4th and 5th Generation) |
| Operating Systems | Microsoft Windows* 8.1 Desktop (32 and 64-bit) |
| Programming Languages | C++, C#, Java (for face, voice, and gesture) |
| Microsoft Visual Studio* | VS 2008, VS 2010, VS2012, VS2013 |
| Supported Camera | Intel® RealSense™ 3D Camera (Bell Cliffs) |
| Development Tools | ▪ Processing* Open Source Programming Language and Environment<br>▪ Unity* Game Development Environment<br>▪ Havok* Vision Engine<br>▪ Intel® SDK for OpenCL* Applications 2013<br>▪ Support Forums<br>▪ Raw-Depth Access<br>▪ Tutorials<br>▪ Gesture Authoring Tool<br>▪ RealSense™ Productivity Extensions |

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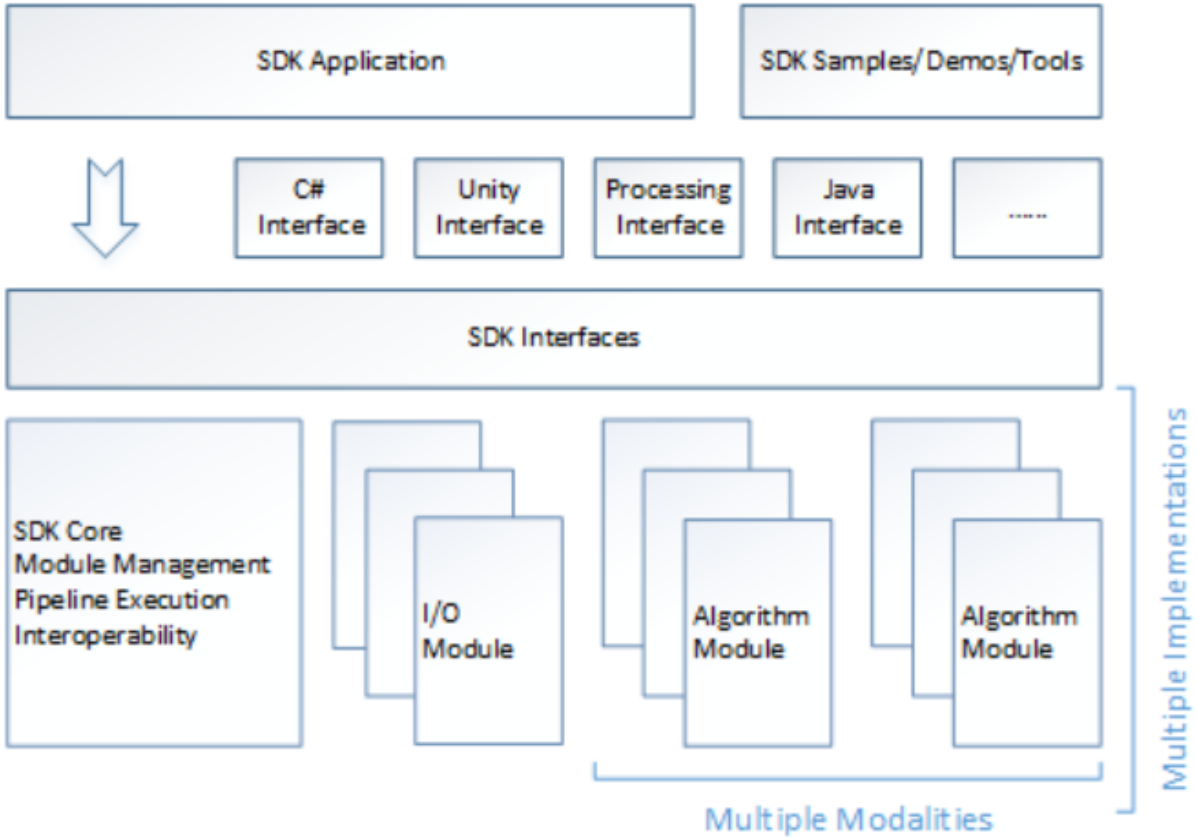
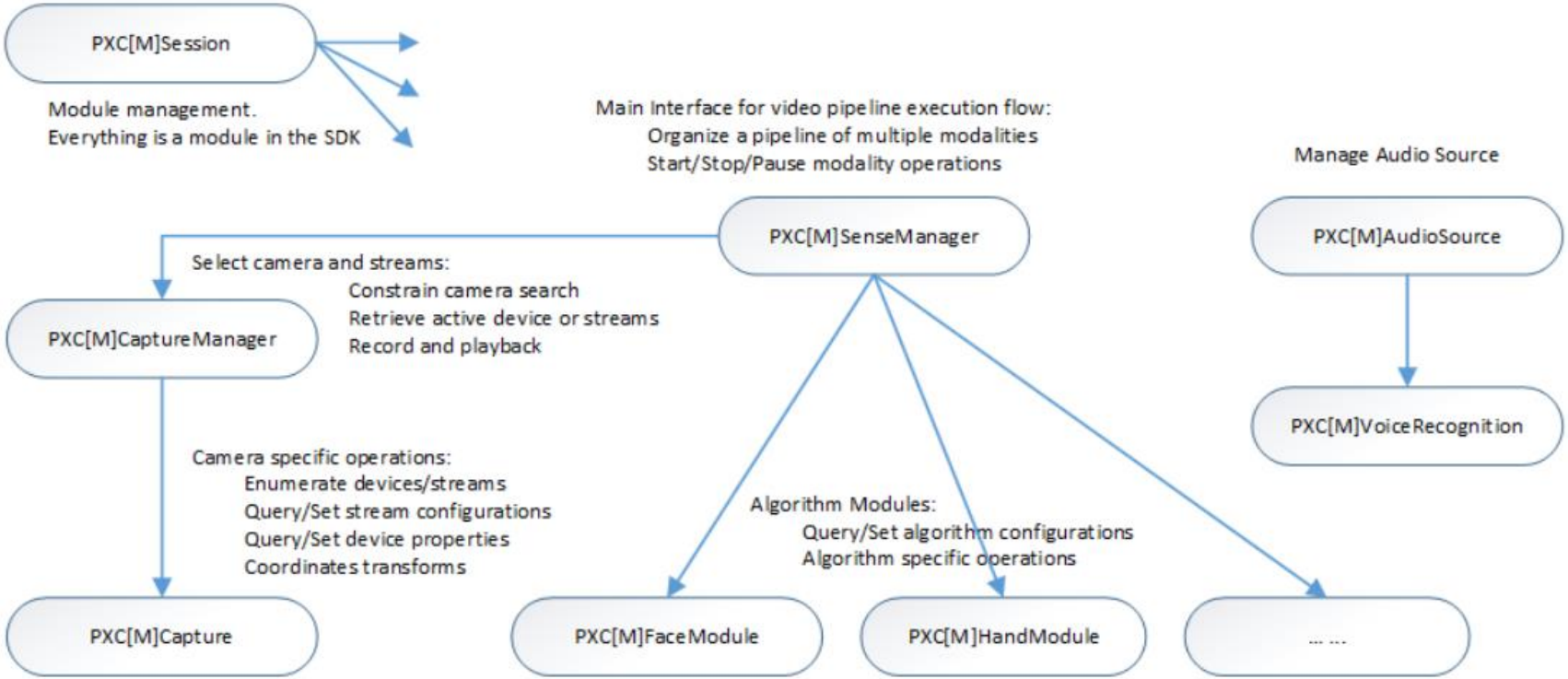
# SDK Architecture

# Architecture Of 2014 RealSense SDK



# SDK Interface Hierarchy



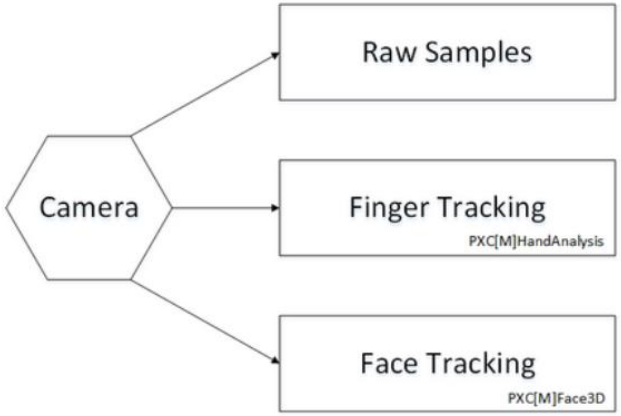
# Session and Modules

- Session :
  - A context which holds I/O and algorithm modules. Every SDK application must contain at least one session.

- Modules :
  - The SDK building blocks which implement certain SDK interfaces, there might be multiple implementations of the same SDK interface.

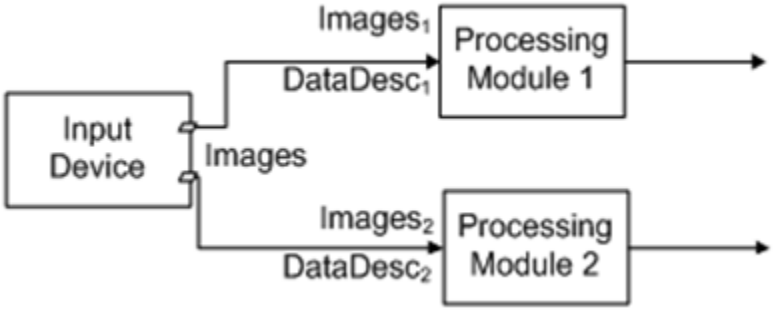
# SenseManager

- PXC[M]SenseManager :
  - The main interface to any **predefined** use cases.
    - One or more algorithm modules.
    - One single camera input device.
    - Serving input data to algorithm modules.



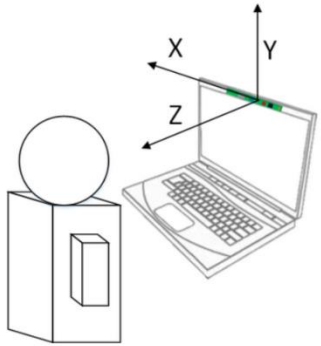
# CaptureManager

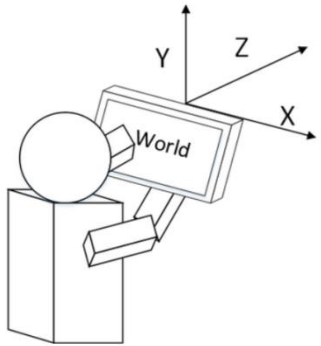
- Helper interface for creating complex pipelines.
- Consolidate the input needs of processing modules and locate the right I/O device.



# SDK's two coordinate systems

- **Image Coordinate** : refer to the **pixel (x,y)** in the depth/color image pictures, where x is in the range of 0~width-1, y is in the range of 0~height-1.
- **World Coordinate** : **3D coordinates (x,y,z)** relative to the camera. (0, 0, 0) is the original point of camera depth point. X axis points to left, Y axis points to up and Z axis points to the user when the user face to the camera. The [illegible] are in meter [illegible]tly specified.



# Programming using SenseManager

# Procedure of initiating pipeline

- Create a PXCSenseManager Instance.
- Enable the module.
- Control the execution flow and retrieve results.
  - Message loop.
  - Event callbacks.
- Releasing the instance no longer need.

# Control the execution flow.

## ➢ Message loop

```
// Create a PXCSenseManager instance
PXCSenseManager *sm=PXCSenseManager::CreateInstance();

// Select the color stream
sm->EnableStream(PXCCapture::STREAM_TYPE_COLOR,640,480);

// Initialize and Stream Samples
sm->Init();
for (;;) {
   // This function blocks until a color sample is ready
   if (sm->AcquireFrame(true)<PXC_STATUS_NO_ERROR) break;

   // retrieve the sample
   PXCCapture::Sample *sample=sm->QuerySample();

   // work on the image sample->color
   ...

   // go fetching the next sample
   sm->ReleaseFrame();
}

// Close down
sm->Release();
```

## ➢ Event callbacks

```
class MyHandler: public PXCSenseManager::Handler {
public:

   virtual pxcStatus PXCAPI OnNewSample(pxcUID, PXCCapture::Sample *sample) {
       // work on sample->color
       ...
       // return NO ERROR to continue, or any ERROR to exit the loop
       return PXC_STATUS_NO_ERROR;
   }
};

void MainRoutine(void) {
   // Create a SenseManager instance
   PXCSenseManager *sm=PXCSenseManager::CreateInstance();

   // Enable depth stream at 320x240x60fps
   sm->EnableStream(PXCCapture::STREAM_TYPE_DEPTH,320,240,60);

   // Initialize my event handler
   MyHandler handler;
   sm->Init(&handler)

   // Stream depth samples
   sm->StreamFrames(true);

   // Clean up
   sm->Close();
   sm->Release();
}
```

# Capture color and depth stream

## ➢ Aligned

```
void CaptureAlignedColorDepthSamples(void) {
   // Create a SenseManager instance
   PXCSenseManager *sm=PXCSenseManager::CreateInstance();

   // Select the color and depth streams
   sm->EnableStream(PXCCapture::STREAM_TYPE_COLOR,640,480,30);
   sm->EnableStream(PXCCapture::STREAM_TYPE_DEPTH,320,240,30);

   // Initialize and Stream Samples
   sm->Init();
   for (;;) {
       // This function blocks until both samples are ready
       if (sm->AcquireFrame(true)<PXC_STATUS_NO_ERROR) break;

       // retrieve the color and depth samples aligned
       PXCCapture::Sample *sample=sm->QuerySample();

       // work on the samples sample->color and sample->depth
       ...

       // go fetching the next samples
       sm->ReleaseFrame();
   }

   // Close down
   sm->Release();
}
```

## ➢ Unaligned

```
void CaptureUnalignedColorDepthSamples(void) {
   // Create a SenseManager instance
   PXCSenseManager *sm=PXCSenseManager::CreateInstance();

   // Select the color and depth streams
   sm->EnableStream(PXCCapture::STREAM_TYPE_COLOR,640,480,30);
   sm->EnableStream(PXCCapture::STREAM_TYPE_DEPTH,320,240,30);

   // Initialize and Stream Samples
   sm->Init();
   for (;;) {
       // This function blocks until any sample is ready
       if (sm->AcquireFrame(false)<PXC_STATUS_NO_ERROR) break;

       // retrieve the color and depth samples unaligned
       PXCCapture::Sample *sample=sm->QuerySample();
       if (sample) {
           if (sample->color) {
               // work on the color sample
               ...
           }
           if (sample->depth) {
               // work on the depth sample
               ...
           }
       }

       // go fetching the next samples
       sm->ReleaseFrame();
   }

   // Close down
   sm->Release();
}
```

# Access Image(Audio) Data

- PXC[M]Image/Audio : interface to abstract the image/audio storage.
- Image Data Access – *AcquireAccess* : lock access to the image storage and retrieve the details in **ImageData**

  – *ReleaseAccess* : release the lock of accessing buffer.

```
// image is a PXCImage instance
PXCImage::ImageData data;
image->AcquireAccess(PXCImage::ACCESS_READ,PXCImage::COLOR_FORMAT_RGB32,&data);
... // color data in data.planes[0] in RGB32.
image->ReleaseAccess(&data);
```

# Create Image Instance

- Must use the *CreateImage* function from *PXC[M]Accelerator* interface to create PXC[M]Image

```
// session is a PXCSession instance

PXCImage::ImageInfo info;
memset(&info,0,sizeof(info));
info.format=PXCImage::COLOR_FORMAT_RGB32;
info.width=image_width;
info.height=image_height;

PXCImage::ImageData data;
memset(&data,0,sizeof(data));
data.format=PXCImage::COLOR_FORMAT_RGB32;
data.type=PXCImage::SURFACE_TYPE_SYSTEM_MEMORY;
data.planes[0]=image_buffer;
data.pitches[0]=ALIGN16(info.width*4)*info.height;

PXCSmartPtr<PXCAccelerator> accel;
session->QueryAccelerator(&accel);

PXCSmartPtr<PXCImage> image;
accel->CreateImage(&info,0,&data,&image);
```

Without Data Copy

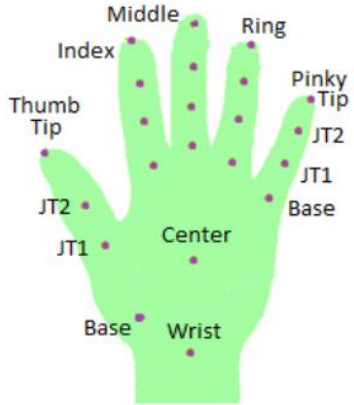
```
// session is a PXCSession instance

PXCImage::ImageInfo info;
memset(&info,0,sizeof(info));
info.format=PXCImage::COLOR_FORMAT_RGB32;
info.width=image_width;
info.height=image_height;

PXCSmartPtr<PXCAccelerator> accel;
session->QueryAccelerator(&accel);

PXCSmartPtr<PXCImage> image;
accel->CreateImage(&info,&image);

PXCImage::ImageData data;
image->AcquireAccess(PXCImage::ACCESS_WRITE,&data);
... // copy the imported image to data.planes[0]
image->ReleaseAccess(&data);
```

With Data Copy

# Hand Tracking

# Tracked information

- HandData : Hand's id, body side, finger data, joint data etc…
- FingerData : degree of foldeness of finger, radius of finger tip.
- JointData : four points of each finger, palm center, wrist.
- ExtremityData : special tracking such as left most point of the hand, nearest point of the hand to the camera etc…



# Hand Analysis Procedure

- Invoking *EnableHand* to active hand tracking in Sense Manager.
- Retrieving *PXC[M]HandModule* interface by calling *QueryHand*.
- Get detailed information of hand by utilizing *PXC[M]Hand* interface

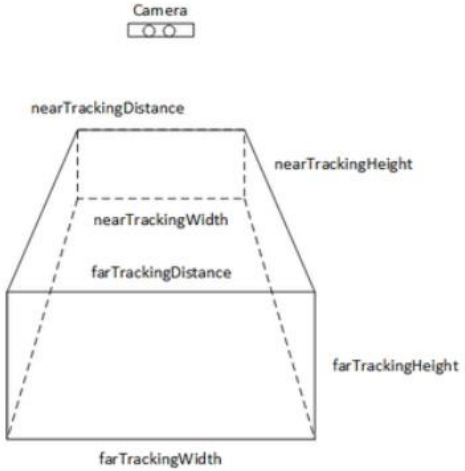
```
// Create an instance of the SenseManager
PXCSenseManager *sm=PXCSenseManager.CreateInstance();

// Enable hand tracking
sm->EnableHand();

// Get a hand instance (or inside the AcquireFrame/ReleaseFrame loop) for querying/configuring features
PXCHandModule *hand=sm->QueryHand();
...

// Initialize the pipeline
sm->Init();

// Stream data
while (sm->AcquireFrame(true)>=PXC_STATUS_NO_ERROR) {
  // retrieve hand tracking results if ready
  PXCHandModule *hand2=sm->QueryHand();
  if (hand2) {
      ...
  }

  // resume next frame processing
  sm->ReleaseFrame();
}

// Clean up
sm->Release();
```

# Configuration and boundary

- Get *PXCHandConfiguration* instance.
- Use *Update* to retrieve recent module configuration parameters.
- Use *ApplyChange* to push the changes back to hand module

```
// hand is a PXCHandModule instance
PXCHandConfiguration *cfg=hand->CreateActiveConfiguration();

// Set to enable all alerts
cfg->EnableAllAlerts();

// Apply changes
cfg->ApplyChanges();

// Clean up
cfg->Release();
```

- Use *Set/GetTrackingBounds* to change the bounds of tracking zone



# Data Retrieval

- Get *PXCHandData* instance.
- Use *Update* to retrieve recent processed data.

```
// hand is a PXCHandModule instance
PXCHandData *hdata=hand->CreateOutput();

// Get the number of tracked hands
pxcI32 nhands=hdata->QueryNumberOfHands();

// Clean up
hdata->Release();
```

- Get hand Id by *QueryHandId* to distinguish different hand.

```
// hdata is a PXCHandData instance
// retrieve the hand identifier
pxcUID handId;
hdata.QueryHandId(PXCHandAnalysis::ACCESS_ORDER_NEAR_TO_FAR, 0, handId);

// retrieve the hand data
PXCHandData::IHand *ihand=0;
hdata->QueryHandDataById(handId,&ihand);
```

# Default supporting gestures

| Illustration | Gesture Name |
|---|---|
| | spreadfingers |
| | fist |
| | tap |
| | thumb_down |

| Illustration | Gesture Name |
|---|---|
| | thumb_up |
| | two_fingers_pinch_open |
| | v_sign |

# Recognize gesture data

```
// hcfg is a PXCHandConfiguration instance

class MyHandler:public PXCHandConfiguration::GestureHandler {
public:

   virtual void PXCAPI OnFiredGesture(const PXCHandData::GestureData &data) {
      ...
   }
};

// Subscribe to the gesture notification event
MyHandler handler;
hcfg->SubscribeGesture(&handler);
hcfg->ApplyChanges();

...

// Unsubscribe
hcfg->UnsubscribeGesture(&handler);
hcfg->ApplyChanges();
```

# Handle Alert Notification

```
// hcfg is a PXCHandConfiguration instance

class MyHandler:public PXCHandConfiguration::AlertHandler {
public:

   virtual void PXCAPI OnFiredAlert(const PXCHandData::AlertData &data) {
      ...
   }
};

// Subscribe to the alert notification event
MyHandler handler;
hcfg->SubscribeAlert(&handler);
hcfg->ApplyChanges();

...

// Unsubscribe
hcfg->UnsubscribeAlert(&handler);
hcfg->ApplyChanges();
```

# Face Tracking

# Hand Analysis Procedure

- Invoking *EnableFace* to active hand tracking in Sense Manager.
- Retrieving *PXCFaceModule* interface by calling *QueryFace*.
- Get detailed information of face by utilizing *PXCFace* interface

```
// Create the SenseManager instance
PXCSenseManager *sm=PXCSenseManager.CreateInstance();

// Enable face tracking
sm->EnableFace();

// Get a face instance (or inside the AcquireFrame/ReleaseFrame loop) for configuration.
PXCFaceModule *face=sm->QueryFace();
...

// Initialize the pipeline
sm->Init();

// Stream data
while (sm->AcquireFrame(true)>=PXC_STATUS_NO_ERROR) {
  // retrieve the face tracking results
  PXCFaceModule *face2=sm->QueryFace();
  if (face2) {
      ...
  }

  // Resume next frame processing
  sm->ReleaseFrame();
}

// Clean up
sm->Release();
```

# Configuration and data retrieval

## ➢ Configuration

```
// face is a PXCFaceModule instance
PXCFaceConfiguration *cfg=face->CreateActiveConfiguration();

// Set to enable all alerts
cfg->EnableAllAlerts();

// Apply changes
cfg->ApplyChanges();

// Clean up
cfg->Release();
```

## ➢ Data retrieval

```
// face is a PXCFaceModule instance
PXCFaceData *fdata=face->CreateOutput();

// Get the number of tracked faces
pxcI32 nfaces=fdata->QueryNumberOfDetectedFaces();

// Clean up
fdata->Release();
```

# Location and expression

## ➢ Location

```
// fdata is a PXCFaceData instance
pxcI32 nfaces=fdata->QueryNumberOfDetectedFaces();
for (pxcI32 i=0;i<nfaces;i++) {
   // Retrieve the face location data instance
   PXCFaceData::Face *face=fdata->QueryFaceByIndex(i);
   PXCFaceData::DetectionData *ddata=fdata->QueryDetection();

   // work on DetectionData
   PXCRectI32 rect;
   ddata->QueryBoundingRect(&rect);
   ...
}
```

## ➢ Expression

1. Configuration

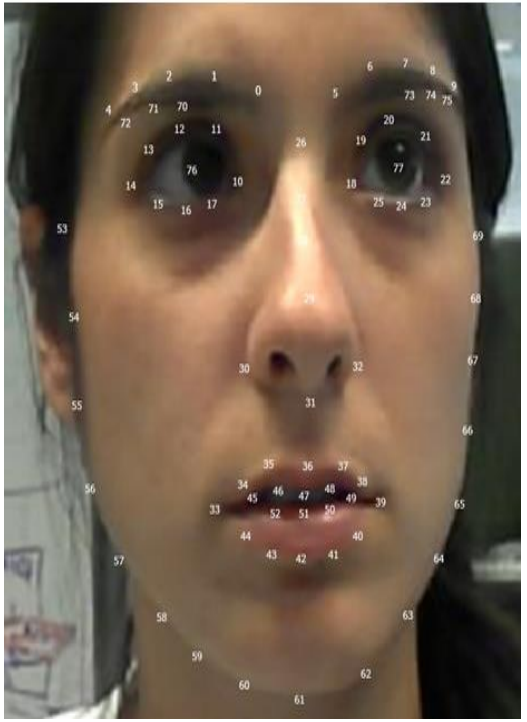
```
// cfg is a PXCFaceConfiguration instance
PXCFaceConfiguration::ExpressionsConfiguration *ecfg=cfg->QueryExpressions();
ecfg->Enable();
ecfg->EnableAllExpressions();
```

2. Retrieving

```
// fdata is a PXCFaceData instance
pxcI32 nfaces=fdata->QueryNumberOfDetectedFaces();
for (pxcI32 i=0;i<nfaces;i++) {
   // Retrieve the expression data instance
   PXCFaceData::Face *face=fdata->QueryFaceByIndex(i);
   PXCFaceData::ExpressionsData *edata= face->QueryExpressions();

   // retrieve the expression information
   PXCFaceData::ExpressionsData::FaceExpressionResult score;
   edata->QueryExpression(PXCFaceData::ExpressionsData::EXPRESSION_SMILE, &score);

   // action based on detected expression
   ...
}
```

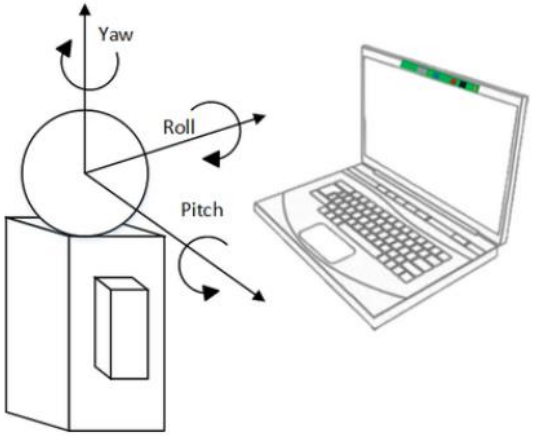
# Landmark

```
// fdata is a PXCFaceData instance
pxcI32 nfaces=fdata->QueryNumberOfDetectedFaces();
for (pxcI32 i=0;i<nfaces;i++) {
   // Retrieve the face landmark data instance
   PXCFaceData::Face *face=fdata->QueryFaceByIndex(i);
   PXCFaceData::LandmarksData *ldata=fdata->QueryLandmarks();

   // allocate the array big enough to hold the landmark points.
   pxcI32 npoints=ldata->QueryNumPoints();
   PXCFaceData::LandmarkPoint *points=new PXCFaceData::LandmarkPoint[npoints];

   // get the landmark data
   ldata->QueryPoints(points, &npoints);

   // Clean up
   delete[] points;
}
```



# Pose

```
// fdata is a PXCFaceData instance
pxcI32 nfaces=fdata->QueryNumberOfDetectedFaces();
for (pxcI32 i=0;i<nfaces;i++) {
   // Retrieve the face landmark data instance
   PXCFaceData::Face *face=fdata->QueryFaceByIndex(i);
   PXCFaceData::PoseData *pdata= face->QueryPose();

   // retrieve the pose information
   PXCFaceData::PoseEulerAngles angles;
   pdata->QueryPoseAngles(&angles);
}
```



# Recognition

## ➢ Configuration

```
// cfg is a PXCFaceConfiguration instance
PXCFaceConfiguration::RecognitionConfiguration *rcfg=cfg->QueryRecognition();

// Enable face recognition
rcfg->Enable();

// Create a recognition database
PXCFaceConfiguration::RecognitionConfiguration::RecognitionStorageDesc desc={};
desc.maxUsers=10;
rcfg->CreateStorage(L"MyDB", &desc);
rcfg->UseStorage(L"MyDB");

// Set the registeration mode
rcfg->SetRegistrationMode(PXCFaceConfiguration::RecognitionConfiguration::REGISTRATION_MODE_CONTINUOUS);

// Make it effective
cfg->ApplyChanges();
```

## ➢ Recognition

```
// fdata is a PXCFaceData instance
pxcI32 nfaces=fdata->QueryNumberOfDetectedFaces();
for (pxcI32 i=0;i<nfaces;i++) {
   // Retrieve the recognition data instance
   PXCFaceData::Face *face=fdata->QueryFaceByIndex(i);
   PXCFaceData::RecognitionData *rdata= face->QueryRecognition();

   // recognize the current face?
   pxcI32 uid=rdata->QueryUserID();
   if (uid>=0) {
       // do something with the recognized user.
       ....
   }
}
```

# Demo

Face detecting/tracking, gesture viewer

# User Experiences

Head, Gesture Tracking and Voice Recognition

# Front Facing Depth Camera Usages & Experiences

## Interact Naturally

Navigate content and perform simple actions with robust and comfortable gestures or voice

## Immersive Collaboration

Mimic real-life interactions in immersive virtual spaces and easily share or create digital content

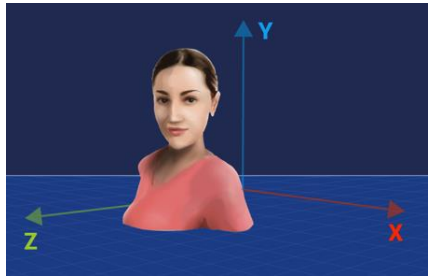
## Gaming & Play

Enhance gaming experience with natural language and intuitive gestures, AR and head tracking

## Learning & Edutainment

Blend physical and digital worlds for a more immersive and engaging learning & edutainment experience

## 3D Capture, Share & Recreate




Scan, share, edit, augment, or 3D print objects and people

# Intel® Realsense™ Camera Portfolio

## Front Facing

**BELL CLIFFS (IVCAM) (F200)**

Technology: Coded Light; VGA 60fps
Platform: HSW, BDW;
Schedule: Q4 '14
Range: Indoors; 0.2 – 1.2m
Depth Map: Realtime 60fps VGA Res
2D Camera: 1080p RGB
OS: Windows 8.1; Schedule:
SDK: Yes

Immersive Collaboration /Creation

Learning and Edutainment

Interact Naturally

Capture and Share

Gaming and Play

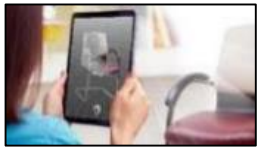
## Rear Facing

**Double Springs (DS4) (R200)**

Technology: Active Stereo; VGA 60fps
Platform: CHT/Android, BDW/Win
Schedule: 1H '15
Range: 0.5 – 3m (Indoors);
10+m Outdoors
OS: Android, Windows 8.1
Schedule: 1H''15
SDK: Yes

Immersive Gaming & Learning & Collaborate

Enhanced Video



Capture the World in 3D

Enhanced Photography

Enhanced Photography

**Davis Reef (Intel RealSense Snapshot (R100)**

Technology: 1fps post processed Stereo
Lead Platform: Moorefield
Schedule: Q4 '14
Range: 20m; Indoors/Outdoors
OS: Android, Windows - TBD
SDK: Yes

# 3D Capture, Share, and Create Usage Vision

**New Usage Opportunity**

Quickly & easily capture my world….

I want to 3D capture my physical world so I can share, edit, augment, and 3D print the things that matter to me

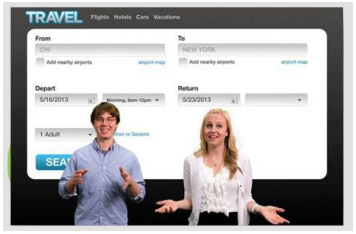
| | 2014 (Front) | 2015 (Front) | Future |
|---|---|---|---|
| 3D Object Capture | Capture a small object quickly and easily, and then 3D print, share to Facebook, or save the 3D object model | Capture a wider range of objects quickly and easily: small, medium, and large objects + areas/rooms | Establish 3D object capture usages as part of consumers' daily routines and lives, and as a viable alternative to 2D photography for specific usages |
| 3D Person Capture | Capture a face, head, or torso quickly and easily, and then 3D print, share to Facebook, or save the 3D person model | Capture a face, head, torso, or full body quickly and easily with minimal post-capture editing required | Establish 3D person capture usages as part of consumers' daily routines and lives |

# Immersive Collaboration and Creation Usage Vision

**New Usage Opportunity**

I want to interact with people at a distance as if we are together….

I want to mimic real-life interactions in immersive virtual space & facilitate easy sharing and creation of content with friends, family and colleagues



| | 2014 (Front) | 2015 (Front) | Future |
|---|---|---|---|
| HD VC | Smooth, clear HD (up to 1080p) visual quality in a larger viewing area with more detail (vs. comp and non-optimized) | Person remains in "HD" even under very slow networks. Simple ability to replace the background for more privacy. Share and interact with content | HD-TV like visual quality with ability to share any content on any network connection. |
| 3D-Enhanced Collaboration | Group video chat + content sharing all in the same virtual space, for instance on top of an online shopping web site. | More realistic user extraction, immersive casual gaming in the common virtual space, meeting transcription and note-taking, user augmentation | Establish immersive collaboration usages as part of consumers' daily routines and lives, and as a viable alternative to 2D videoconferencing |
| Content Creation | Author, record and publish a presentation with content and presenter occupying the same virtual space. | More realistic user extraction, natural interaction with your presentation content (gestures, face tracking, physics based interaction), custom content themes | Establish immersive content creation as part of consumers' daily routines and lives, encouraging greater knowledge sharing |

# Interact Naturally Usage Vision

**New Usage Opportunity**

Give me easier ways to interact with my devices….

I want to navigate my content and perform simple actions with robust and comfortable gesture interfaces, particularly when I "lean back" or otherwise cannot touch my device

| | 2014 (Front) | 2015 (Front) | Future |
|---|---|---|---|
| "Touchless Touch" | Navigate Windows 8 with gestures for a few simple, common actions on clamshell and AIO form factors. | Support more actions. Support additional form factors (e.g. tablet) and OS's. | Support more actions and features as suggested through additional UX research into user needs. |
| Gesture Applications (ISV) | Navigate maps with gestures. | More apps TBD | More apps TBD |

# Gaming and Play Consumer Usage Vision

**New Usage Opportunity**

Creating new ways to Game and Play…

want to blend my physical and digital worlds to give me more immersive and engaging forms of entertainment

| | 2014 (Front) | 2015 | Future |
|---|---|---|---|
| Gaming & Play | Enhanced gaming and play through inclusion of gestures, hand skeleton tracking, segmentation, facial tracking, object tracking, augmented reality and voice enabled through engagements with ISVs in the ecosystem | Get a natural lifelike interaction experience using scanned real life objects<br>Bring your games and favorite characters into the real world<br>Expand the ISV and ecosystem partners to deliver additional compelling gaming and play titles | Explore additional modalities and immersive technologies to further improve the gaming and play space |

# Learning and Edutainment Usage Vision

**New Usage Opportunity**

Creating new ways to Learn….

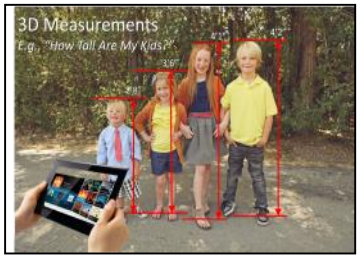
I want to be able to blend my digital and physical worlds to give me more immersive and engaging forms of learning and edutainment

| | 2014 (Front) | 2015 | Future |
|---|---|---|---|
| Learning & Edutainment | Enhanced learning and edutainment through inclusion of gestures, hand skeleton tracking, segmentation, facial tracking, object tracking, augmented reality and voice, enabled through engagements with ISVs in the ecosystem. | Build and create virtual projects<br>Show me how" to do it – assistance with everyday tasks and challenges<br>Expand ISV and ecosystem partners to deliver additional compelling learning and edutainment titles. | Explore additional modalities and immersive technologies to further improve learning and edutainment space. |

# Enhanced Photography and Videography

**New Usage Opportunity**

I take pictures as before, now I want the pictures to do more on my device, with my social friends and my business associates



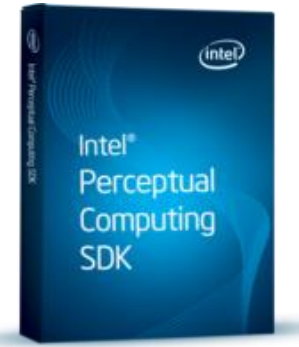
| | 2015 (Front) | Future |
|---|---|---|
| Enhanced Photography and Videography | Take a picture or video just like before – but now with depth for<br>• Measurements<br>• Selective filters (focus/color/light)<br>• Motion effects<br>• Social sharing | Cloning,<br>Better object removal and addition,<br>Better pre-shot focus,<br>Gaze correction,<br>New sizing edits<br><br>More features and applications working with ISVs in the ecosystem |

# Enhanced Photography and Videography

# Intel® RealSense™ Pillars

## Intel® RealSense™ 3D Camera

- Showcased several designs from top OEMs at CES and Computex
- Wide range of form factors (Ultrabook™, All-in-One PC, Notebook, Ultrabook™ 2 in 1)




## Intel® RealSense™ SDK 2014

- Hand/ finger tracking, background removal, AR, hand skeleton, 3D scanning
- http://www.intel.com/realsense for free download

## Intel® RealSense™ Ecosystem

- Targeting top marquee apps, indie and scale developers
- Hackathons, AE Sessions, Challenges and Webinars
- $1 Million Intel® RealSense™ App Challenge, 2014

# Additional Resources

| Resource Type | Access |
| --- | --- |
| Intel® RealSense™ technology website | http://www.intel.com/RealSense |
| Intel® RealSense™ developer resources | http://www.intel.com/RealSense/sdk |
| 2014 Intel® RealSense™ $1m challenge | http://www.intel.com/RealSense/challenge |
| Intel® RealSense™ Youtube channel | http://www.youtube.com/IntelRealSense |
| Intel® RealSense™ Facebook page | http://www.facebook.com/IntelRealSense |
| Intel® RealSense™ Twitter Page | http://www.twitter.com/IntelRealSense |

# 2014 Intel® RealSense™ Challenge

# Ideation Phase

## Pioneer

7/28/14 – 10/1/14

Phase 1 of the Intel® RealSense™ App Challenge Pioneer Track is open to developers from around the world. The 1000 Top Scoring Ideas will be invited into the Pioneer Track Development Phase.

# Development Phase

## Pioneer

11/14/14 – 01/20/15

1000 participants will be invited to turn their Ideas into working Demos. Participants will be loaned the Intel® 3D Camera as part of the development process.

# Prizes

GRAND PRIZE (1)
$25,000

One overall winner chosen from the first place winners of each category will win an additional $25,000 cash prize.

FIRST PLACE (5)
$25,000

The top scoring demo in each category will win a $25,000 cash prize

SECOND PLACE (10)
$10,000

Two demos from each of the 5 categories will receive a $10,000 cash prize

EARLY SUBMISSION (50)
$1,000

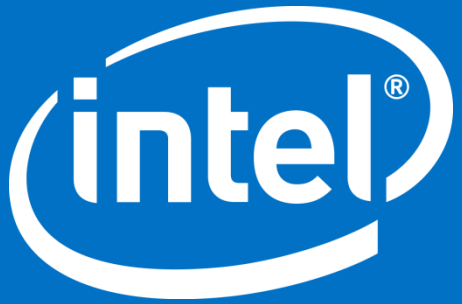
The top scoring demos, submitted prior to the Early submission deadline, across all 5 categories will each receive a cash prize of $1,000

HASWELL NUC (250)

The top 250 scoring demos from Phase 1, across all 5 categories, will receive a Haswell NUC device valued at nearly $600.

intel

Thank You

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