3D Imaging and Gesture Recognition
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• 3D Vision and TOF Technology Overview
• Key Product Lines and Products
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• Demonstration DS325 + iiisu 3.6 Close Interaction
SoftKinetic Company Intro
SoftKinetic – Who are we?
End-to-End natural gesture solutions: Full Solution Provider + IP Licensing

SoftKinetic Drives the reference design for 3D markets
About SoftKinetic
End-to-End natural gesture solution

<table>
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<tbody>
<tr>
<td>Established</td>
<td>Fundamental research since 2002.</td>
</tr>
<tr>
<td>Ownership</td>
<td>Private.</td>
</tr>
<tr>
<td>HQ</td>
<td>Brussels, Belgium.</td>
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<tr>
<td>Global</td>
<td>North America (Sunnyvale, CA) &amp; Asia (Korea, Hong-Kong).</td>
</tr>
<tr>
<td>Staff</td>
<td>110 employees with 15 nationalities.</td>
</tr>
<tr>
<td>Experts</td>
<td>User interfaces / Video games / Gesture-based applications / IC Design / Optics / Software engineering / Image processing.</td>
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<tr>
<td>Sales</td>
<td>Software sales started since Q1 2008.</td>
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<tr>
<td>Investment</td>
<td>€16 Million. Main investors include: Hunza Ventures, Belgacom, SRIW Techno.</td>
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SoftKinetic | End-to-End Depth Sensing Solution

- Time of Flight Sensors
- Cameras & Modules
- Gesture Middleware

Segment Partners

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Sensor Partner: Texas Instruments

- TI has entered into a license with SoftKinetic for 3D Time-of-Flight sensor technology
- Strategic partnership will accelerate go-to-market of gesture-based, natural user interfaces (NUI) using 3D time-of-flight imaging
- TI will produce and commercialize TI-branded 3D ToF sensors and companion ASICs as part of TI’s Audio & Imaging product portfolio
- TI and SoftKinetic will collaborate closely to develop advanced 3D ToF sensor roadmap that leverages TI’s advanced manufacturing process as well as analog and digital product portfolio
- A basic reference design called a CDK, or Camera Development Kit, will be rolled out shortly.

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SoftKinetic-Intel Connection

- Intel has licensed SoftKinetic’s 3D hand-tracking software ("iisu") to use within the PerC Software Development Kit (SDK).
  - PerC SDK also includes voice recognition from Nuance, virtual reality software and some 2D imaging algorithms from Intel Labs

- The PerC Camera is identical to the SoftKinetic DS325 – same electronics with different casing, and is manufactured for Intel/Creative by SoftKinetic Korea (SKK), a JV of SoftKinetic and Namuga of Korea.

- Creative has launched the end-consumer product as “Senz3D” in Fall of 2013
  - 3D Games & Apps
  - Face Login
  - Voice Assistant
  - Immersive Video Chat
Sony Playstation 4

- Softkinetic’s iisu® body tracking middleware has been adopted in Just Dance® 2014 for PlayStation® 4 (PS4™).
3D Vision and TOF Technology Overview
3D Vision Disruptive Technology

Evolution of Machine Vision Technologies

Black & White

Color RGB

Depth Z
3D vs. 2D Vision
Which one to choose?
Man vs Machine

3D vs 2D vision
Man vs Machine
3D vs 2D vision
SoftKinetic Vision

Enable machines to see

DepthMap + Smart Algorithms

ENABLE MACHINES TO SEE!

Smart Object Explosion

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Types of 3D technologies

How is TOF different?

• Stereo Vision – two views

• Time of Flight (TOF) – smart pixels

• Structured Light -Triangulation
TOF Measurement: Principle

Signal sent out

Signal received
TOF Measurement: Principle

Signal sent out

Signal received
TOF Measurement: Principle

Signal sent out

Signal received

Correlation
TOF Measurement: Principle

- Signal sent out
- Signal received
- Correlation
TOF Measurement: Principle

Signal sent out

Signal received

Correlation
TOF Measurement: Principle

Signal sent out

Signal received

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TOF Measurement: Principle

Signal sent out

Signal received

Correlation
DepthSense Technology

How does TOF work?

\[
\text{Phase} = \arctan\left(\frac{Q}{I}\right)
\]

\[
D = \frac{1}{2} \frac{\text{Phase}}{\frac{2\pi}{\lambda}}
\]
DepthSense Technology
How does TOF work?

$V_{\text{guide}2} \neq V_{\text{guide}1}$

$E_{1} = h\nu$

$D_{\text{eff}}, f_{m}, q_{e}$

$D_{\text{eff}}, f_{m}, q_{e}$
DepthSense Technology
TOF main parameters

\[ \Delta D = \frac{c}{2 \cdot f_m} \cdot \frac{1}{\sqrt{8}} \cdot \frac{\sqrt{q_e \cdot I_t}}{D_{\text{eff}} \cdot q_e \cdot I_s} \]

Defines Distance Uncertainty

c = 3 \times 10^8 \text{ m/s (speed of light)}

f_m = \text{modulation frequency}

D_{\text{eff}} = \text{demodulation efficiency}

q_e = \text{quantum efficiency}

I_t = \text{total intensity}

I_s = \text{active light signal intensity}
What are the benefits of TOF?

Some advantages

- **Speed** - real-time image, measure a complete scene at once, no scanning is needed
- **Robustness** - no moving components
- **Efficiency** – low CPU power required
- **Scalability** - several parameters influence the signal-to-noise ratio, such as modulated light intensity, integration interval and modulation frequency.
Comparison to structured light

Time-of-Flight
Dedicated native TOF sensor
QQVGA (160 x 120)

Structured Light
Regular sensor w/ postprocessing
VGA ???
Key Product Lines and Products

Disclaimer:
Product related data and numbers in this slide set are indications only, and do not constitute actual product specifications. The actual product specifications may differ from values mentioned in this slide set.
Depth Sensors

The road to higher resolution and more integration

- SoftKinetic depth sensors
  - Developed in house
  - Proprietary knowledge base
  - Continuous path to higher resolution and integration

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Cameras and Embedded Modules

DepthSense Roadmap

2011
Game Console / TV

2012
PC / Laptop

2013
TV / AOI Module

2014
PC / Tablet Module

2015
Mobile / Tablet Module
**Middleware: iisu**

**iisu overview**
Originaly released in 2008, SoftKinetic’s iisu middleware is the most complete, easy-to-use natural gesture recognition development environment available.

**Multi-Platform**
- SDK available on Windows®, Linux® and Android®

**Scalability**
- Highly optimized for lowest CPU usage
- Full-featured from ARM Cortex A9 to high-end Intel Sandy Bridge platforms
  - 1 core for full body tracking & scene analysis
  - Size optimized CLLib and HT modules
- Low power UI mode for TV navigation

**Deploy everywhere**
- Compatible with all 3D depth sensing cameras
- Build once and deploy on any depth sensing enabled platform

**Key Functionality**
- Filtering incoming data
- Scene segmentation
- Gesture recognition
- Full skeletal tracking on 4 individuals
- Close Interaction Hand Tracking

**SDK**
- IISU Toolbox
- Interaction Designer Tool
  - Expandable iisu gesture library

**Developer Friendly**
- Unity 3D / Adobe Flash plugins
- Freemium license model
- Quick support response

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3D Gesture based Applications

Content and Applications built on top of iisu middleware

DanceWall

Kickers
Long Range
Full Body recognition (long range) with DepthSense311

- **ILLUMINATION**: Eye-Safe Infrared light illuminates the scene
- **USB**: Simple device connection to PC
- **DEPTHSENSE**: CMOS sensor creates 3D scene data
- **SCENE**: IR light is reflected back to the camera
- **TRACKING MOVEMENTS**: iisu tracks your movements to control all the actions on screen.

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Close Interaction
Hand and Finger tracking with DepthSense 325

New range of natural gesture
- 10cm to 1m
- Intuitively interact with the desktop
- No need to constantly clean the screen
- Don’t worry what’s on your hands

Wide field of view
- Captures the space in front of your screen
- 2 hand / 10 finger tracking

Lag Free
- 60 FPS captures every movement
- Mouse-like precision at your fingertips
DS325: World’s First 3D Time-of-Flight Camera for PC/Laptop, CR

Intel Perceptual Computing Project

- PC Peripheral
  - QVGA depth resolution
  - HD RGB
  - 2 Microphones

- Optimized and Certified
  - iisu 3.5 and higher (Close Range)
  - Intel Perceptual Computing SDK

- In Production

Single USB Connection
Long-Range Module & Camera

**DS520**

- For TV and All-in-One
- QVGA depth resolution; HD RGB; 2 Microphones
- Timeframe
  - Samples available now

**DS320**
Short-Range Module

DS536

- Available resolution: QQVGA
- Close Range

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Application Examples
Market Opportunity

Application Examples: Consumer Electronics & Professional Markets

- Automotive
- Robotics
- Digital Signage
- Home Automation
- Virtual Reality
- Medical
- Health
- Sport & Fitness
- Retail
- Military
- Television
- Video Games
- Entertainment
- Computers
- Handheld

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## Application Examples (standalone or module)

### Consumer Products
- **Virtual reality**
  - Augmented reality applications
- **Home automation**
  - Home equipment gesture control
- **Health**
  - Revalidation exercise equipment
- **Sports & Fitness**
  - Monitoring equipment e.g. counters
- **Television**
  - Remote control
- **Video Games & Entertainment:**
  - 3D interactive

### Professional & Industrial
- **Robotics**
  - Robotics vision & obstacle detection
- **Digital Signage**
  - Interactive advertising
- **Retail**
  - Retargeting to avatar wearing virtual garments
- **Military**
  - Combat simulation

### LR
- **Computer:** 3D gesture control
- **Handheld devices:** 3D gesture control
- **Home automation**
  - Home equipment gesture control
- **Video Games & Entertainment:**
  - 3D interactive
  - 3D scanning (and printing)
- **Glasses with built-in camera:** augmented reality

### CI
- **Automotive**
  - On board equipment 3D gesture control
  - Driver monitoring applications
- **Medical**
  - E.g. 3D Face recognition
What’s next?

Smart objects
Demonstration
DS325 + iisu 3.6
Close Interaction
Demo: DSSDK Depthsenseviewer

Color, Phase, Confidence, Depth, Vertices, UV mapped on vertices

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Demo: iisu Toolbox

**CI demo**

- **Features**
  - LR and CI
  - Gesture and posture recognition
    - LR: gesture control box, incl. number signs
    - CI: gesture and posture recognition
  - Full tracking
    - LR: Full skeletal tracking, single or multi player
    - CI: Full hand tracking (fingertips, palm normal, ..)

- iisu Toolbox
  - offers control and visualization of iisu data

- Interaction Designer
  - Expandable iisu gesture library

- Full SW API
  - Access to a wide range of 3D data, parameters, events, filters, ...

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Demo: CI Applications
Supersonic Stuntman, 3D Object manipulation, Augmented Reality

Head Tracking