# Forum 8

# Fusion of 3D Scan and Thermography data to Visualize Heat and Water Leaks in Buildings

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2011/11/17

# 3D Scanning System: Overview

Project started this year (2011)

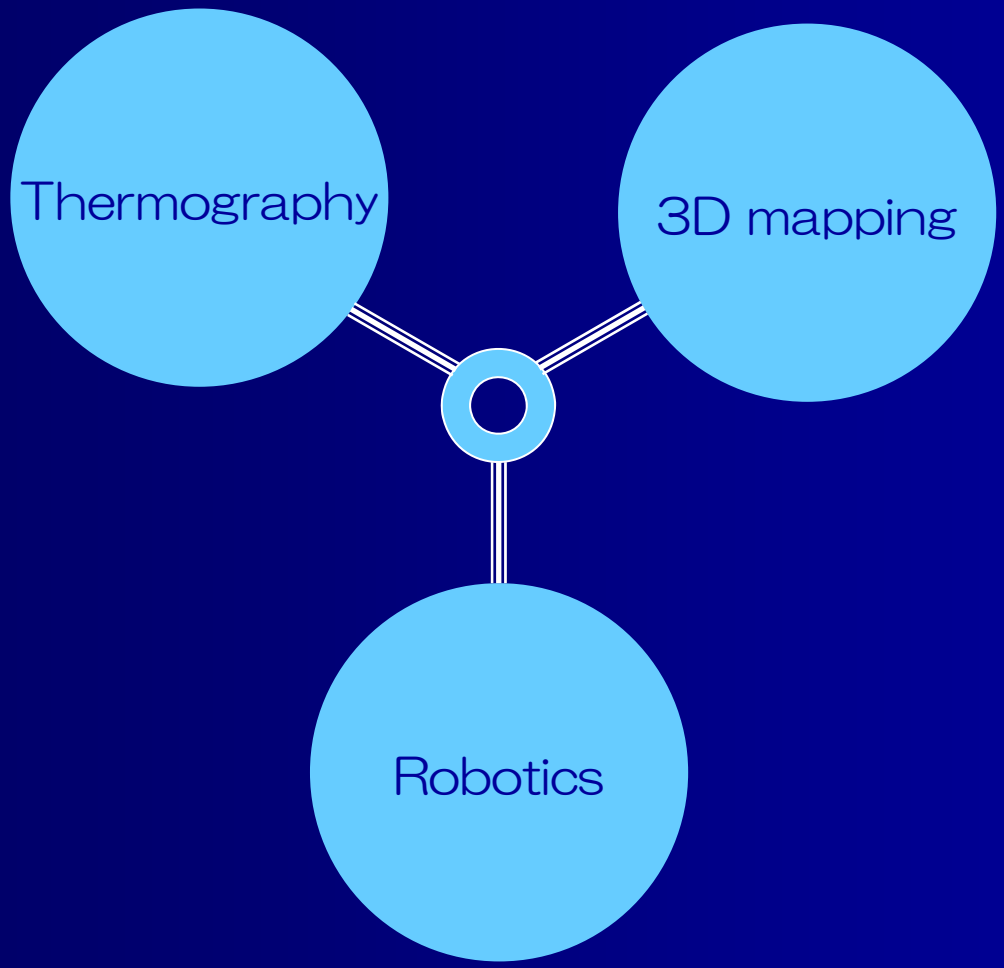
Main idea: integrating thermography data to existing 3D mapping technologies

Purpose: produce a 3D representation of the heat and water leaks of buildings and homes to improve inspection process
(optimization of energy efficiency)

Prospects: by extension, 3D mapping of sensor data in areas not easily accessible or potentially dangerous for Humans (nuclear plant)

2. Depth Camera Applications: Handleless driving, Gesture Interface, Digital Signage, Motion Capture (BVH Module)

# 3D Scanning System: Main Modules



# 1. Thermography Module

# 1. Thermography Module

Detection of temperature gradients by using a far infrared camera (Tau320).

Tau320 (from FLIR)

# 1. Thermography Module

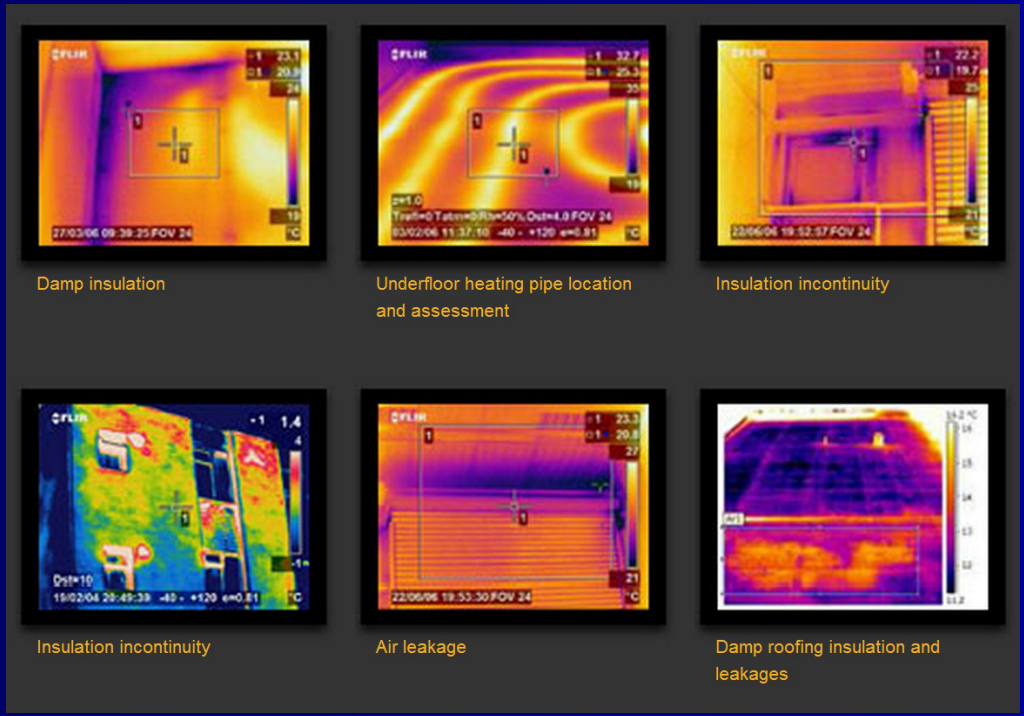
The gradient map can be represented in real time with different colormaps

Main limitation: cost of the infrared camera (Tau320: ¥900,000)

➔ Development of a prototype integrating an RGB camera.

# 1. Thermography Module

*Building heat scans by using a thermography camera:*



Damp insulation

Underfloor heating pipe location and assessment

Insulation incontinuity

Insulation incontinuity

Air leakage

Damp roofing insulation and leakages

*Current applications of heat scans with different colormaps*

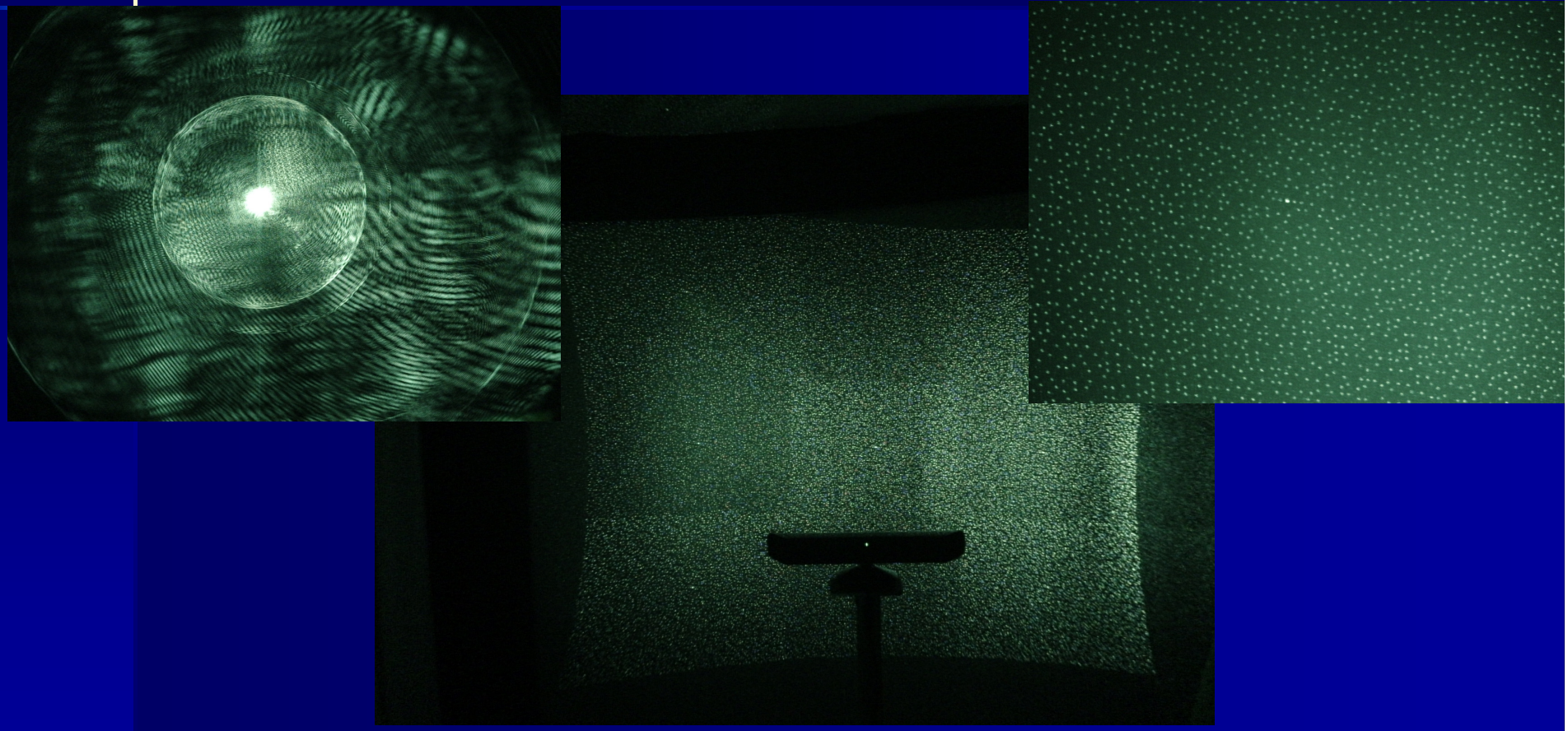
# 2. 3D Mapping Module

# 2. 3D Mapping Module: Depth Camera

3D mapping: achieved by using the depth map capability of the XtionPRO or Kinect Sensor (using a near infrared laser).

Xtion PRO
(PrimeSense & ASUS)

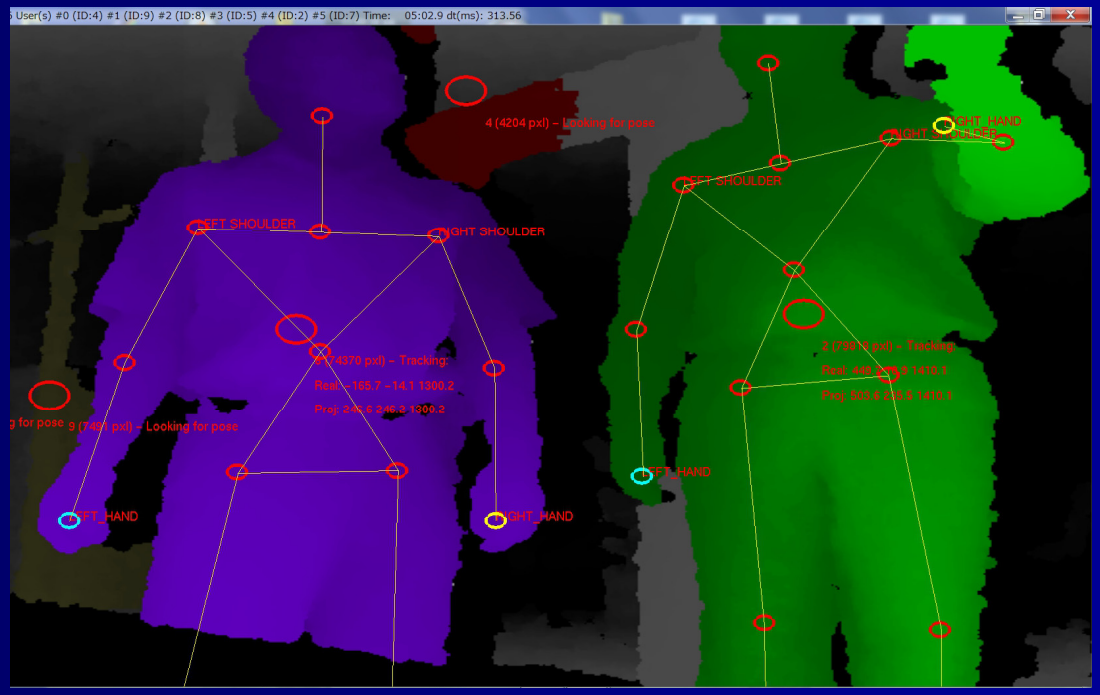
# 2. 3D Mapping Module: Depth Camera



Kinect: Infrared laser Pattern projected on a wall

# 2. 3D Mapping Module: Applications of depth camera

- *Gesture Interface based on Depth Camera (Kinect, Xtion Pro)*



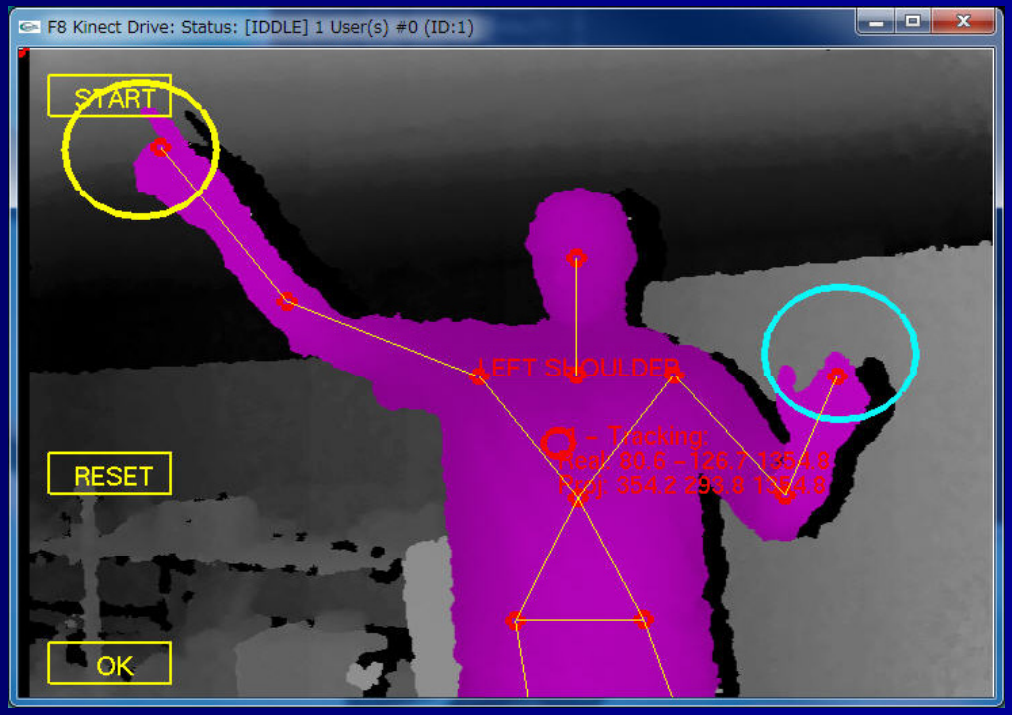

Skeleton tracking, Multi-users

Application: Human/Machine Interface

(Air Driving, Digital Signage)

# 2. 3D Mapping Module: Applications of depth camera

- *Gesture Interface based on Depth Camera (Kinect, Xtion Pro)*

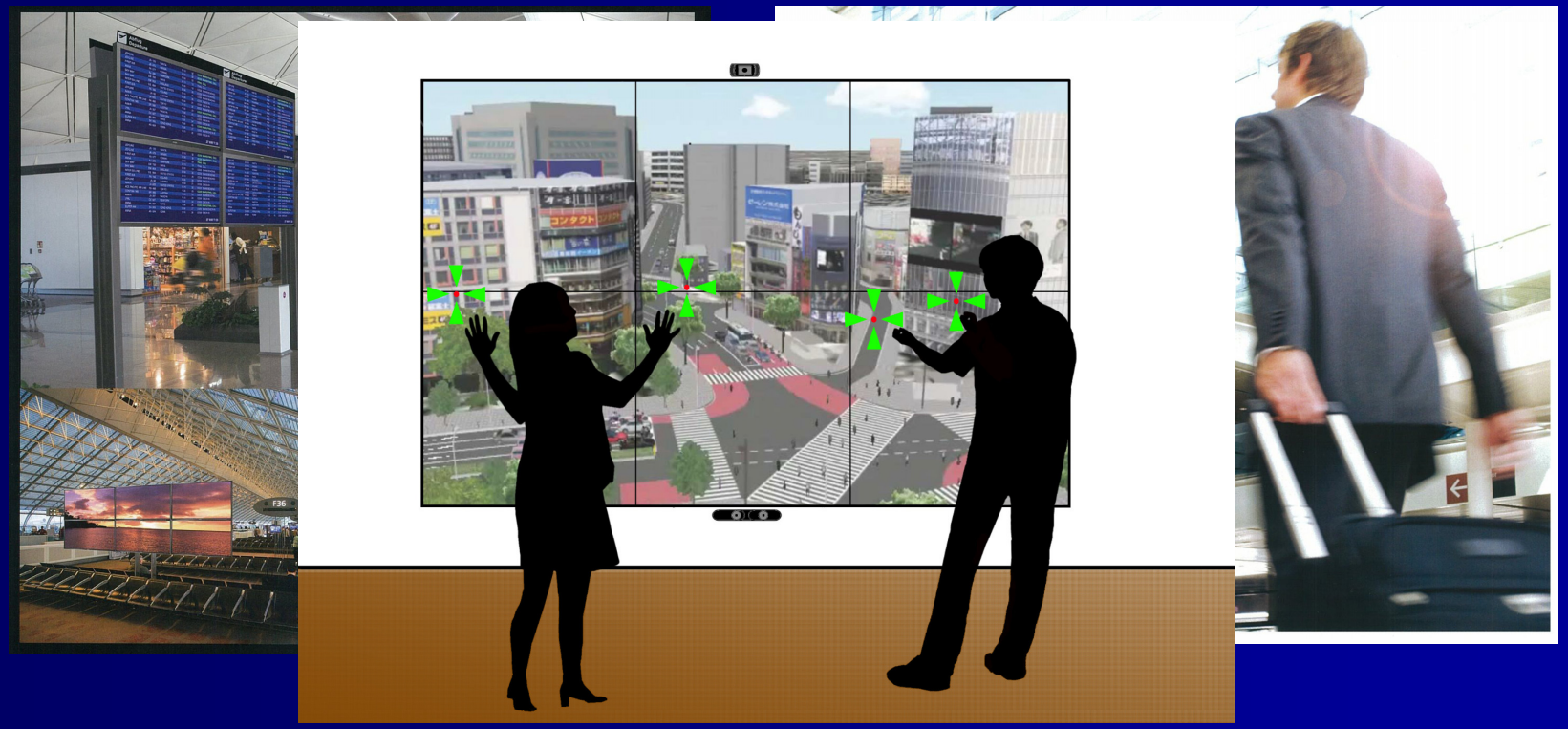



*Gesture Interface (First Version)*
*(Second version in demonstration at design festival)*

# 2. 3D Mapping Module: Applications of depth camera

- Digital Signage (New Project 2011)

User interaction based on depth camera (Xtion PRO)



Digital Signage Examples
Interactive Digital Signage System

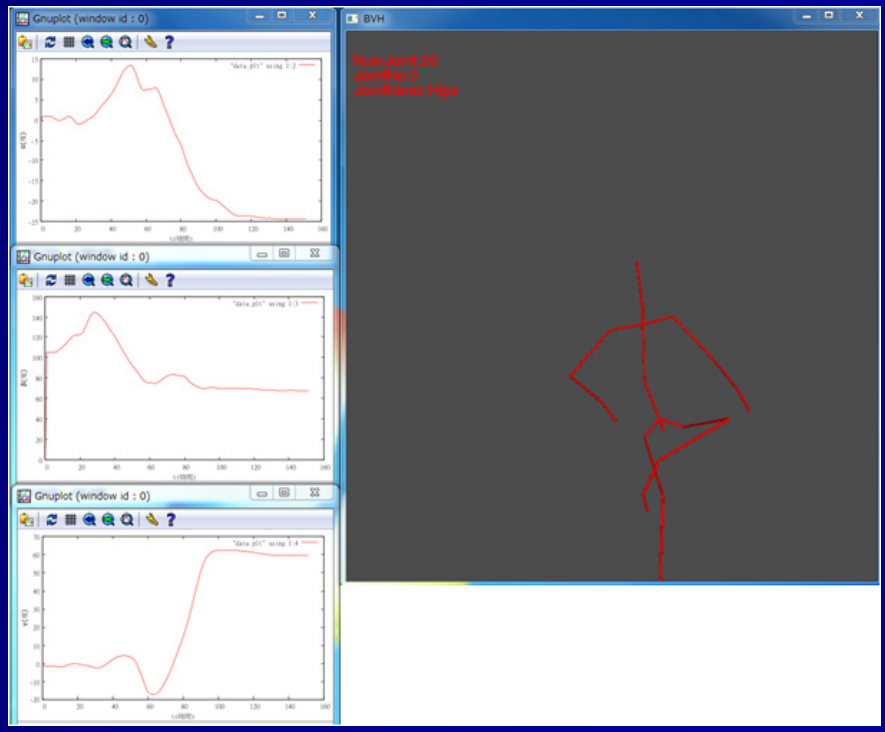
# 2. 3D Mapping Module: Applications of depth camera

- Motion Capture:

BVH Module (BioVision Hierarchical data)
Purpose: create our own FBX models

```
HIERARCHY
ROOT root_name
{
  OFFSET 0 0 0
  CHANNELS 6 Xposition Yposition Zposition Xrotation Yrotation Zrotation
  JOINT joint1
  {
    OFFSET 0 10 0
    CHANNELS 3 Xrotation Yrotation Zrotation
    End Site
    {
      OFFSET 0 10 0
    }
  }
}
MOTION
Frames: 100
Frame Time: 0.033
0 0 0 0 0 0 0 0 0    ←フレーム1の姿勢
0 0 0 0 0 0 0 0 0    ←フレーム2の姿勢
...
0 0 0 0 0 0 0 0 0    ←フレーム100の姿勢
```

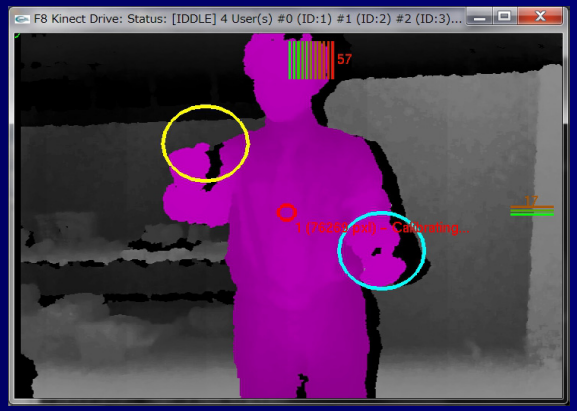
Support of BVH format




FBX model: Forum8 Motion Editor

# 2. 3D Mapping Module: Applications of depth camera

## 、Handleless driving: *Air Driving*




Air Driving

Wheel Angle
Accel/Brake

+ Gesture
(2011/09)

UC-win/Road

# 2. 3D Mapping Module: Applications of depth camera

、 Handleless driving: *Air Driving*


Air Driving:
Accurate control of Acceleration/Brake
in seating position
(CEATEC 2011)

# 2. 3D Mapping Module: Applications of depth camera

## 、 Handleless driving: *Air Driving*

### Air Driving: References

**BBC Click**
bbc、co、uk/click (˝Ceatec – pushing a touch screen's buttons˝)

**Gizmodo**
http://www、gizmodo、jp/2011/10/ ceatecvrdrivear、html

# 2. 3D Mapping Module

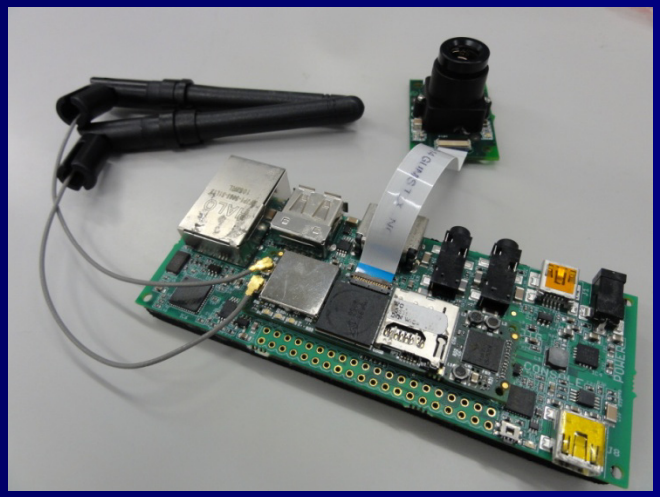
- Video 1: Gesture capture
- Video 2: Environment reconstruction (SLAM algorithm)

# 3. Robotics

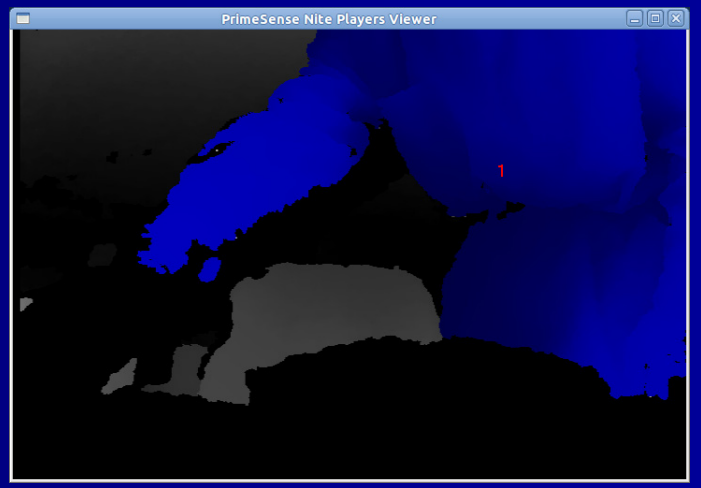
# 3. Robotics

- Core: Gumstix Overo
  - OS: Ubuntu, Angstrom Linux
  - Size: 105mm*40mm

  ➔ Integration on small robots to access to the Kinect, Xtion PRO data



Gumstix Overo

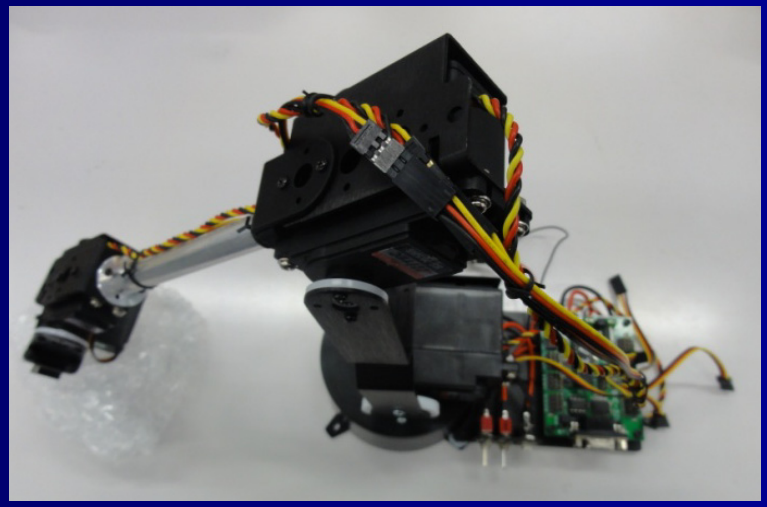



Depth map
(Kinect + Gumstix Overo)

# 3. Robotics

Robot Arm:

Allows a smooth scanning of the environment while keeping the robot in stationary position



Robot Arm

# 3. Robotics

Scanning system in 3 configurations:

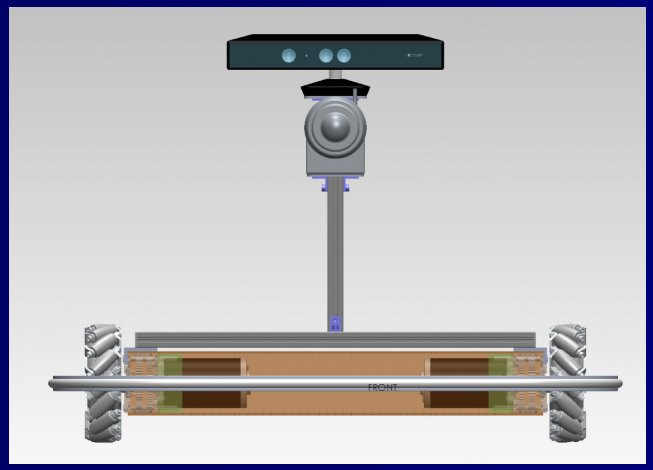
1. Hand type

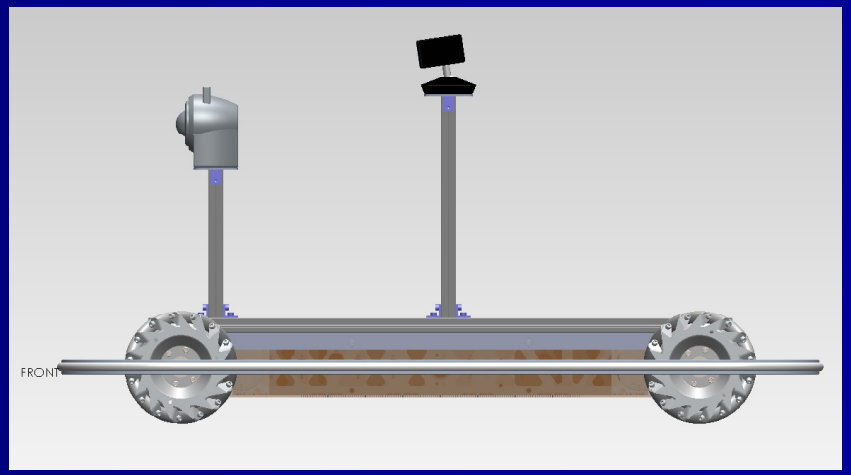
2. Mobile Robot type

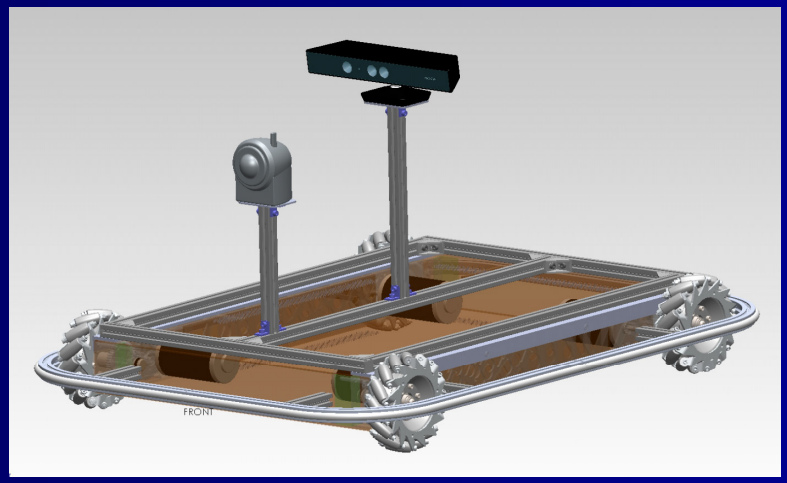
3. UAV type (Unmanned Aerial Vehicle)

# 3. Robotics

- Mobile Robot Type




3D environment reconstruction

# 3. Robotics

- UAV Type (Unmanned Aerial Vehicle): AR Drone

AR Drone development (Quadricopter)

- iPhone Controlled
- 2 Cameras (Front & Underneath)
- Automatic Altitude Control

# 3. Robotics

- UAV Type (Unmanned Aerial Vehicle): AR Drone

## AR Drone: Control from PC



3D Tracking of ARDrone using AURELO
(ARDrone Controlled from PC)

# 4. Conclusion

A new project was started at Forum8, with the fusion of Thermography, 3D mapping and robotics to allow a 3D representation of heat scans of buildings.

We are currently testing the Xtion PRO in the 3D mapping context with different algorithms, as well as developing a robotic platform to carry autonomously the scanning system and sensors.

By extension, this system will be used for scanning potentially dangerous places like nuclear plants.