Augmented reality with HoloLens

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Microsoft HoloLens
Augmented vs. Virtual reality

AR is **not** just VR + CG layer!

AR has extra:
- multifocal rendering
- understanding of environment topology
- inside out tracking, anchors
- lighting

AR is a new computation/presentation platform
Microsoft HoloLens (2016-)

- Holographic visualization (GPU, stereo)
- Wireless: Bluetooth, WiFi
- Voice commands, hand gestures
- Real-time spatial mapping (to understand the current environment)
- Precise 6DOF tracking & sharing (anchors)
  - 4 environment cameras
How is it made?

**Holographic display**
- beam “waveguide”
- 4 layers: RGBG

**Spatial mapping, tracking**
- Inertial Measurement Unit
- IR beamers + 4 IR cameras
- 1 depth camera
- 1 HD IM camera

**Computation**
- HPU (custom)
- CPU (Intel Atom 1GHz)
- GPU (Intel)
AR light combining system

Patent US 2016/0231568 (based on Nokia research)
- very small structures (~wavelength), TIR
Details

Windows 10
- limited multitasking
- UWP, DirectX 11.1

Memory
- 2GB RAM
- 64GB Flash

RGB camera
- 1280×720, 45° horizontal

Optics
- 2 HD 16:9 light engines
- Holo resolution: 2.3M total light points
- Holo density: >2.5k radiants (light points per radian)
HPU – Holographic Processor Unit

- 24 Tensilica DSP cores
- 1GB internal DDR3 DRAM
- FPGA (i.e. “custom”)
- 300 special custom instructions
- 65M logic gates
- 8MB static RAM
Spatial mapping

Based on “Time of Flight”
– similar to lidar systems
Energy efficient, compact
Allows multiple users to work simultaneously!
Inside-out tracking

Tracking position and orientation of the helmet
- passive (observing the environment)

Markerless!

Allows multiple users

Transform of coordinate systems
“Anchor”
- significant part of 3D scene
- 3D maps + textures

Limitations:
- exteriors
- big space
- how to track controllers?
Programming

Layers, API

0. hardware
1. driver & Microsoft layer
2. HL API, Win10 UWP (C++)
3. Unity, Vuforia, OpenCV (C#, C++)
Limitations of HoloLens 1 (2↑)

- Limited field of view
  - 30 × 17.5° only

- IR spatial mapping
  - sunlight, limited distance, 3cm detail

- No GPS, no GSM
  - not intended for outdoors

- No chance to dim incoming light

- Turning around ⇒ losing orientation?
  - rear camera?

- Intel Atom CPU (performance)
  - will be replaced (Snapdragon 850)
Typical applications

- Medicine
- Engineering
- Military
- Architecture

B2B applications
- … whenever artificial 3D data layers are needed
Fata Morgana

Real-time streaming of reconstructed environment to distant VR operators

- comments
- navigation
- communication
- object classification
- measurements, environment analysis

Additional sensor system
Fata Morgana in Temelín

Pocket Virtuality + ŠKODA JS a. s.
- service support in a nuclear power-plant
- reduce the dose of radiation
- better assistance
HoloObserver

Shows artificial 3D model on a real object

Server-client
  – multiple user support
  – guide mode (Visitor)

Object recognition and automatic alignment
Holotable

Horizontal big **touch-screen** (table)

Synchronized 3D content

Clients with HoloLenses (1+)
Augmented patient

Physical figurine
– tracking (even limbs!)

Augmented graphics in HoloLens
AR in education

Math (geometry)
Chemistry
Biology

© Zienta.com (Geometry 101)

© ThinkMobiles

© Gregory Woods
AR in science

Exploration of 3D objects in real space
  - user is able to select best viewpoints

Visualization
  - + “steering” (dynamic control)
Mixed Reality API (DirectX 11+)

HolographicFrame
- prediction of future headset position and orientation

Stereo rendering
- transparent dual-render-target using instancing
- custom instancing can be preserved
- tuple of View-Projection matrices (small modifications of vertex/geometry/tessellation shaders)

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Future will be augmented!

© 2016 Keiichi Matsuda (Hyper-Reality)