New 3D video subjective test method: a multidimensional approach

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Context

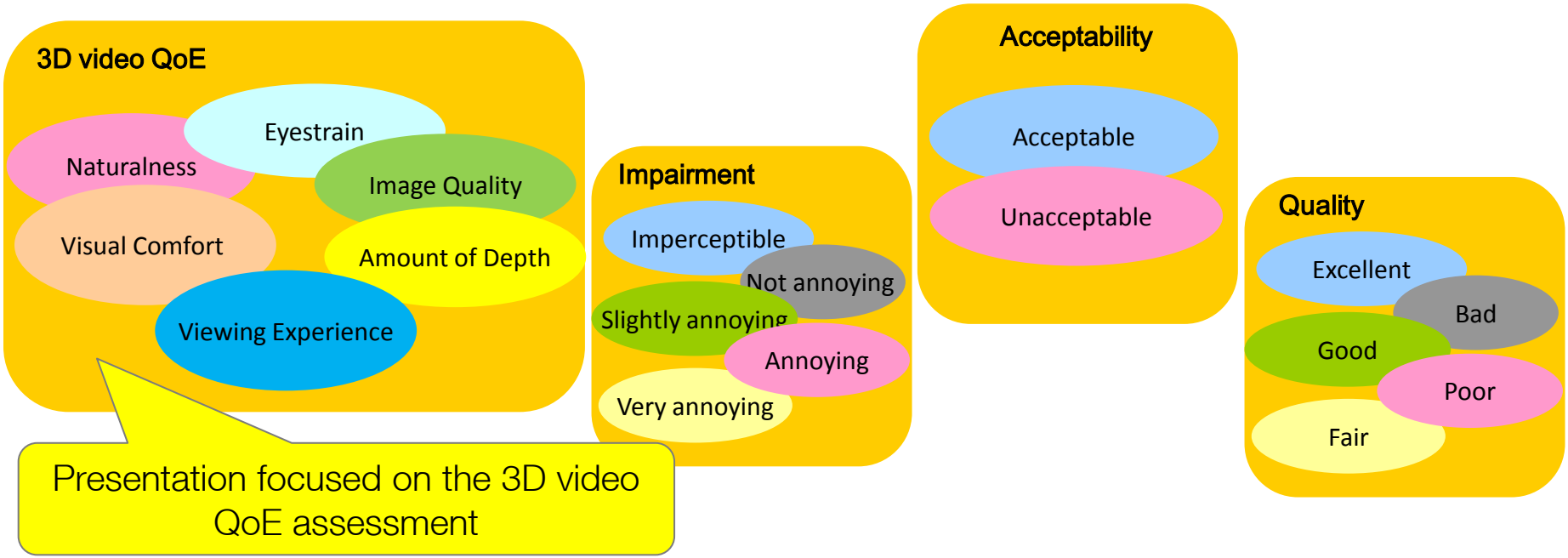
Subjective assessment of 3D video contents

- **New 3D video contents brings new QoE to viewers**
  - Enhancement of the Visual Experience due to the added binocular depth
  - But also new problems such as visual discomfort
- **Subjective video quality assessment is the conventional method to assess the perceived quality of 3D video contents**
  - However, the conventional perceived Image Quality concept is not enough to reveal the advantages and the drawbacks of 3D contents
- **The main goal of this contribution is to propose key elements to consider in a new 3d video subjective test method**
  - SAMVIQ-based method (Recommendation ITU-R BT.1788)
  - Use of 3 quality scales: Visual Experience, Image Quality and Visual Comfort
  - Selection of Reference considering Visual Comfort and Visual Experience

3D video quality assessment

Experiment on binocular depth issue

- An experiment has been conducted on the 3D video QoE
  - Exploration of binocular depth variations
- 3D video QoE indicators : multidimensional approach is required



Exploration of 3D video QoE: the binocular depth issue

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QoE indicators for stereoscopic images

Multidimensional approach is required

- ‘2D’ Image quality
  - Rendering of texture and motion, visibility
- Depth quantity
  - Amount of perceived depth using the monocular and binocular depth cues
- Visual comfort
  - Related to multi-symptoms (e.g. eye strain, dry eyes, double vision) as well as the sensation of visual impairment or the sense of vision difficulties when moving the fixation point from one area of the image to another area
- Depth rendering
  - Quality of perceived depth, depending on the subject’s preference on the basic criteria related to stretching or compression of the depth and the shape of objects
- Naturalness
  - Natural appearance of images, i.e. more or less representative of reality
- Visual experience
  - Overall quality of experience in terms of immersion, perceived image quality as well as depth rendering (shape and dimension)

Since non-expert viewers do not have a lot of experience on stereoscopic images, **a clear definition of QoE indicators is very important**.

Stereoscopic images generation and capture

Natural and synthetic contents

Basket

Butterfly

Interview

Forest

Bench

Natural scene capture is sponsored by

Depth(in meter) features per scene

Scene Name*	Foreground	Background	Region of Interest	Zero disparity plane
Basket(N)	5	10	7	5
Butterfly(S)	5.8	12	6.8	6.8
Forest(S)	5	23	7.5	5
Interview(N)	2.6	5	3	2.6
Bench(N)	<14	32	20	14

Natural content: Mirror rig and side-by-side rig with two professional 2D cameras (camera sensor 8.8x6.6 mm^2)

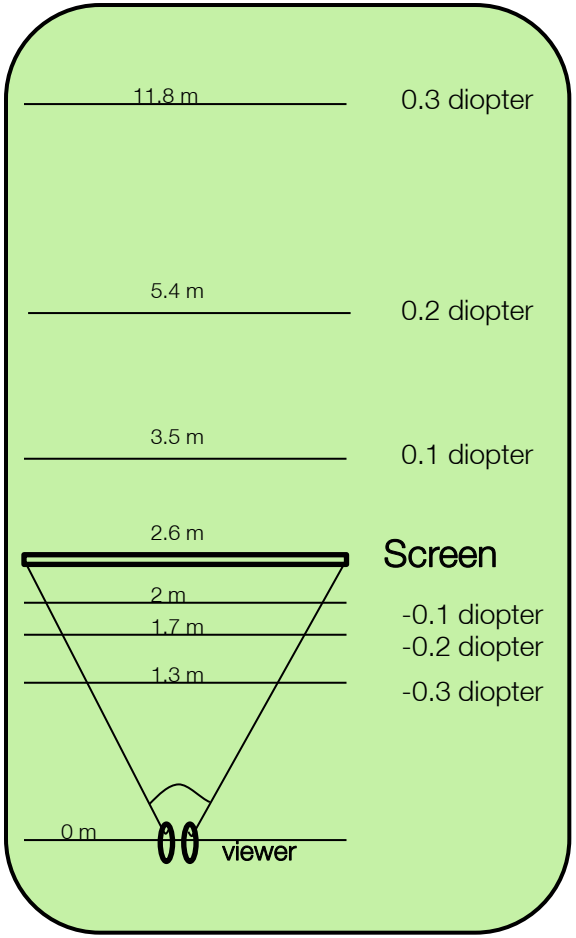
Synthetic content: Blender software (virtual camera sensor 32x16 mm^2)

Scene complexity in terms of texture, motion and depth is a key issue to assess the 3D video QoE

Scene features

Shooting parameter and distortion estimation

Different camera baselines for the same perceived depth

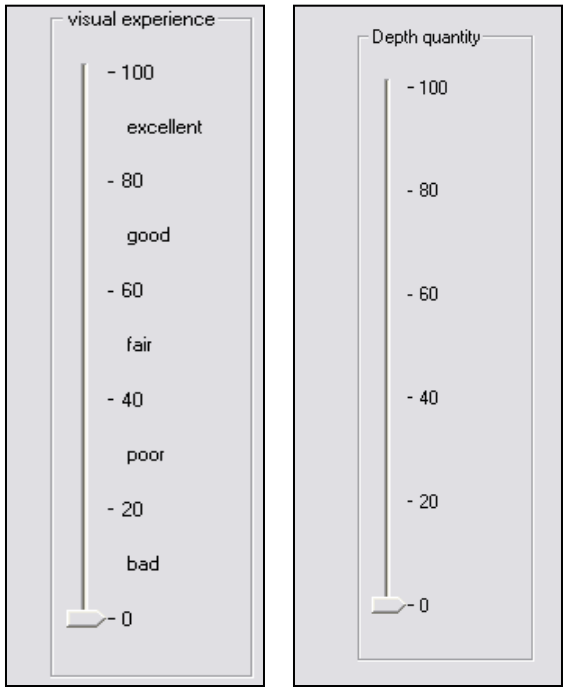


Scene Name	Focal	Camera baseline		
		DoF 0.1	DoF 0.2	DoF 0.3
Basket(N)	9	160	324	485
Butterfly(S)	70	118	236	353
Forest(S)	36	93	185	278
Interview(N)	22.5	35	65	105
Bench(N)	20	180	362	540

Scene Name	Stereoscopic shape distortion factor		
	DoF 0.1	DoF 0.2	DoF 0.3
Basket(N)	1	2.54	4.76
Butterfly(S)	0.69	1.38	2
Forest(S)	0.55	1.26	2.20
Interview(N)	0.5	1	1.78
Bench(N)	0.41	1	1.8

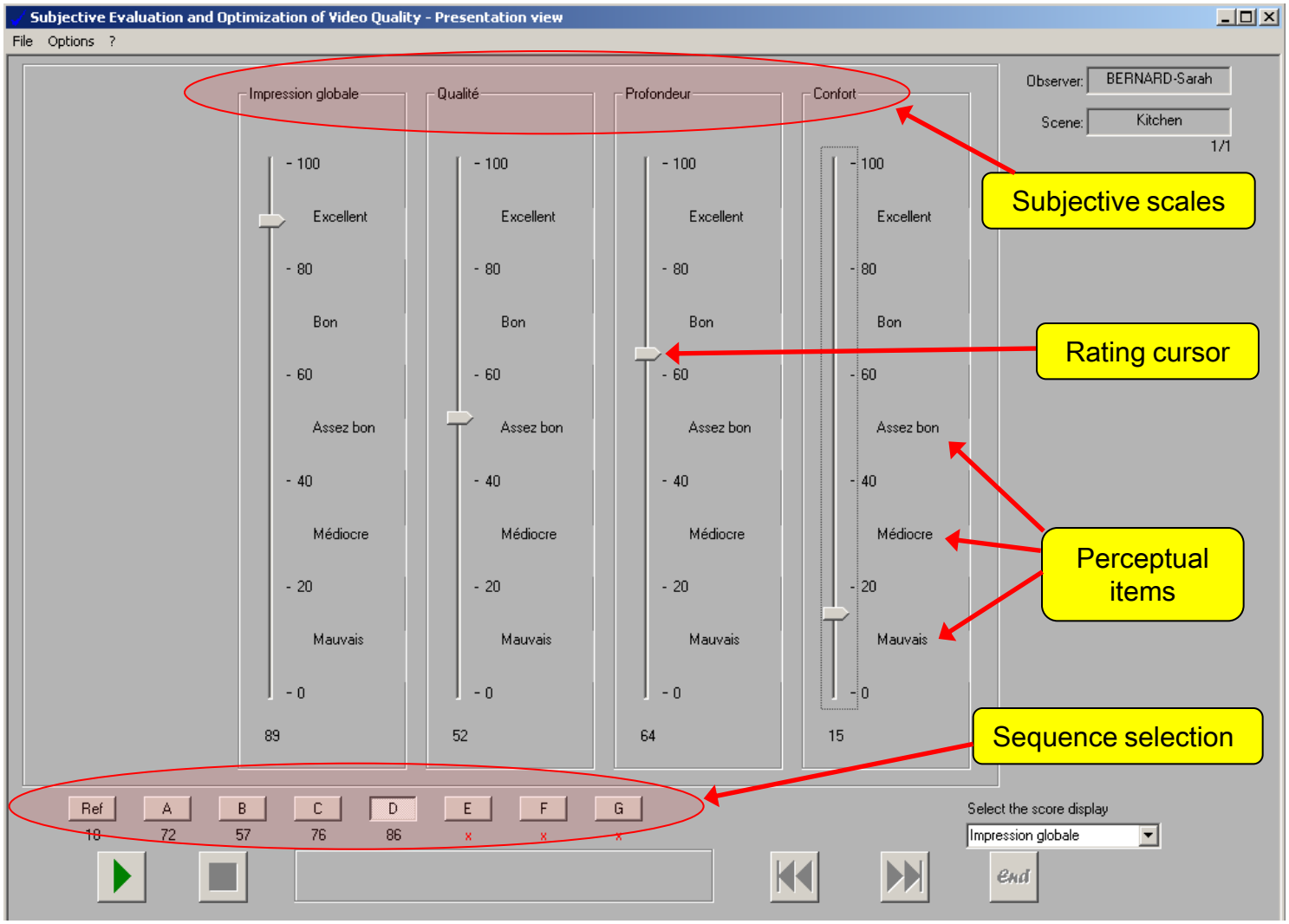
Subjective quality assessment
Test environment

- **Test session**
  - Six session corresponding to the six QoE indicators
  - Each session 4x5 stimuli
- **Equipment**
  - ITU-R BT.500 compatible environment
  - 46 inch Hyundai S465D line interleaved display
  - 4.5 times of display height viewing distance
- **Observers**
  - 28 observers (Pass the vision test)
- **Stimuli:**
  - 2D, 0.1, 0.2 0.3 DOF for five scenes
- **Procedure:**
  - SAMVIQ method



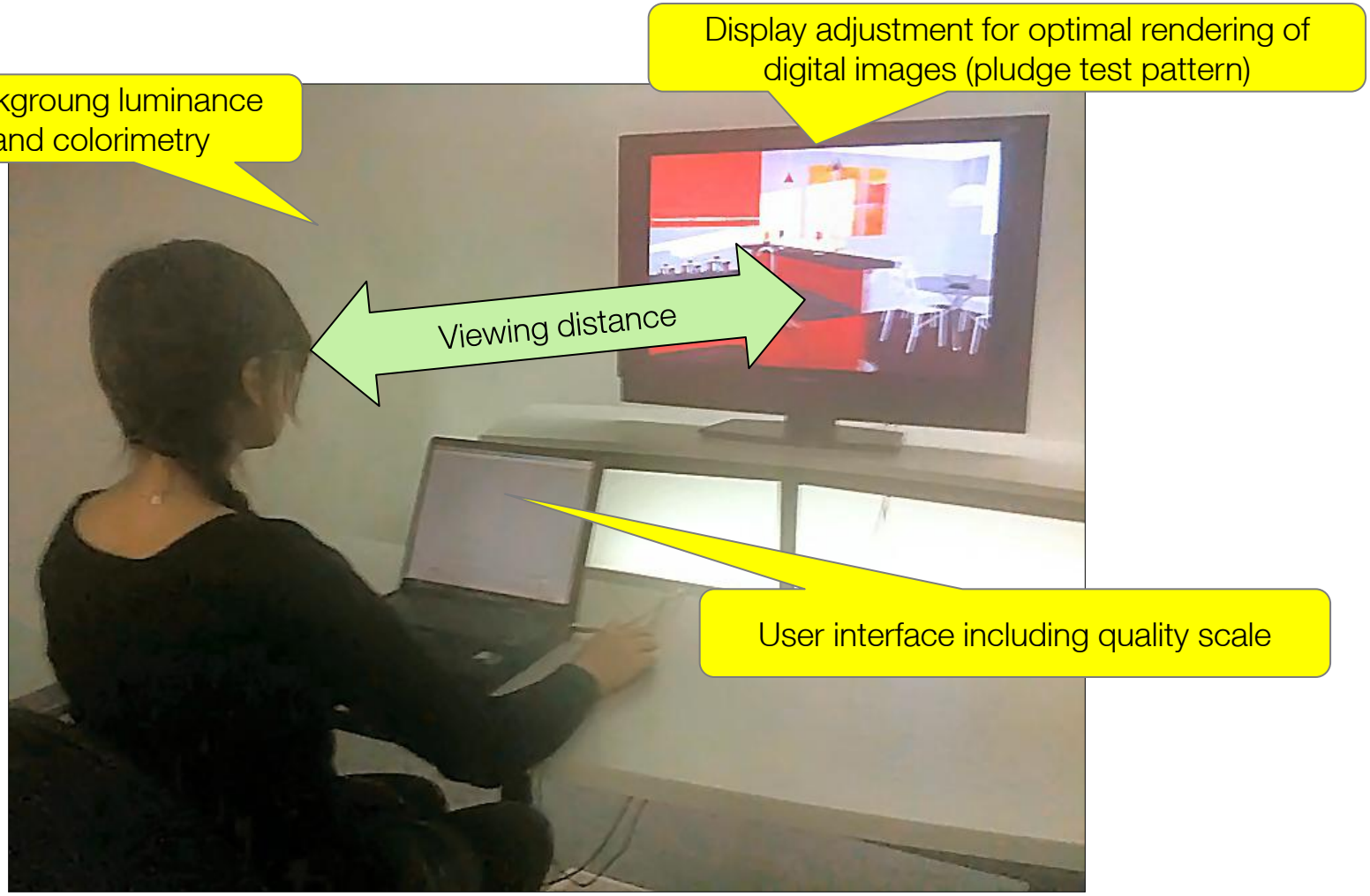
3D test methodology

User interface description: scales presented separately in experiments



Testing room environment

3D-TV example: user interface using a continuous quality scale

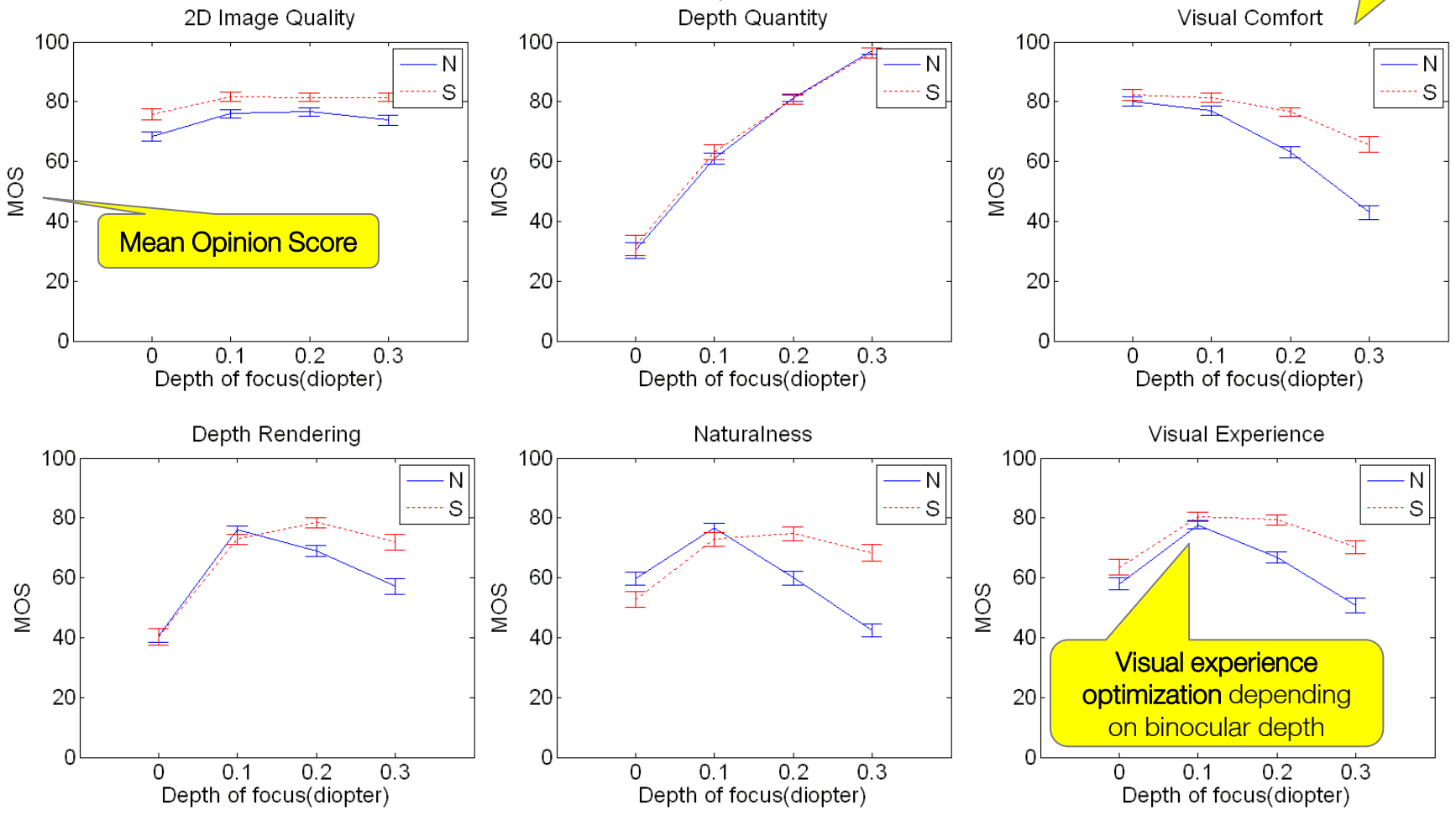


Main results

Considering quality indicators and scene contents

Increasing the binocular depth **increase the perceived depth quantity**

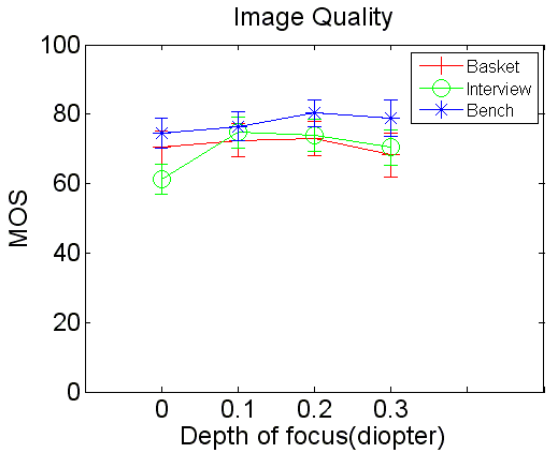
Increasing binocular depth **decrease the visual comfort.**

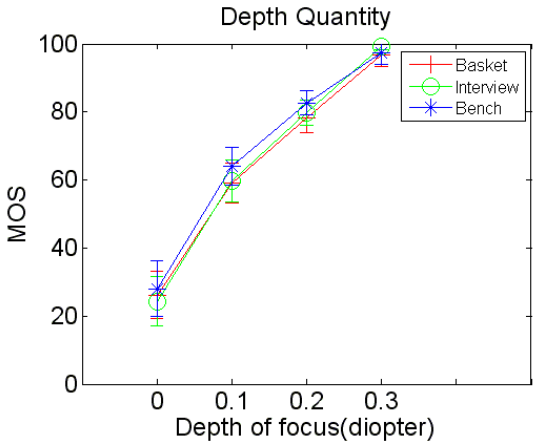


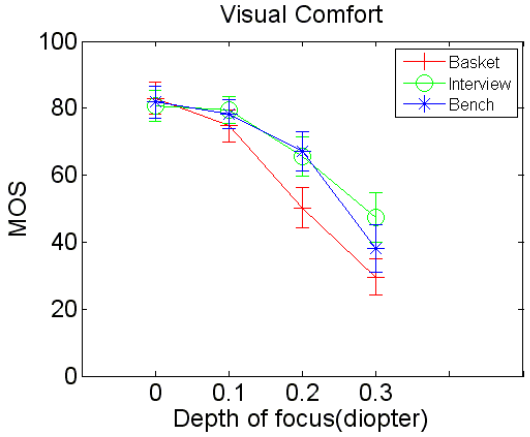
MOS (with their 95% confidence intervals) vs. variation of DoF for different QoE indicators (Natural scene in solid line and Synthetic scene in dotted line)

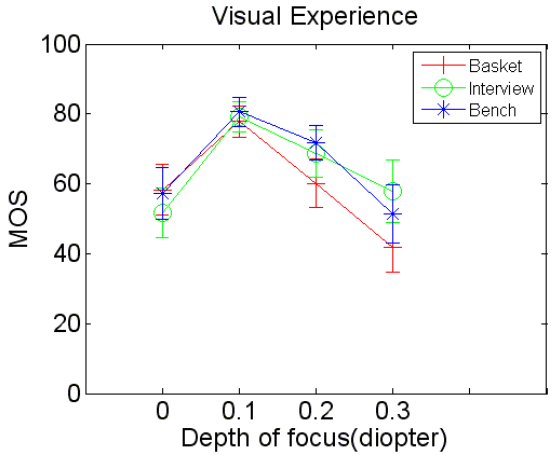
Main results

Focus on natural scene contents results







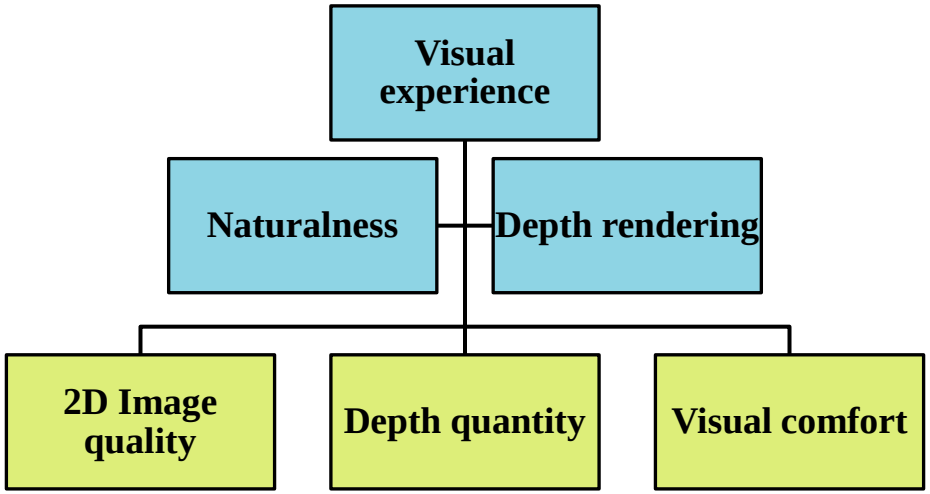


- We observe that optimization of Visual Experience is the trade-off between Depth Quantity and Visual Comfort.

MOS (with their 95% confidence intervals) vs. variation of DoF for different QoE indicators

Modeling the 3D video QoE

Basic and Higher level quality indicators



- Basic level indicators
  - 2D Image quality (IQ)
  - Depth quantity (D)
  - Visual comfort (VC)
- Higher level indicators (QoE)
  - Visual experience
  - Naturalness
  - Depth rendering

Proposal for a new 3D video subjective test method

Proposal

Elements to be considered in a new 3D video test method

- **SAMVIQ-based approach (Recommendation ITU-R BT. 1788)**
  - Multi stimulus method with random access to sequences
    - Sequences to evaluate are directly accessible (scene access)
    - Viewers can start or stop the evaluation, give, change or keep the current score of each clip when they want
  - Good discrimination between low quality as well as high quality video contents
    - Use of References (sequences without any treatment)
    - Subjective evaluation capabilities and ability to discriminate near quality
  - Continuous quality scale graded from 0 to 100 annotated by 5 linearly spaced quality items (Excellent, good, fair, poor, bad)
  - Results accuracy and reliability with non-expert viewers
- **Visual Experience, Image Quality and Visual Comfort in case of 3D**
  - Depth quantity not needed: linear relationship with physical parameters
  - Naturalness and Depth rendering not needed: highly correlated to Visual Experience

Proposal

Elements to be considered to select reference test material

- **Selection of References: Visual Experience and Visual Comfort requirements**
  - To ensure a fair comparison of technologies as well as reliable results, we propose to select original scene contents as the following:
    - 3D source contents with Visual Comfort score close to 2D one
      - If not, much more difficulties to evaluate the interest of 3D technologies or algorithms to guarantee an optimal video QoE
    - Higher Visual Experience than 2D
    - Scene contents of various video complexities (texture, motion and depth)
- **Before launching 3D video subjective tests, 2 options shall be considered**
  - Selection of original test contents in a video bank (if already characterised)
  - Dedicated subjective test to select Reference sequences in accordance with proposed Visual Experience and Visual Comfort requirements

Conclusion

New subjective test method to assess 3D video contents

- **The main features to consider in this new test method are:**
  - Use of the well-tested SAMVIQ 2D method principles to ensure reliable results
  - Use of 3 quality scales: Visual Experience, Image quality and Visual Comfort
  - Use of original test sequences with:
    - Visual Comfort scores equivalent or similar to 2D ones
    - Visual Experience scores higher than 2D ones
- **This new test method can be used in different contexts**
  - 3D reference selection
  - 3D video compression
  - 2D/3D or 3D/3D conversions
  - 3D image formats comparison
  - etc.

Thank you! Question?