Kapitel 12

3D Television Based on a Stereoscopic View Synthesis Approach

- DIBR (Depth-Image-Based Rendering) approach
- 3D content generation
- DIBR from non-video-rate depth stream
- Autostereoscopic displays

DIBR Approach (1)

- Traditional approach to 3D TV:
  End-to-end stereoscopic video chain (capturing, transmitting and display of two separate video streams, one for each eye)
- New approach DIBR (Depth-Image-Based Rendering):
  Input: Monoscopic stream + depth stream
  Output: Stereoscopic TV stream

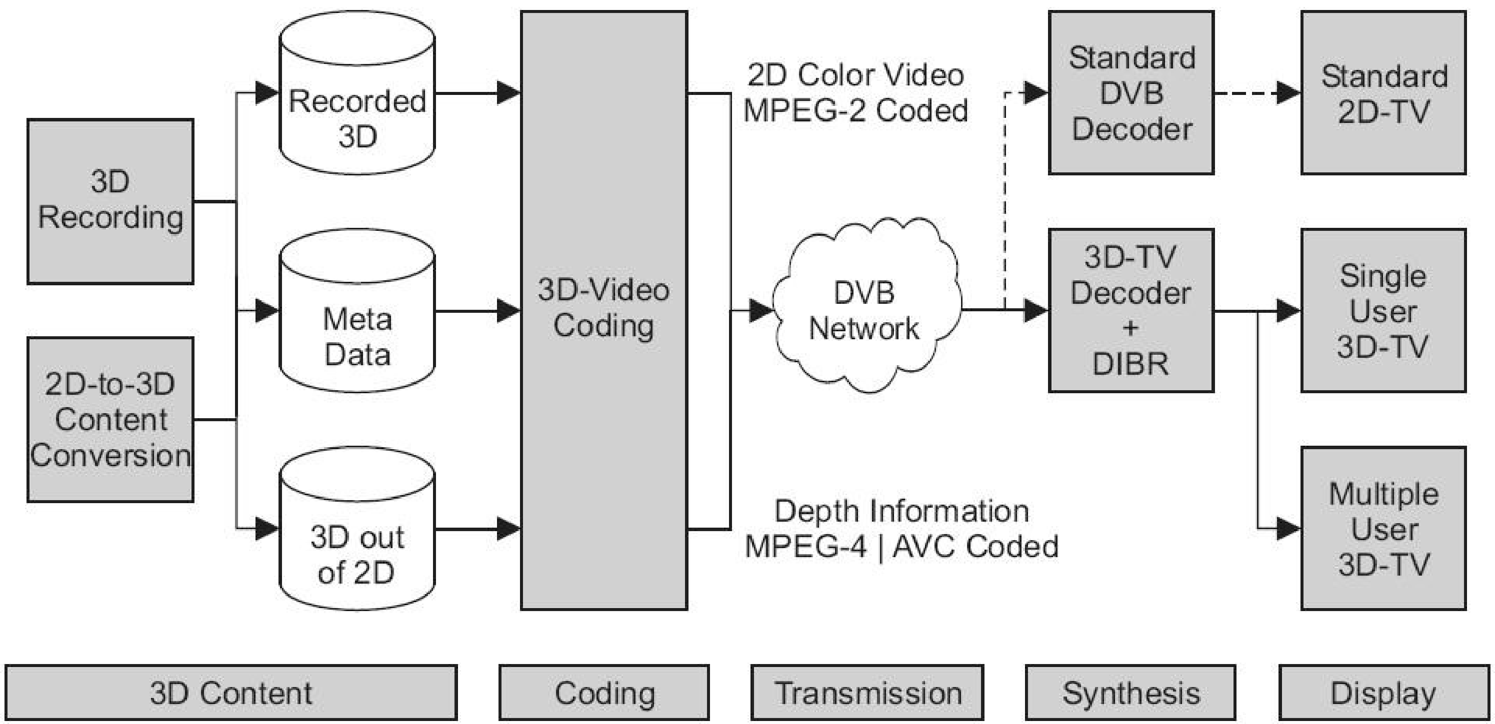
$\Downarrow$

virtual left image + *virtual* right image

DIBR Approach (2)

Most important issues of DIBR-based 3D TV:

- 3D content generation
- Coding, transmission
- Virtual view synthesis
- 3D display



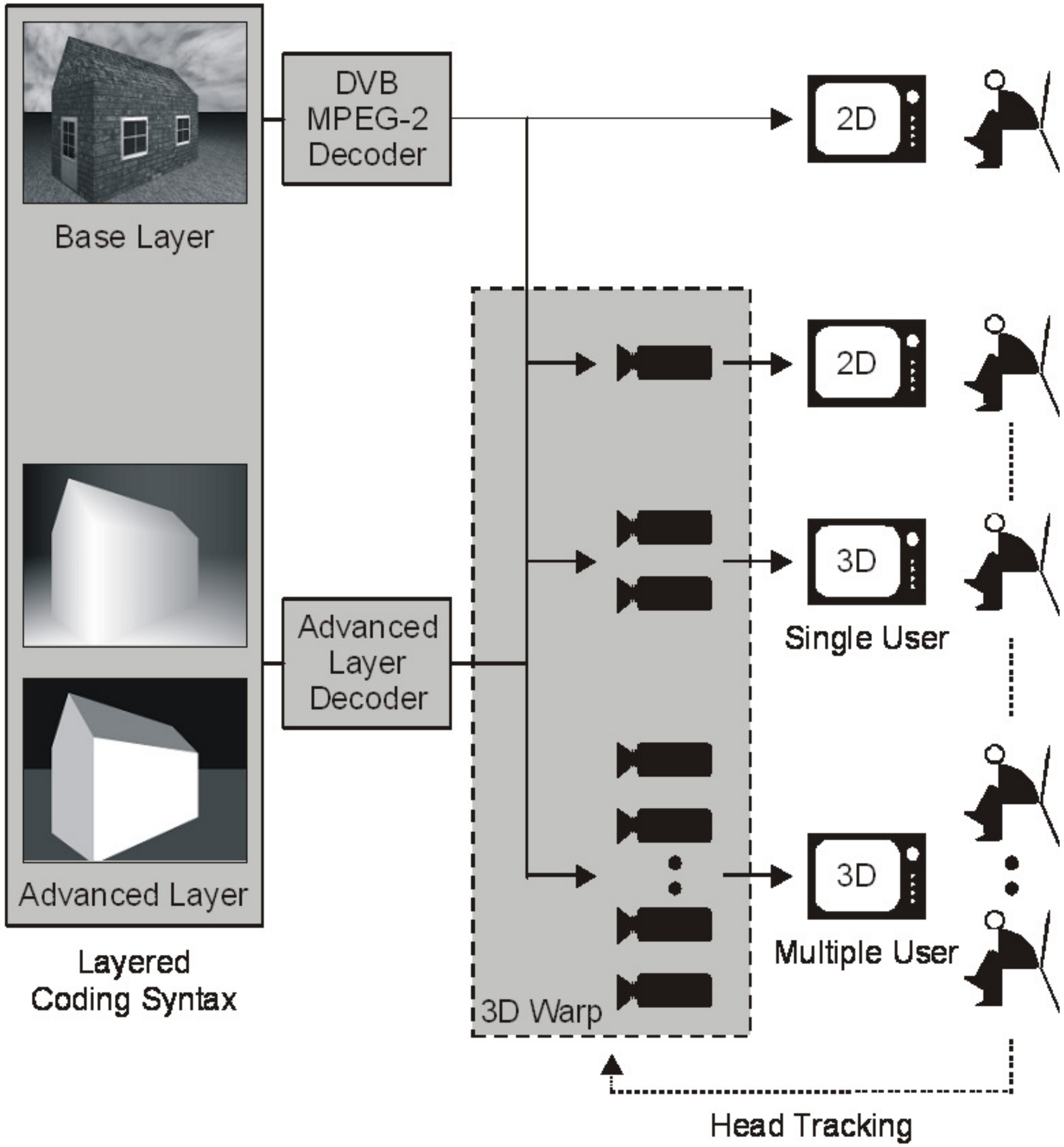
DIBR Approach (3)

Advantages against traditional end-to-end stereoscopic TV chain:

- Backward compatibility with existing 2D TV systems
- Relatively simple and efficient way to produce sufficient, high-quality 3D content
- Flexibility (optimal 3D effects customized to different 3D displays and users needs)
- Support of a wide range of autostereoscopic single- and multiple-user (multiview) 3D displays
- Efficiency (coding and transmission of depth stream cheaper than a monoscopic TV stream)

DIBR Approach (4)

Compatibility with 2D TV Systems:



DIBR: 3D Content Generation

Challenge: Video-rate depth stream (3D content generation)

- Hardware solutions:
  - Use of 3D cameras: restriction of indoor, small-scale scenes (up to a few meters of depth), high costs, etc.
  - Use of stereo cameras

  Cannot be used for converting existing 2D videos to 3D

- Software solutions:
  - Shape-from-X approaches to 3D reconstruction (X stands for different sources of information such as shape, texture, contour, shadow, etc. which may help in 3D reconstruction)
  - Use of non-video-rate depth stream; synthesis of in-between depth frames

  Applicable to converting existing 2D videos to 3D

DIBR from Non-Video-Rate Depth Stream (1)

Input:

- Monoscopic (color) video stream: n frames $F_0, F_1, \ldots, F_{n-1}$
- Depth information D_0 and D_{n-1} for first and last frame only

Output:

- Complete set of depth images $D_0, D_1, \ldots, D_{n-1}$

Advantages:

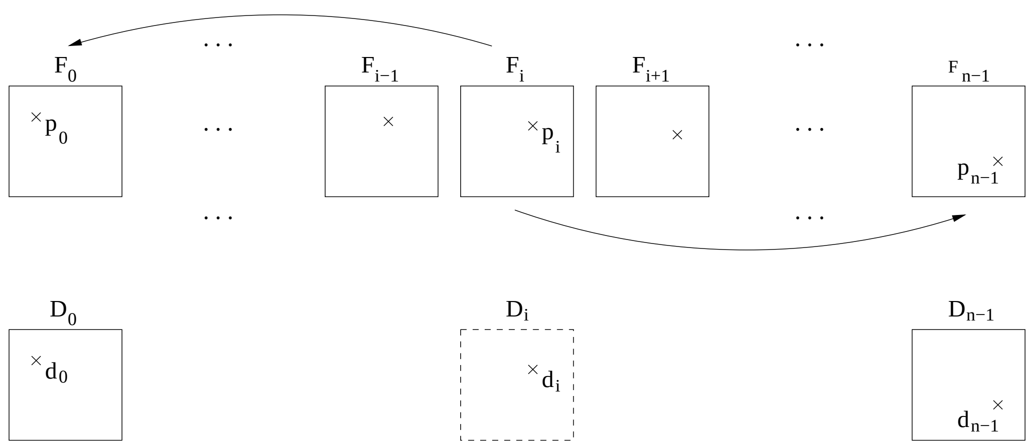
- Ease the recording of 3D material (use cheaper, non-video-rate 3D cameras and complete the missing depth images automatically)
- Enhance existing 2D video material with 3D effects by automatically completing depth information from a few, possibly manually created, depth images

Details: X. Jiang and M. Lambers, Synthesis of stereoscopic 3D videos by limited resources of range images, Proceedings of 18th International Conference on Pattern Recognition, 1220–1224, Hong Kong, 2006 (available at lecture homepage)

DIBR from Non-Video-Rate Depth Stream (2)

Algorithm outline:

- Track each point in the scene as it moves to different pixel positions from frame to frame in monoscopic stream
- For a point $p_i \in F_i$ ($0 < i < n-1$), the corresponding positions $p_0 \in F_0$ and $p_{n-1} \in F_{n-1}$ are then known and thus also the associated depth values d_0 and d_{n-1}
- Depth value d_i for unknown depth image D_i can finally be computed by an interpolation of d_0 and d_{n-1}



DIBR from Non-Video-Rate Depth Stream (3)

Test Videos:

- Videos *Interview* and *Orbi* widely used in DIBR literature (with depth ground-truth)

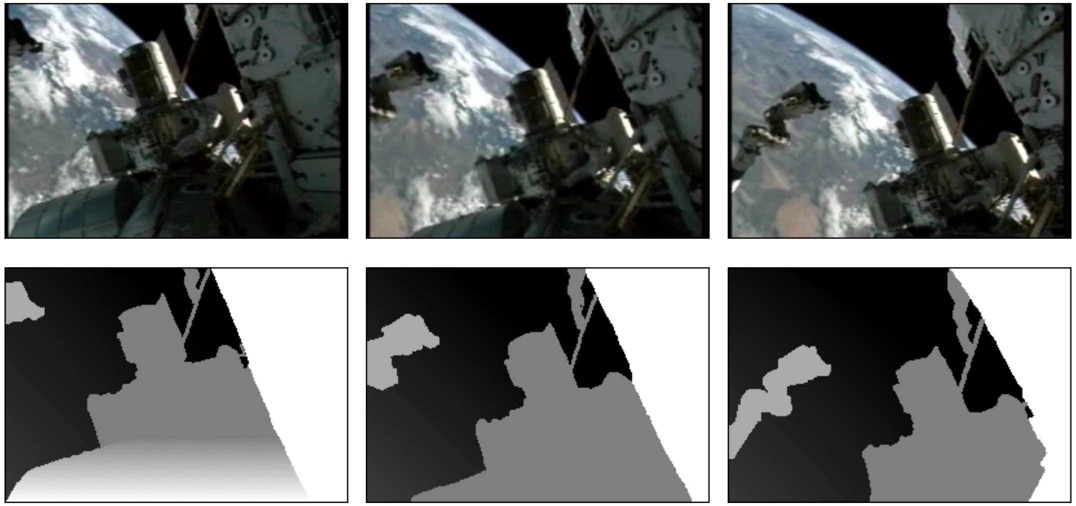
- A third video *Nasa* (part of a NASA mission video) (without depth ground-truth)

- Two additional cartoon films (without depth ground-truth)

DIBR from Non-Video-Rate Depth Stream (4)

Input depth images:

- Videos *Interview* and *Orbi* with depth ground-truth:
  Chosen from the known depth stream
- Video *Nasa* without depth ground-truth:
  Three simplistic, qualitative depth images were created manually with minimal efforts: one for first/middle/last frame (resulting in a distance of 225 frames between two known depth images)



- Two addition cartoon films without depth ground-truth:
  Similar to *Nasa*

Autostereoscopic Displays (1)

Fundamental of autostereoscopic displays:

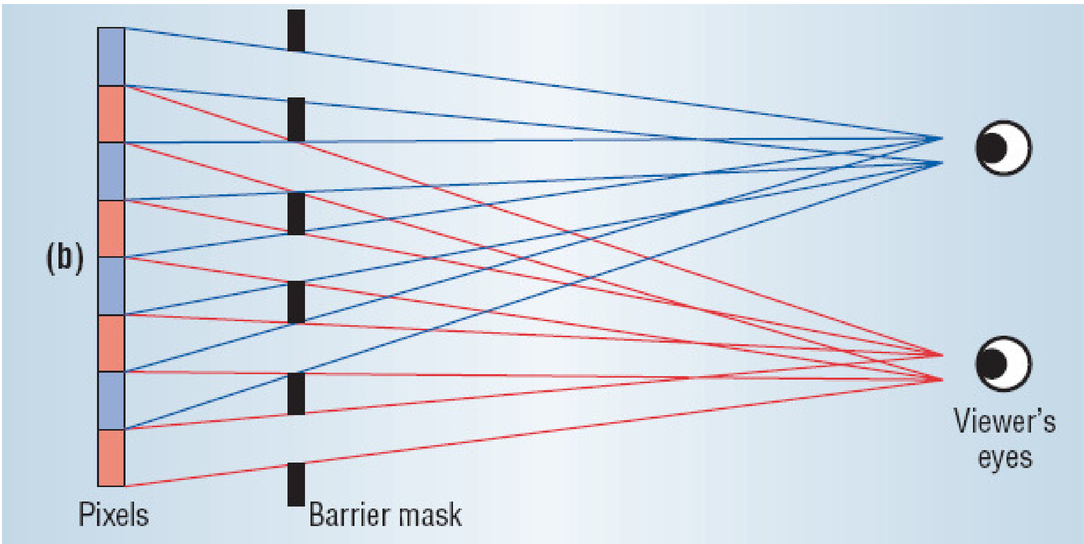
Distribute left and right view of a scene to the corresponding eye of the viewer *independently*

- Provide 3D viewing experiences without the need of glasses or other encumbering viewing aids
- Users obtain the best approximation of natural working in a 3D computer environment

Autostereoscopic displays have found many applications in games, scientific visualization, human-computer interface, etc.

Autostereoscopic Displays (2)

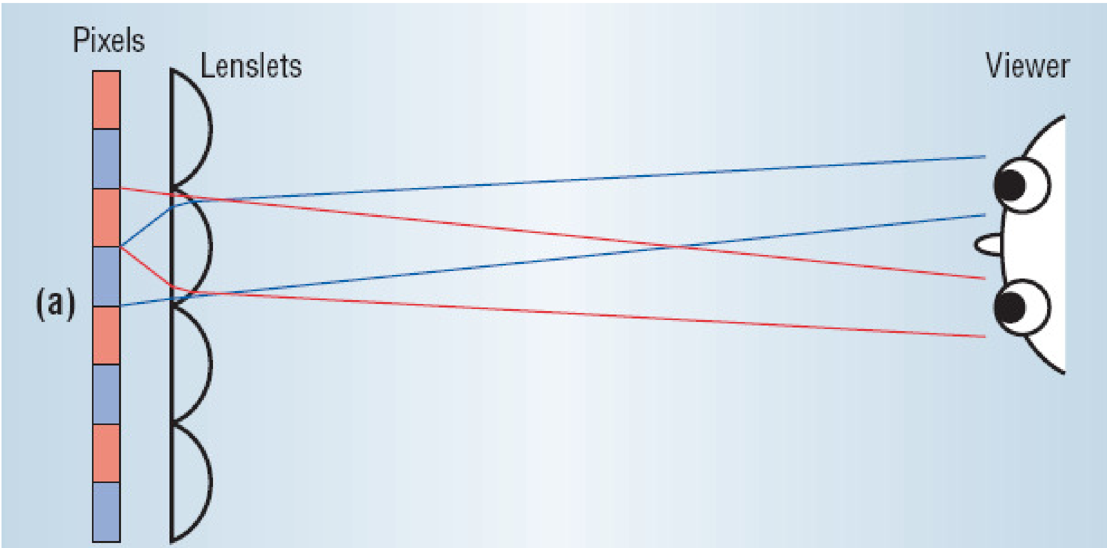
Principle of Parallax Barrier:
A stereo image pair is displayed by interleaving columns of two images; one image in odd-numbered columns and the other image in even-numbered columns



A barrier mask is placed in front of the pixel raster so that each eye sees light from only every second pixel column (left); *2D/3D switchable* autostereoscopic display from DTI

Autostereoscopic Displays (3)

Principle of Lenticular Sheet:
A stereo image pair is displayed by interleaving columns of two images; one image in odd-numbered columns and the other image in even-numbered columns



An array of cylindrical lenslets is placed in front of the pixel raster, directing the light adjacent pixel columns to different viewing slots so that each of the viewer's eye sees light from only every second pixel column

Autostereoscopic Displays (4)

3D displays using lenticular sheet are based on similar principle to the popular 3D postcards. A scientific application is the Lang test in ophthalmology (standard for testing random-dot stereovision under natural conditions; showing several objects car/cat/etc.)