Using 3D for Rebalancing the Visual System of Amblyopic Children

Angelo Gargantini
Ingegneria Informatica - Università di Bergamo - Italy
cs.unibg.it/gargantini
3d4amb.unibg.it

Joint work with Mariella Bana and Flavia Fabiani
Centro di Ipovisione, Riabilitazione Visiva e Oftalmologia Pediatrica - A.O. Ospedali Riuniti di Bergamo
Outline

• Amblyopia and classical treatment
• Some recent advances
  • Virtual reality
  • Vision rebalancing
• Using 3D systems for **Vision Rebalancing**
  • Principle
  • Implementation
• Expected results
Amblyopia - prevalence

• is a disorder of the visual system that is characterized by poor vision or lack of vision in an eye that is otherwise physically normal.
  • Also knows as “lazy eye”

• Prevalence of amblyopia
  • Around 3% per cent in untreated childhood and adults [1-5%]
  • lifetime risk of visual loss of at least 1.2%

• It is the first cause of poor vision in the young population under20 yrs

• Context: unilateral functional amblyopia
Treatment - occlusion

• Amblyopia is **reversible**
  - has to be treated within the sensitive period for visual development
  - Classical treatment: occlusion

**PROBLEMS**

• is unpopular
• requires very long periods of time
• disrupts fusion
• poor or noncompliance

**effective treatments should address the compliance problem**
Vision Rebalancing

- partial occlusion/penalization
  - good eye is penalized, not occluded
  - optically/filtering/ pharmaceutically

- By using virtual reality
  - Virtual Reality Applications Research Team (VIRART) – - Univ. Nottingham-IBiT™

- By HMDs
  - Fateh and C. Speeg. Rebalancing the visual system of people with amblyopia "lazy eye" by using HMD and image enhancement. In VMR ’09 LNCS, 5622
Goals of **3D4Amb** Project

- Vision rebalancing system that is
  - Inexpensive
    - use of standard technologies and/or appliances like TVs, PCs
  - Friendly to use
    - can be operated autonomously by the children themselves
  - Suitable for domestic use
    - without frequent time-consuming visits to the hospital.
    - suitable for frequent use at home
  - Enjoyable
    - recreational activities
  - Easily extensible
    - new applications, activities and programs to be added
  - Monitorable
    - The physician can inspect the data about the system use

- 3D technology with LCD active glasses
3D with shutter active glasses

- The monitor works at 120 Hz (double of the min speed) and shows alternatively two images.
- The glasses are synchronized with it in order to show each image to each eye.

Monitor

LCD

Glasses

NVIDIA® 3D Vision™
Advantages of this technology

• Full image quality per eye
  • In 3D mode, each eye receives the full resolution of the display. The colors are not altered

• Wide viewing angle for 3D
  • There are no restrictions on the viewing angle in 3D mode. Users are free to move their heads without losing the 3D effect

• Excellent 2D operation
  • Monitor can be reused for normal operation

• Personalized fit
  • Glasses can be worn over prescription glasses.

• Acceptable cost
Vision Rebalancing by 3D

- The 3D system is not used to create the depth of a scene
- But only to send two different images/videos to the two eyes

- **normal eyes receives a penalized version**
- **amblyopic eye receives the enhanced version**

- Note: poor vision without glasses
Implementation

- We use AviSynth
  - www.avisynth.org
    - Frameserver – software
    - allows real time video rebalancing
    - Any video content can be processed.
    - No video “pre-processing”
    - Filters easily added and removed even during its use.
  - + pantarheon toolbox
    - http://www.pantarheon.org/AviSynth3DToolbox/

1. The video is duplicated in two streams
2. Each stream is filtered
3. The two streams are recombined in a 3D video

- The process is a AviSynth script
  - simple commands
  - Working on an editor
Filters

- Penalizing filters:
  - reduce brightness and contrast
  - blur, unsharpen, noise introduction ...
- enhancing filters
  - sharpen ....

Occhio sano

Occhio ambliopico
Filter Application

1. Continuous
   - Similar to occlusion

2. Delayed
   - Start after a while

3. Periodic

4. Gradual
Expected results

• No clinical trials (yet)

• Better compliance
  • appealing activity in a domestic environment, in a graduate and personalized manner
  • Poorer vision whithout glasses

• Binocularity
  • Both eyes are stimulated

• Video rebalancing
  • partial occlusion can achieve a better visual outcome then the complete patching

• Other uses of the 3D4Amb system:
  • screening, active treatment by video games, ...
Conclusions

- 3D can be used for vision rebalancing
  - The good yes is penalized
  - Amblyopic eye is stimulated
  - Software implementation using avisynth
  - Final goal **better compliance**

- Web site:
  - 3d4amb.unibg.it

- Open for collaborations ...

- Future work
  - ...