Autostereoscopy and Motion Parallax for Mobile Computer Games Using Commercially Available Hardware

Jens Ogniewski
Agenda

- Introduction / Motivation
- Background
- Implementation
- Study
- Results & Discussion
Introduction / Motivation

- Recent push towards 3D displays
- 3D solutions for home & mobile entertainment “just around the corner”
- Concentration on movies, tv, etc.
  - Also studies
  - However: limited content
- In most games 3D description of world already included → 3D displays could be easily introduced
  - NVIDIA 3D Vision
  - Several other systems announced, may come already this year
Introduction / Motivation

- Can already existing systems be turned into (good) 3D displays?

- Do gamers want 3D displays?

- Chosen System:
  - Iphone 3G with Wazabee 3Dee-Shell
  - A simple non-interactive scene from a futuristic racing game
Background

- What is a 3D display?
  - Basically every display that heightens the depth reception
  - Stereoscopy
  - Motion Parallax
Background

- Motion parallax

- The change of the perspective in accordance to the occurring movement.

- Can be meaningful for gameplay
Background

- **Motion parallax**
  - Introduces via user tracking (e.g. face tracking, eye tracking)
  - Approximation via accelerometer possible
  - Usable with many modern gaming systems
  - Limitation: one user only (if not combined with multiview display)!
Background

- Stereoscopy:
  - Creating a different image for each eye using optical elements
Background

- Autostereoscopy:
  - Creating a different image for each eye using e.g. lenticular sheets
Background

- Autostereoscopy
  - User needs to sit at a certain position
  - Not possible together with motion parallax?

- Solution:
  - Move LEDs or optical element
  - Alternatively: dynamical allocation of the (sub)pixels to the views (e.g. using (sub)pixel masks)
  - called tilt-compensation in the following (since tracking via accelerometer)
Background

- Autostereoscopy, limitations:
  - Picketfence Effect
    - Visible black lines if optical element aligned with LED grid
    - Solution: use slanted optical element
  - Pixelmask becomes more complicated and irregular
    → may want to use anti-alias to remove introduced artifacts
Background

- Autostereoscopy, limitations:
  - Cross-Talk / Ghosting
    - One or both eyes see(s) pixel(s) destined to the other one
    - Can cause eye strain (eye pain, headache, disorientation)
Background

- Autostereoscopy, limitations:
  - Other artifacts exists
    - Less visible
    - Mostly solvable by finetuning the software
Implementation

- **Wazabee 3Dee Shell**
  - Autostereoscopic lenticular sheet for Iphone
  - Comes with its own shell, removable lenticular sheet

(Source: Manufacturer's Homepage)
Implementation

- Drawbacks
  - Touchscreen below lenticular sheet unusable
  - Since detachable: needs calibration every time when newly attached
Implementation

- **Drawbacks**
  - Iphone 3G: fixed graphics pipeline => no subpixel resolution, no anti-alias!
Implementation

- Drawbacks
  - Iphone 3G: fixed graphics pipeline => no subpixel resolution, no anti-alias!
Study

- **Overview**
  - Part 1: different masks (resolution vs. crosstalk)
  - Part 2: different depth cues (motion parallax, autostereoscopy, none)
  - Questionnaire (about the person, overall impression, usage scenarios)

- **Testgroup:**
  - 12 subjects, mainly male students of a technical program
  - 9 little or less experience with 3D displays, 3 medium
Study

1. Crosstalk optimized mask vs. Resolution optimized masks (higher values are better)

<table>
<thead>
<tr>
<th>Optimized for:</th>
<th>Crosstalk</th>
<th>Resolution</th>
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</thead>
<tbody>
<tr>
<td>Image quality</td>
<td>15</td>
<td>21</td>
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<tr>
<td>3D effect</td>
<td>18</td>
<td>18</td>
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<tr>
<td>Stress factor</td>
<td>13</td>
<td>23</td>
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</table>

Really meaningful or tainted due to artifacts?
## Study

### 2. Stereo Cues

<table>
<thead>
<tr>
<th>auto-stereoscopy</th>
<th>tilt compensation</th>
<th>motion parallax</th>
<th>distorted image</th>
<th>mean</th>
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**Image quality**

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**3D effect**
Study

3. Questionaire: Usage Scenarios

- One subject mentioned that he would even like such a system for professional applications, e.g. physical and chemical simulations
Results

- Can already existing systems be turned into (good) 3D displays?
  - Yes.
  - Especially motion parallax leads to a high increase in the 3D perception and is possible with many current gaming systems.

- Do gamers want 3D displays?
  - Yes.
Results

So what are we waiting for?
Results

- Improvements of the used system:
  - Optical tracking of user rather than accelerometer!
  - Use programmable graphics hardware!
  - Resolution too low?
Questions?
Thank you very much!

For more info, visit me at:
http://www.icg.isy.liu.se/people/en/jenso/

www.liu.se