Augmented Reality and GPU computation

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Agenda

• What is Augmented Reality (AR)

• Why is AR computationally expensive and how can GPU help

• Future of AR (with the help of GPU)
What is Augmented Reality
Why is AR computationally expensive and how can GPU help
The key for AR is understanding “our reality”: recognize and understand the space.

Features (detection, description, matching, tracking) play a key role

- SIFT
- SURF
- Corners
- Edges
- Etc...
Example: 2D feature matching

- In a 10k features case, matching takes **around 80%** of the time (around 41.7 ms) on a PC (CPU speed 2.4 GHz) \(\Rightarrow\) roughly 20 FPS.

- A seamless AR experience should reach **at least 30 FPS** (more in case of VR).
Example: 2D feature tracking

- In a 10k features case, tracking takes **around 35%**
- Typically we want to do both matching and tracking in the same frame (extract new features, match them *and* track those that were observed earlier).
Hybrid Model Tracking
Hybrid Edge / SLAM Tracking with (GP)GPU support
### Some numbers

<table>
<thead>
<tr>
<th>Iterations * Samples, Number of Lines</th>
<th>No</th>
<th>No</th>
<th>Manually built small car model</th>
<th>Complex Generated car model</th>
<th>Very Complex generated car model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Car Model</strong></td>
<td>15 x 100, 40</td>
<td>15 x 200, 40</td>
<td>15 x 1000, 50</td>
<td>15 x 5000, 5000</td>
<td>15 x 5000, 10000</td>
</tr>
<tr>
<td>Original implementation</td>
<td>30ms (33fps)</td>
<td>64ms (16 fps)</td>
<td>180ms (5.5fps)</td>
<td>440ms (2 fps)</td>
<td>920ms (1fps)</td>
</tr>
<tr>
<td>Optimized version for CPU</td>
<td>30ms (33fps)</td>
<td>61ms (16 fps)</td>
<td>140ms (7 fps)</td>
<td>270ms (4 fps)</td>
<td>310ms (3.5fps)</td>
</tr>
<tr>
<td>Optimized version for GPGPU</td>
<td>40ms (25 fps)</td>
<td>40ms (25 fps)</td>
<td>42ms (24 fps)</td>
<td>44ms (23 fps)</td>
<td>(47ms) (21 fps)</td>
</tr>
</tbody>
</table>

Future of AR (with the help of GPU)
RGB-D Sensors at Metaio

Kinect/Asus/PrimeSense

Kinect One

Occipital/Structure Sensor

Creative Cam

Tango Phone/Tablet

others
Dense Visual Odometry
ays on, always augmented
Hello beautiful

See our most popular earrings move with you without ever opening the case

TOUCH TO BEGIN
Coherent Illumination in Augmented Reality
USING THE USER’S HEAD AS A LIGHT PROBE

MACHINE LEARNING

ILLUMINATION ESTIMATOR
Real-Time Estimation of Grayscale Illumination
Front camera as reference for light and shadow
Correct light and shadow in augmentation
Correct light and shadow in augmentation
• New sensors means more data and more information.
• In order to exploit data and information we need more computational power.
• GPU can alleviate the computation traditionally performed by the CPU.
• Data + Computation Power
→ Seamless AR experience.

Always on, always augmented
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