EMBEDDED-COOKBOOK

RUPERT STELZ, ANDREAS RITTINGER IMAGE ACQUISITION
STEMMER IMAGING
HOW TO MAKE A NICE CAKE

Motivation → Recipe → Baking → Party
WHAT IS EMBEDDED? OR.. WHY DO I WANT A CAKE AND NOT A SCHWEINEBRATEN?

- Size/Geometry?
- Price?
- Performance?
- Availability?
- Maintenance?
...

STEMMER IMAGING
WHY EMBEDDED?

- Why is embedded the best solution and/or what does that mean?
- What cameras, how many, what interface?
- How many units do we need in what timeframe at what price?
- Do I need a special housing?
INVESTIGATION

Can my application run on an embedded platform?

- Performance
- Interfaces
- Fixed setup for a given time

See presentation on „Performance Comparison of Embedded Systems“
INGREDIENTS

- **Platform** (Processor & Memory & Interfaces)
- **Hardware** (Geometry & Environment)
- **Operating System** (Board support package and Rollout)
- **GPU/TPU**
# DEVICES

## ARM Based

<table>
<thead>
<tr>
<th>Device</th>
<th>CPU</th>
<th>OS</th>
<th>Memory [GB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry Pi 4</td>
<td>4x Cortex A72</td>
<td>Raspbian (32 Bit)</td>
<td>2</td>
</tr>
<tr>
<td>Odroid-N2</td>
<td>2x Cortex A53, 4x Cortex A73</td>
<td>Ubuntu 1804</td>
<td>4</td>
</tr>
<tr>
<td>Tegra Xavier</td>
<td>8x Carmel ARMv8.2</td>
<td>Ubuntu 1804</td>
<td>16</td>
</tr>
</tbody>
</table>

## X86 Based

<table>
<thead>
<tr>
<th>Device</th>
<th>CPU</th>
<th>OS</th>
<th>Memory [GB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel Up²</td>
<td>Pentium N4200</td>
<td>Windows 10 Ubuntu 1804 (WSL)</td>
<td>8</td>
</tr>
<tr>
<td>Desktop i5 6600</td>
<td>i5-6600</td>
<td>Windows 10 Ubuntu 1804 (WSL)</td>
<td>16</td>
</tr>
</tbody>
</table>
INGREDIENTS

- Camera Interface & Camera (Sensor, MIPI, GEV, U3V)
- Machine Vision Software and other libraries
- Application (HMI/GUI or stand alone, RT)
- Power/Infrastructure/Communication
- Housing
## Camera Interfaces

<table>
<thead>
<tr>
<th>Feature</th>
<th>GEV</th>
<th>U3V</th>
<th>MIPI-CSI2</th>
<th>CXP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable length</td>
<td>long</td>
<td>medium</td>
<td>short</td>
<td>long</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>large</td>
<td>small</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CPU-Load</td>
<td>high</td>
<td>low</td>
<td>low/med</td>
<td>low</td>
</tr>
<tr>
<td>Control</td>
<td>easy</td>
<td>easy</td>
<td>difficult</td>
<td>medium</td>
</tr>
<tr>
<td>Size</td>
<td>medium</td>
<td>small</td>
<td>very small</td>
<td>large</td>
</tr>
<tr>
<td>Cost</td>
<td>medium</td>
<td>medium</td>
<td>Low</td>
<td>high</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>medium</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
</tbody>
</table>
INSTRUCTIONS

- Identify existing components to build on
- Find the right partners for the different building blocks
- Find an agile roadmap
- Come up with a rough price

COORDINATE THE WORKPACKAGES

Motivation  Recipe  Baking  Party

- Organize/Build HW & OS & Driver
- Create/Modify Application
- Design Housing
- In some cases create special packages like FPGA code
DELIVERY

- Successful Product Design
- Lifetime management Maintenance
EXAMPLE

Merge 3D data from multiple sensors and provide a point cloud

- Calibrate multiple 3D sensors to have a common coordinate system
- Acquire 3D data from multiple sensors
- Align the data
- Merge to a single Point Cloud
- Send the Point Cloud via GEV Server
CONCLUSION

Embedded means usually custom. We can help you with:

- Finding the right recipe for your needs!
- Build the solution with partners!
- Deliver reliably!
THANK YOU FOR YOUR TIME

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