A function-rich FPGA system of camera image processing for video meeting

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Introduction

- The video conferencing tools are often used
- These tools offer a variety of features
  - Virtual background
  - Screen sharing
- A few features require the software stacks and processor performance
- A function-rich web camera system using an FPGA
Architecture of VPS

- **VPS (Video Processing System)**

![Diagram of VPS Architecture]
Architecture of VPM

- VPM (Video Processing Module)

Diagram:
- Camera Data
- Background Data
- Video Processing Module:
  - human-face resizing
  - virtual background
  - gaussianblur
  - message displaying
- AXI4-Stream (24bits RGB Data)
Examples of video processing functions

- Virtual background function
- Human-face resizing function
- Message displaying function
Demo
Evaluation

Evaluation Environment

- **Tools**: Vivado 2019.1, Vivado-HLS 2019.1
- **Device**: Zybo Z7-20 (XC7Z020), Pcam 5C

## Evaluation

### Resources

<table>
<thead>
<tr>
<th></th>
<th>LUT</th>
<th>FF</th>
<th>BRAM</th>
<th>DSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPM</td>
<td>4,853 (9.1%)</td>
<td>5,100 (4.8%)</td>
<td>38.5 (27.5%)</td>
<td>28 (12.7%)</td>
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<tr>
<td>Total</td>
<td>18,840 (35.4%)</td>
<td>23,247 (21.9%)</td>
<td>60.5 (43.2%)</td>
<td>28 (12.7%)</td>
</tr>
<tr>
<td>Available (XC7Z020)</td>
<td>53,200</td>
<td>106,400</td>
<td>140.0</td>
<td>220</td>
</tr>
</tbody>
</table>
Evaluation

Performance (CPU vs FPGA)
- CPU : ARM Cortex-A9 (650MHz)
- Language : Python
- Library : OpenCV

Results
- CPU : 3.2fps
- FPGA : 60.0fps

1280x720 pixels
Conclusion and Future Work

Conclusion
- A function-rich web camera system using an FPGA
- VPM provides three video processing functions
- High frame rates at 60fps of 1280x720 pixels

Future Work
- Virtual background function without a green screen (Semantic segmentation, etc.)
Thank you for listening!