Computer Graphics & Multimedia Systems Group

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Real Time Fusion of Range and Light Field Images

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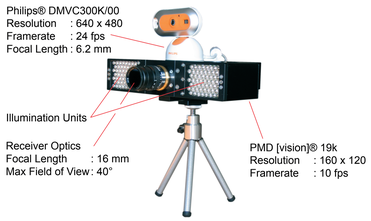
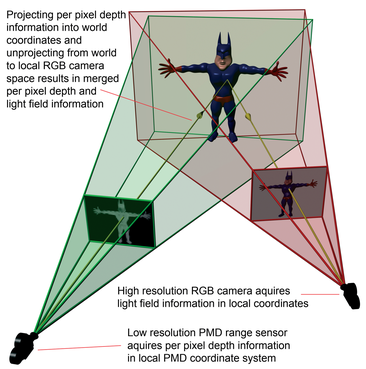
Setup and Operation

- Commodity digital RGB camera mounted on top of PMD range sensor
  - Light field information captured at 25 fps by RGB camera
  - Range data captured at 10 fps with a precision of ~6mm at resolution 160x120 by PMD camera
  - Alternative setup captures at 15 fps at resolution 16x64
  - Fixed RGB camera installation and easy camera registration enables handheld data aquisition



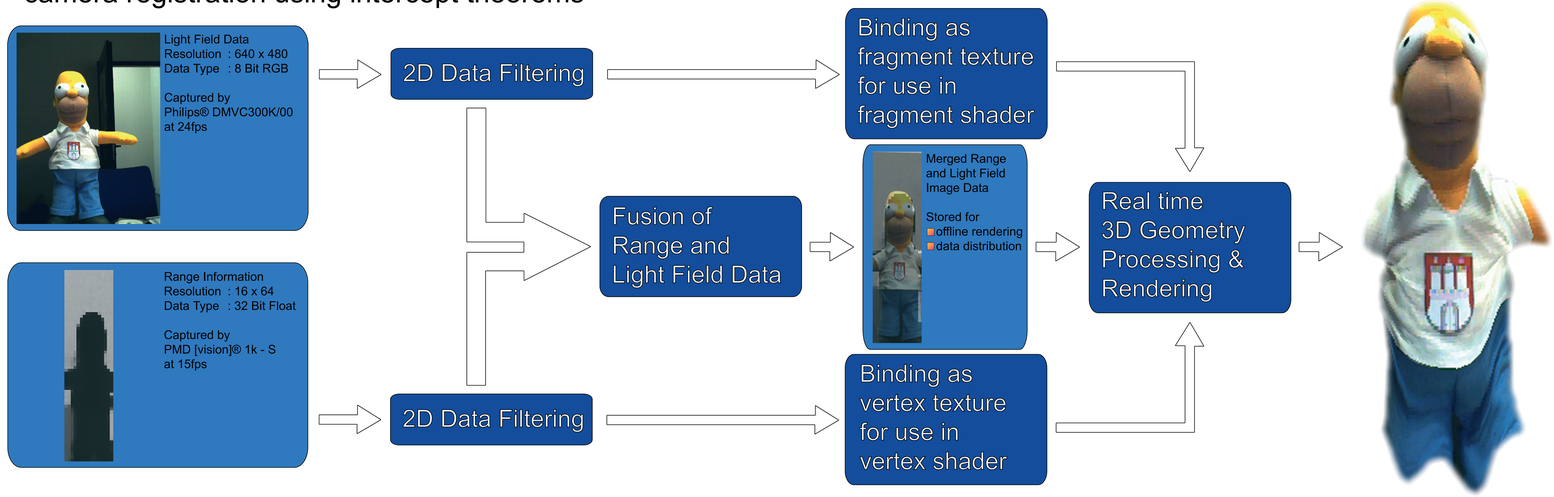
Camera Registration

- Registration using only one known marker
  - AR Toolkit marker detected in light field and PMD grayscale data supplies good guess for camera transformation
  - Registration error is depending on the quality of the AR Toolkit Camera Calibration (error evaluation has not been performed yet)
  - Using manually corrected depth information of the marker image, the transformation can be easily adjusted for best fit
  - Best camera registration results are measured using a PMD range sensor operating at 160x120 in combination with a RGB camera setup operating in VGA (640x480) mode



Range and Light Field Fusion

- Data Fusion based on intrinsic and extrinsic camera parameters
  - Camera focal length, pixel dimension, resolution and transformation between cameras required
- Projection from sensor space to world space and unprojection to camera space
  - Corresponding points are calculated based on the camera registration using intercept theorems



Data Processing

- GPU based 2D Image Filtering
  - Filters and kernels can be applied to source images directly on the GPU or while uploading to the GPU
- Merged range and light field data file format
  - Geometry and light field data stored in one image file
  - Per pixel depth value stored in alpha channel
  - Additional 82 byte header required:
    Transform. matrix 16 x 32 bit + 2 x (focal length 32 bit, pixel dimensions 2 x 4bit, resolution 2 x 16 bit)

Rendering

- Vertex texture for per vertex displacement
  - Range data images as vertex texture
  - Per pixel displacement mapping for geometry reconstruction in real time
- Light field image as standard fragment texture
- Per vertex normals for artificial lighting
  - Normals calculated on the fly using central differences

Results and Future Directions

- Running System capable of simultanously aquiring registered depth and light field data
  - Identifiying one known marker in the scene the Lumigraph is fully describable in real time
- Emerging precision and resolution for new directions
  - Higher resolution for more accurate geometry reconstruction and rendering

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