

Real Time Fusion of Range and Light Field Images

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Abstract

This poster presents preliminary results of our approach to interactively acquire, process and render corresponding depth and light field information. Our system is based on a handheld image based range sensor in combination with a commodity digital RGB camera facilitating the synchronous acquisition of registered image data. We demonstrate our intermediate system including the ability to simultaneously acquire and process range and greyscale image data and interactively transforming and rendering the data to geometry.

1 Introduction

With the evolution of 3D shape digitization devices the process of capturing complex geometry and material attributes for single objects or whole scenes is getting simpler, faster and more interactive. Unfortunately existing systems usually suffer from their limited capability to faithfully reproduce real world illumination.

The Lumigraph system [Gortler et al. 1996] introduced the combination of rough geometry representation and high quality light field information to overcome the shortcomings of traditional 3D scanning devices and their subsequent data processing pipeline. Based on a simplified plenoptical function the Lumigraph is capable of rendering arbitrary images of the virtual environment from any vantage point of a virtual camera. The rendering process evolves from light field information images taken in advance. Using silhouette techniques a rough volumetric geometry representation of the observed object is recoverable from the light field images at considerable computational cost. To fully describe the simplified plenoptical function, the camera position is determined for each sample image. For successful camera calibration external markers can be used or great effort can be spent on marker less feature point tracking systems [Koch et al. 2005]. Based on the camera calibration projecting the 2D light field into 3D space is a trivial task.

Our approach introduces a real time system merging high resolution light field information and low resolution range data in real time at a consumer price level. The system uses a prototype of a handheld image based PMD (Photonic Mixer Device) range sensor [Kraft et al. 2004] to generate a low resolution (160×120) depth information data set in combination with a commodity digital imaging camera working at VGA resolution (640×480) mounted on top.

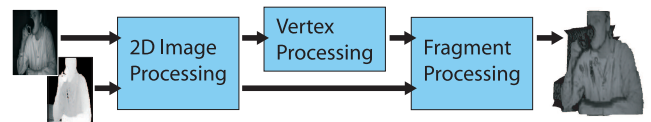
2 Exposition

The integrated PMD range sensor is capable of capturing pixel aligned depth and greyscale images at interactive frame rates (approx. 10 fps). The connected RGB camera provides full VGA resolution images of the scene in real time. Image data is acquired constantly at maximum frame rate to maximize interactivity.

In order to achieve high interactivity and ease of use, geometric reconstructions have to be rendered on the fly. Binding the range data images as a vertex texture, the vertices of a highly tessellated

grid can be displaced to approximate the captured geometry in real time using shader programs for vertex processing. Binding the light field image as fragment texture the resulting vertex object is textured using standard fragment operations. Normals are calculated using central differences to approximate partial derivatives per vertex. This way artificial lighting is easily added to generate more sophisticated rendering results.

Implementation: In our current system fusion of the range sensor's depth and greyscale image has been implemented as a proof of concept. Data acquisition, data processing and geometric modeling is performed in real time. The range and light field images acquired are fed into a filtering stage. The filtered images are taken as data source for interactive geometry rendering as shown in the Figure. Initial experiments have proven that the relative transformation matrix between the mounted RGB camera and the range sensor can easily be determined using only one known marker. The determined matrix is then used as projective texture matrix to transform the light field image into the range image domain. As a calibration process performed once for the camera setup, projecting the light field data back into 3D space can be performed without significant cost at run time.



To improve image quality, noisy artifacts in both images can be reduced by linear low pass filters. Convolution is performed using the OpenGL image processing pipeline. More complex image processing tasks must be implemented within the vertex and fragment programs.

Future Directions: In a running system the same single known marker used for camera calibration can be used to determine the camera direction, the last unknown attribute to fully describe the Lumigraph in real time. Capturing and processing a series of image with our system will enhance the idea behind the Lumigraph system for Light Field Rendering in the near future.

References

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