A Low-Cost Test Bed for Light Field Capture Experiments (sap.0511)

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1 Introduction

Current light-field capture devices are complex, usually require modifying the internals of a conventional camera, and discourage new experimentation in a topic area full of new research questions. We adapt a novel ‘home-made’ camera devised by Wang and Heidrich [2004] for use in a variety of light-field experiments. Unlike commercially available cameras, the camera provides a large effective sensor size, large distance between the lens and the sensor, much larger effective pixel size, extremely high resolution (490 million pixels), low cost (around $500US), and a nominal capture speed of a few seconds. This easily-modified design encourages novices to experiment with light fields. We demonstrate how to implement the microlens based light-field camera of Ng et al. [2005], and the mask based light field camera of Veeraraghavan et al. [2007].

2 Method

Like Wang and Heidrich [2004], we begin by removing the focusing screen and film holder on a Plaubel 8×10 large format camera. In its place we attach a Canon CanoScan LiDE 70 flat-bed scanner. The Canon LiDE scanners use a unique sensor technology where the sensor spans the entire width of the scanner and is much easier to modify than the complex mirror based optics of traditional scanners. We first remove the LED light source adjacent to the sensor. Next we remove the thin microlens array strip over the sensor. This exposes the sensor to the image formed by the lens of the large format camera. The actual sensor is on the circuit board at the base of a black plastic casing. Light reaches the sensor through a 2cm deep crevice that otherwise holds the scanner’s microlens array. We remove almost the entire plastic casing around the sensor (leaving about 2cm at either end) to avoid vignetting artifacts. We then attach the scanner to the back of the large format camera in the place of the film holder. Fitted with a Nikkor-W 210mm f/5.6 large format lens, our camera completes one scan at 2400dpi in approximately 100 seconds.

Light field cameras The camera’s adjustable bellows, and large size allows much easier experimentation and prototyping of new camera designs than most commercially available cameras. For example, we can mount and manually align a 10cm square 100 ×100 microlens array about 2 − 3mm away from the scanner’s moving sensor array without difficulty or specialized equipment. The arrangement then replicates the microlens based light-field camera proposed by Ng et al. [2005], but is much easier to construct. The large size of the camera and lens permits easy insertion and positioning of attenuating masks and other optical elements. We implemented the mask based light field camera [Veeraraghavan et al. 2007] by printing a sinusoidal mask on photographic film. We paste this mask on the glass top of the scanner, placing it about 1cm from the sensor plane. We get an effective pixel size of about 125 microns, which is an order of magnitude larger than conventional digital cameras. This limits the sinusoidal mask frequency to about 4 cycles/mm that is easy to print using the Kodak LVT process.

3 Conclusion

We propose a relatively easy way of prototyping new and unusual camera designs. The large format arrangement provides a human-scale device that is much easier to modify and adjust than a conventional camera, and encourages dramatic experiments. For example, our early experiments destroyed about 10 scanners, but what we learned greatly outweighed the $70 replacement cost. The large size and high resolution provides huge margins for error: our masks and optical elements can tolerate alignment and positioning error that are several orders of magnitude larger than similar modifications to 35mm or medium-format cameras, and at lower overall cost. We believe that this design would be useful to researchers in computer graphics, computational photography, and optics.

References

