New Light Field Camera Designs

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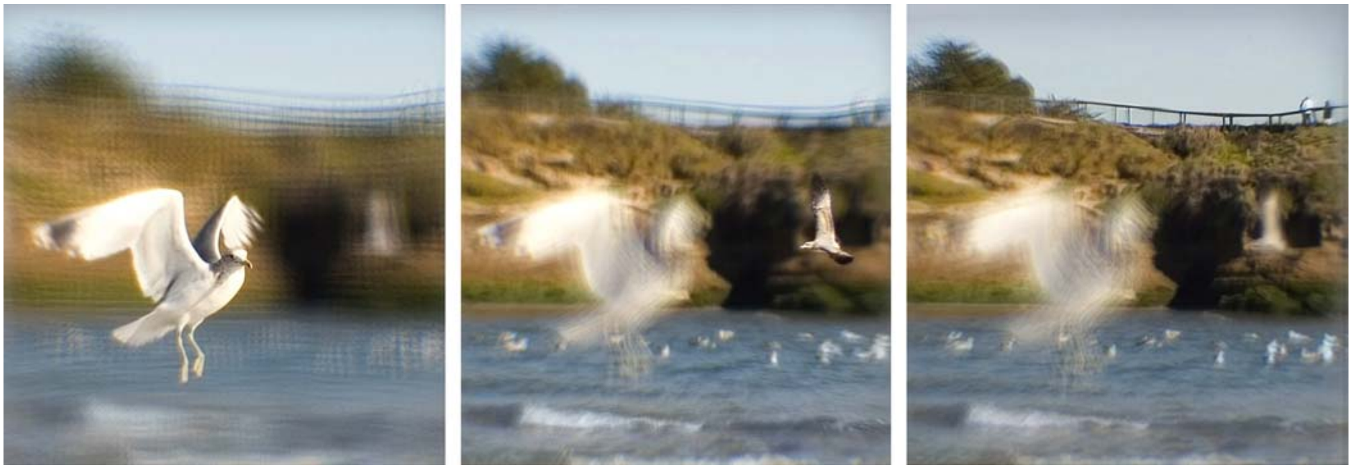

Figure 1: Seagulls in flight captured with our light field camera. We demonstrate refocusing on different depths after the picture has been taken. With conventional cameras the photographer has no time to focus on different objects of interest in a dynamic scene. (For view interpolated version that elliminates the artifcts of this example see Figure 6.)

Abstract

This is a live demo of two new hand held light field cameras. They are based on a new optical element that can be added to any high resolution camera. With a 16 megapixel sensor we demonstrate output resolution of 700X700 pixels with full power of refocusing and other light field effects. This is achieved based on a trade-of with the angular resolution of our light field sampling. The 20 views captured by our system of lenses are interpolated by view morphing into 100 views, which achieves dense synthetic light field. We create a refocusing movie of real life dynamic scenes within 5 minutes of capture. Our new optical designs and view interpolation achieve more than double the output resolution of a recent light field camera developed in Stanford by Ren Ng et. al.

1 Camera designs

Traditional Light Field photography uses an array of cameras taking multiple pictures of the same scene. With the increase in sensor resolution it is becoming possible to capture all of the light field information into one single image of high resolution. We believe this approach will eventually make light field capture and 3D photography cheap and practical.

One such design has been demonstrated by the Stanford group. It is based in a microlens array (of 100000 lenslets) placed inside the camera, and is equivalent to a 100 view light field. Resolution of final output is 300X300 pixels.

Our design captures a 20-view light field, and interpolates it into 100 views by view morphing. Obviously, this increases the number of pixels in each view 5 times. But there is another benefit of our design: Small number of images projected on the sensor means small number of boundaries betwen the images and significant reduction of wasted pixel space. A microlens array typically creates 100000 or more micro images – which is related to huge loss of pixel space at the boundaries. Our approach elliminates this additional loss.

The first design includes a big main lens and an array of negative lenses behind it (Figure 2). The system produces virtual images on the other side of the main lens. A high resolution conventional camera captures all images at once.

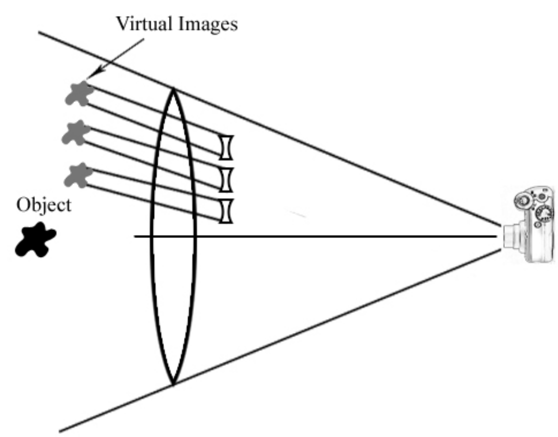

Figure 2: Multiple negative lenses creating virtual images outside a camera.

Our second design is an array of lens-prism pairs, shown in Figure 3. Prisms make the whole device lighter. See a picture of this array of 19 negative lenses and 18 prisms, Figure 4.

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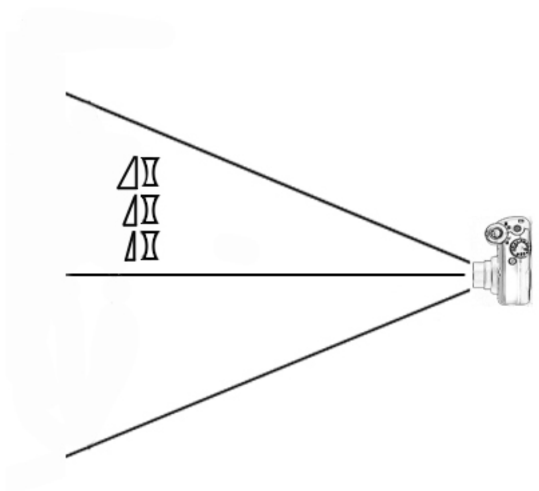

Figure 3: An array of lens-prism pairs placed in front of a high resolution conventional camera.

Figure 4: Picture of our hexagonal array of lenses and prisms creating 19 views of the scene.

Figure 5: Our working model of the camera of Figure 2, with two positive lenses and an array of 20 negative lenses cut into squares.

Figure 6: The seagull of Figure 1 after view interpolation to generate a dense light field and remove sampling artifacts.