

## New 3D Integral Imaging Camera Viewing Parameters

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### ABSTRACT

3D Holographic imaging (also known as Integral imaging) is a technique that is capable of creating and encoding a true volume spatial optical model of the object scene in the form of a planar intensity distribution by using unique optical components. It is akin to holography in that 3D information recorded on a 2D medium can be replayed as a full 3D optical model. Typically, moving from cylindrical lens to the next cylindrical lens is carried out knowing the lens width,  $L_w$ , which defines the translation of the camera along the  $x$  optical axis and hence the position of the new camera cylindrical lens. This new renderer is represented in the paper by the term integral ray tracing (IRT). In this paper, a method of generation 3D integral images camera file parameters is proposed. The camera file is an important part of the process of generating micro-images and set up the camera position. The method is mainly based on Parallel Multiprocessor Ray Tracing System adapted "Tachyon" as renderer. Experimental results show validation of the new algorithm and the lenticular lens can be set up and tested on small-balls, gears, room, tree and teapot scenes.

**Keywords:** Computer graphics, micro-images, 3D camera processing, Cylindrical lens & sheet, 3D TV.

### INTRODUCTION

Basically, a still 3D integral image consists of several cylindrical lenses as shown in figure [5] [6] [12]. Each cylindrical lens acts like a separate camera. Integral ray tracing is used to generate the first micro-image through the first cylindrical lens. A 3D integral imaging camera is used to obtain a new position of cylindrical lens. Creation of real-time 3D micro-images (cylindrical sheet) system using traditional TV-technique for signal receiving and communication is now valid and certain application [1] [2], [3].

The new method introduced 3D integral images as new technique based on multiprocessor ray tracer of representing viewing camera parameters to produce micro images representations of cylindrical lens s. The technique developed proof of concept the new renderer Figure 6. The proposed camera file format technology allows natural accommodation and convergence to accomplish stress-free viewing of the camera.

We have developed a complete software tools based on adapted multiprocessor ray tracing system in the environment of Object Oriented in C++ and Java that allow micro images to be positioned in the appropriate location in the  $x$  direction axis; Figures. 5, 7, 10 and 12.

### RAY TRACING ALGORITHM

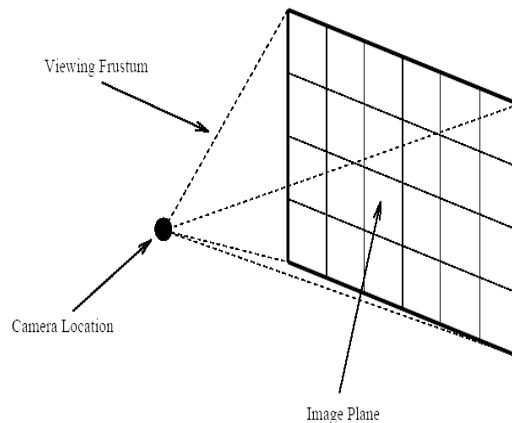
Ray tracing is an approximated solutions to the light transport problem, which is also known as the global illumination problem. The equations describing the physical problem of light transport in a three-dimensional environment are known [4]. Solving these equations is the major theme in the rendering research. The idea of the ray tracing is to simulate the light rays, which are reflected from objects seen by the eye (camera) in an opposite manner. It traces primary rays of light from the viewer's eye to the objects in the scene. This simple algorithm determines the colour and the intensity of a point at the closest intersection of a primary ray with an object.

The first stage in the ray tracing algorithm is the generation of primary rays, the rays that start the recursive ray tracing process. The camera model

employed by most ray tracing systems generates primary rays by simulating a simple pinhole camera. In the pinhole camera model, a primary ray originates at the camera position, and is directed such that it pierces a point lying in the *image plane*. The image plane is subdivided into a two dimensional grid of pixels, which correspond directly to the pixels in the final output image. In a simple ray tracer, primary rays are spawned through the centre of each pixel in the image plane, and the resulting colour is stored in the corresponding pixel in the output image [5].

A centre of projection the *viewer's eye* and a window *image plane* on an arbitrary view plane are selected. The window may be thought of as being divided into a regular grid, whose elements correspond to pixels at a desired resolution. Then for each pixel in the window, a primary ray is spawned from the centre of projection through the centre of the pixel into the scene, as shown in Figure 3. The colour of the pixel is set to that point of the object at the closest intersection [5] [6].

In order to model shadows, from the intersection point of the ray and the object, new rays are spawned towards each of the light sources. These rays, called shadow rays, are used to compute visibility between the intersection point and the light sources. Mirroring reflection and transparency may be modelled similarly by



**Figure1.** Virtual Camera and Image Plane

Figure 1, shows the camera location, image plane, and viewing frustum created by this simple model. In the simplest ray tracer implementations, only one primary ray is used to determine the colour of a pixel in the output image. Improved ray tracing algorithms spawn multiple primary rays through a given pixel's area in the image plane, in order to minimize aliasing artefacts. The number and direction of

shooting new rays into the reflected and/or transmitted directions. These reflection and transparency rays are treated in exactly the same way as primary rays are. Hence, ray tracing is a recursive algorithm [6]. Tracing rays is a recursive process, which has to be carried out for each individual pixel separately. A typical image of  $1000^2$  pixels tends to cost at least a million primary rays and a multiple of that in the form of shadow rays and reflection and transparency rays. The most expensive parts of the algorithm are the visibility calculations. For each ray, the object that intersected the ray first, must be determined. To do this, a potentially large number of objects will have to be tested for intersection with each ray [6].

The first stage in the ray tracing algorithm is the generation of primary rays, the rays that start the recursive ray tracing process. The camera model employed by most ray tracing systems generates primary rays by simulating a simple pinhole camera. In the pinhole camera model, a primary ray originates at the camera position, and is directed such that it pierces a point lying in the *image plane*. The image plane is subdivided into a two dimensional grid of pixels, which correspond directly to the pixels in the final output image. In a simple ray tracer, primary rays are spawned through the centre of each pixel in the image plane, and the resulting colour is stored in the corresponding pixel in the output image.

primary rays used to determine pixel colour is determined by the antialiasing technique used by a given ray tracing system. Antialiasing is discussed in greater detail later in this chapter. The next section is the rendering process is visible surface determination. An example of a camera model is shown in Figure 2, In the example, the camera has focal length  $f$  which is oriented along the Z axis and moves only along the X axis direction.

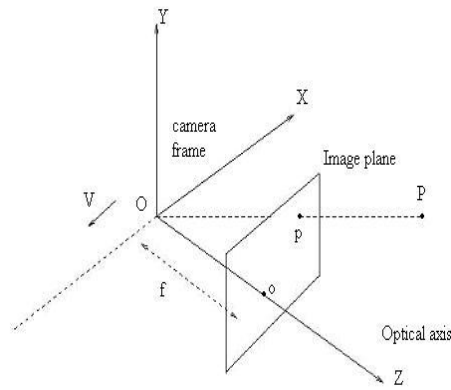


Figure2. The camera system.

Centre of the camera also known as the centre of projection indicates the position of the camera in the scene.

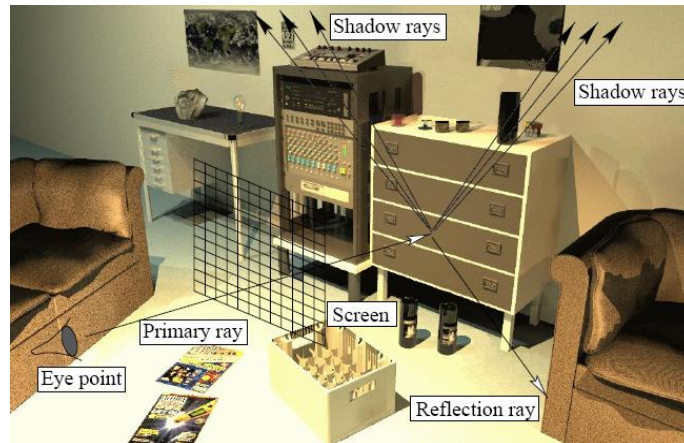


Figure 3: Overview of ray tracing.

### COMPUTER GENERATION OF INTEGRAL IMAGING USING RAY TRACING

All the described properties of ray tracing can be migrated to three-dimensional integral imaging and opens the door to computer graphics applications that facilitate integral imaging displays. Integral imaging increases the perception of the photo-realism in ray tracing for the observer. Computer generation of integral imaging has been reported in several literatures [1] [7][8][9][10][11][26][27]. Computer generation of integral imaging is very useful where an integral image can be replayed using a LCD monitor by overlaying it with a lenticular sheet.[9] modelled the optical system of integral imaging and applied it inside a ray tracing renderer. This new renderer is represented in the paper by the term integral ray tracing (IRT). For both lenticular sheets and microlens arrays, each cylindrical lens or microlens acts like a separate camera. The virtual scene is straddling the modelled lenticular sheet as well as the image plane as shown in Figure 5 and 6. In recent years

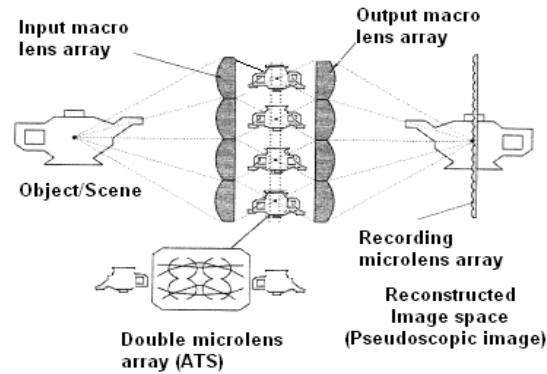
several research groups have proposed similar techniques for generating synthetic integral images [7] [9] [11-14]. However, most of the work concentrated on reproducing the various physical setups to using computer generation software packages such as *POVRAY* [15], and Multiprocessor ray tracing system *TACHYON* [16].

3D Holographic imaging (also known as Integral imaging) is a technique that is capable of creating and encoding a true volume spatial optical model of the object scene in the form of a planar intensity distribution by using unique optical components. It is akin to holography in that 3D information recorded on a 2D medium can be replayed as a full 3D optical model, however, in contrast to holography, coherent light sources are not required. This conveniently allows more conventional live capture and display procedures to be adopted. With recent progress in the theory and microlens manufacturing, integral imaging is becoming a practical and prospective 3D display technology and is attracting much interest in the

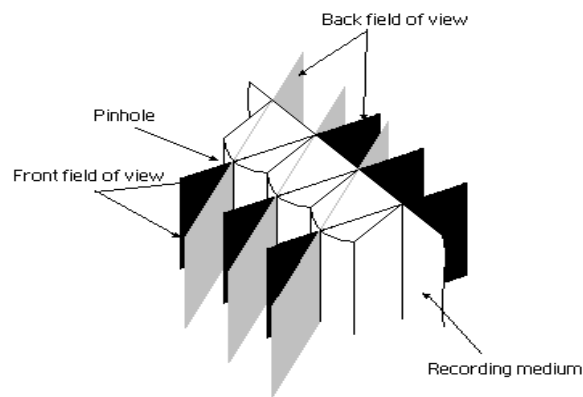
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3D area. To record a 3D Holographic image a regularly spaced array of small lenslets closely packed together in contact with an image sensor (as shown in figure 5 and 6). Each lenslet views the scene at a slightly different angle to its neighbour and therefore a scene is captured from many view points and parallax information is

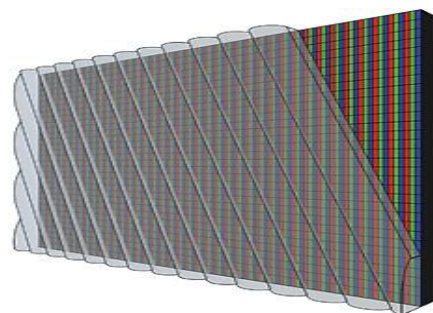
recorded. After processing, if the photographic transparency is re-registered with the original recording array and illuminated by diffuse white light from the rear, the object will be constructed in space by the intersection of ray bundles emanating from each of the lenslets.



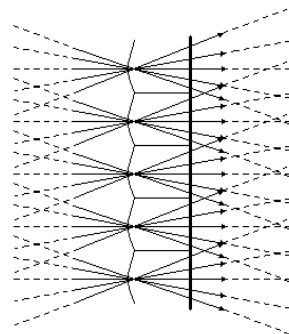
**Figure 4:** An advanced Integral Imaging system [96].



**Figure.5:** Lenticular sheet model in integral ray tracer.



**Figure 6:** The Slanted arrangement of the lenticular lens and pixels in the multiview auto-stereoscopic displays.

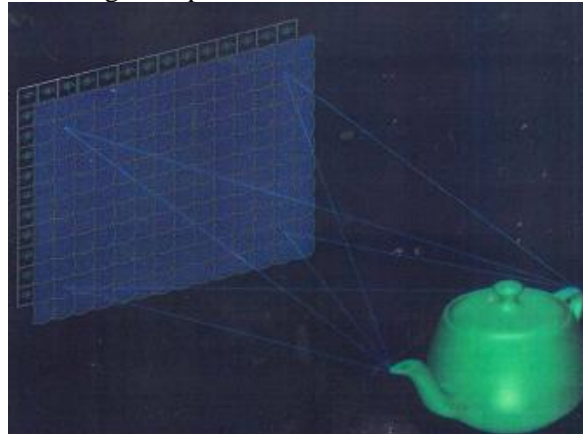


**Figure 7:** Camera model in 3D integral images for computer graphics.

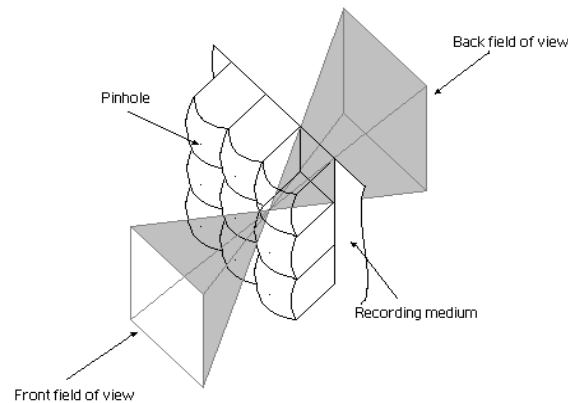
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3D Holographic image is recorded in a regular block pixel pattern. The planar intensity distribution representing a 3D Holographic image is comprised of 2D array of  $M \times M$  micro-images due to the structure of the microlens array used in the capture and replay. The rectangular aperture

at the front of the camera and the regular structure of the hexagonal microlenses array used in the hexagonal grid (recording microlens array) gives rise to a regular 'brick structure' in the intensity distribution as illustrated in Figure 4 and 8.



**Figure 8:** Recording of a 3D Holographic Image.



**Figure 9:** Micro-lens array in integral ray tracing.

The replay of the 3D Integral images is achieved by placing a microlens array on the top of the recorded planar intensity distributions as shown in

figure 5. The microlens array has to match exactly the structure of the planar intensity distribution[26][27].



**Figure 10:** Recorded 3D Holographic content showing a 2D Array of micro-images.

### 3D INTEGRAL IMAGES VIEWING PARAMETERS ALGORITHM FOR MULTIPROCESSOR RAY TRACING SYSTEM

Typically, moving from cylindrical lens to the next cylindrical lens is carried out knowing the

lens width,  $L_w$ , which defines the translation of the camera along the  $x$  optical axis and hence the position of the new camera cylindrical lens. Due to the special characteristics of integral images that lens width must be calculated for each scene of 3D integral images separately and putting

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them the new developed camera file hat will be used as input to the adapted multiprocessor ray tracing system in order to set up, prepare and having a new position of the 3Dcamera . The question raised here, how to accept/import the new camera file format , having a new position for the neighboring micro images and generate a still 3D integral images, new software is developed to allow moving the camera on the  $x$  axis. Camera files for such as a teapot and Gears scenes are developed.

The 3D integral multiprocessor ray tracing (3D IRT) software has been modified [15-25] in order to incorporate 3D integral imaging camera parameters file. That composed of several routines, First of all, the camera set up function is to deal with the three vectors (upvec, viewvec and rightvec) see Table I, II, and to set up the focal length the cylindrical lens, lens pitch, lens pixels, aperture distance, image size and finally the camera zoom. The vector cross and normalization must be calculated at this method.

```
focalLength=focallength;
lensPitch=lenspitch;
lensPixels=lenspixels;
apertureDistance=aperturedistance;
//cout <<"APERTURE DISTANCE ="<<
apertureDistance<<endl;
size=siz;
camZoom=zoom;
apivector newupvec;
apivector newviewvec;
apivector newrightvec;
```

The position of the camera function is to calculate the VC,ross, VNorm and the centre of the projection must be done here.

```
void DPosition(apivector centr, apivector
viewvec, apivector upvec) {
VCross(&upvec, &viewvec, &newrightvec);
VNorm(&newrightvec);
projCent.x;
projCent.y;
projCent.z;
}
```

```
void DCamera(Renderer renderer) {
nLenses = (int) ceil((float);
renderer.GetHRes() / (float) lensPixels);
lensW = (float) size / (float) nLenses;
cout <<"Lens w ="<< lensW<< endl;
lensD = lensW * focalLength / lensPitch;
cout <<"Lens D ="<< lensD<< endl;
}
```

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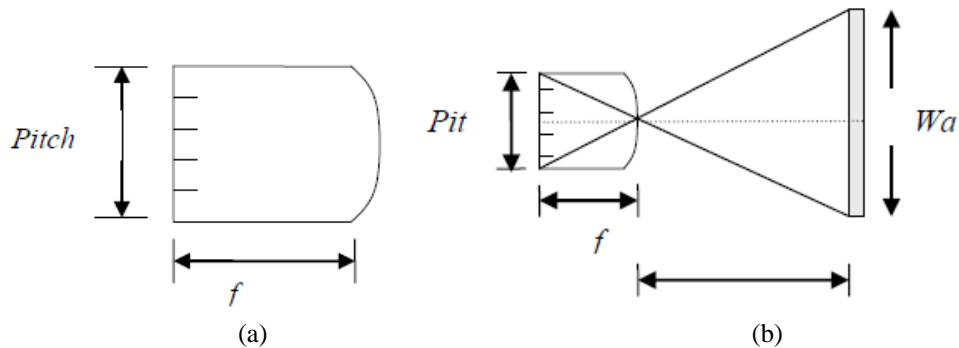
Let  $Lw$ ,  $D$  and  $f$  be the lens width, lens depth, and focal length of the lens respectively.

$$Lw/Pitch = D/f$$

$$\text{Inch} = 25.4\text{m}$$

$$\text{Pitch} = 25.4/10 = 2.54\text{m}$$

$$1.667.$$

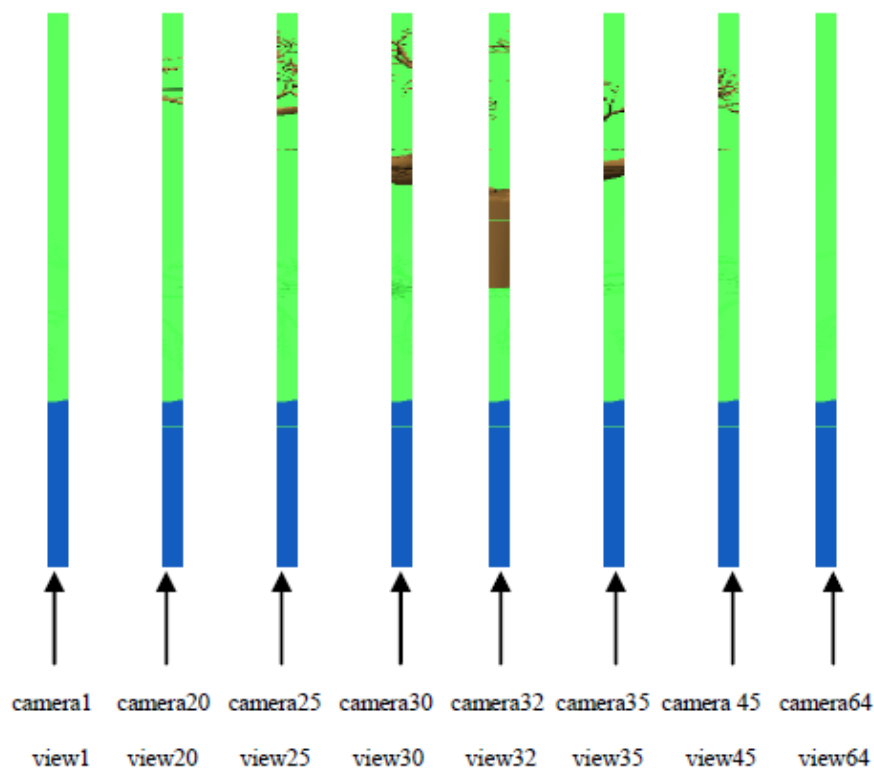


**Figure 11:** (a) sub-aperture and full aperture of micro-lenses. (b) simple geometry of pinhole camera.

## EXPERIMENTS AND RESULTS

The results are extremely satisfactory and for the first time it is proved that moving from cylindrical lens to the next cylindrical lens by knowing the lens width of each separate scene and hence the camera file format can be generated through multiprocessor / parallel ray tracer and used as an input for camera setting

method. In this paper a new viewing camera parameters is adopted (see Table I and Table II). An example of a 3D teapot, room, tree, gears, primitive and small-balls rendered using the multiprocessor integral imaging ray tracer is shown in Figures 12-17. 64 micro images have been generated with image size  $1024 \times 768$ , and 9 pixels behind each cylindrical lens.



**Figure12.** Gears Scene

## New 3D Integral Imaging Camera Viewing Parameters

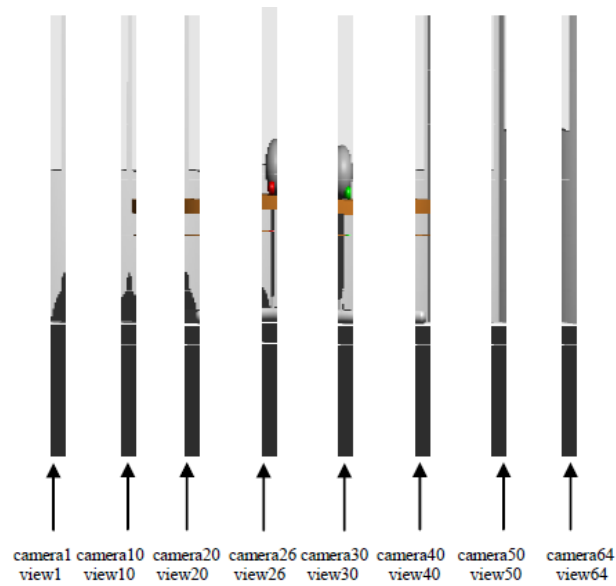


Figure13. Gears scene.

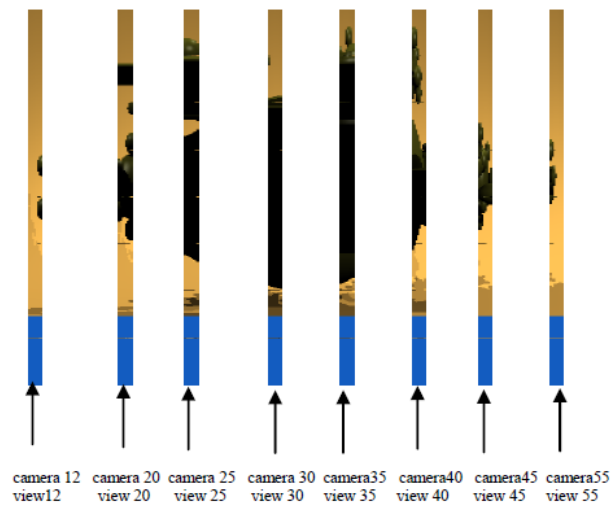


Figure14. Gears scene.

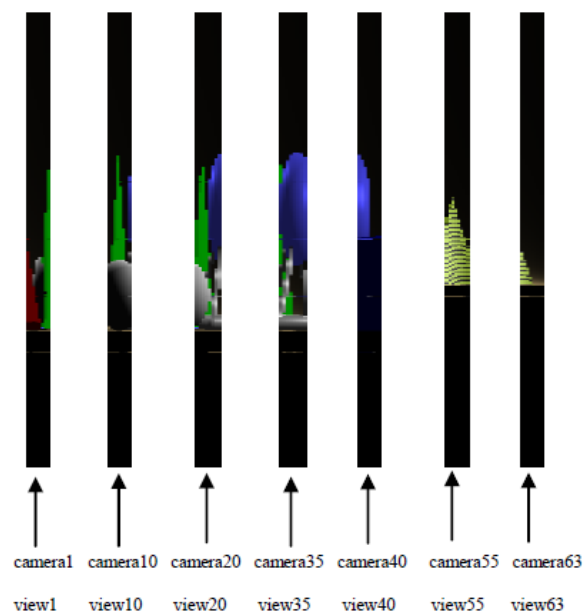


Figure15. Gears scene.



## New 3D Integral Imaging Camera Viewing Parameters

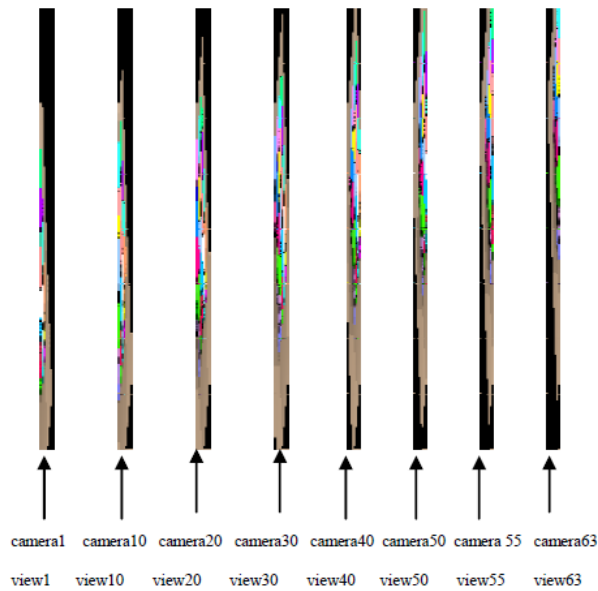


Figure16. Gears scene

Table II: New 3D Camera Viewing Parameters File For Ball Scene

ENTER	VIEWDIR	UPDIR
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-3.67 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-3.58 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-3.49 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-3.4 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-3.31 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-3.22 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-3.13 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-3.04 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.95 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.86 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.77 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.68 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.59 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.5 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.41 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.32 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.23 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.14 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-2.05 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.96 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.87 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.78 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.69 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.6 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.51 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.42 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.33 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.24 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.15 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-1.06 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.97 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.88 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.79 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.7 9.456 5.215
0.054-0.925-0.3777	-0.016 -0.378 0.926	-0.61 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.52 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.43 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.34 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.25 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.16 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	-0.07 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.02 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.11 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.2 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.29 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.38 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.47 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.56 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.65 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.74 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.83 9.456 5.215

## New 3D Integral Imaging Camera Viewing Parameters

0.054 -0.925 -0.377	-0.016 -0.378 0.926	0.92 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.01 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.1 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.19 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.28 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.37 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.46 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.55 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.64 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.73 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.82 9.456 5.215
0.054 -0.925 -0.377	-0.016 -0.378 0.926	1.91 9.456 5.215

Table I: New 3d Camera Viewing Parameters File For Teapot Scene

Center	Viewdir	Updir
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.046875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.09375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.140625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.1875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.234375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.28125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.328125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.421875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.46875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.46875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.515625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.5625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.609375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.65625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.703125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.75 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.796875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.84375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.890625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.9375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	0.984375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.03125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.078125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.171875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.21875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.265625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.3125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.3125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.359375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.40625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.453125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.5 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.546875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.59375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.640625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.6875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.734375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.78125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.828125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.921875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	1.96875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.015625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.0625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.109375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.15625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.203125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.25 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.296875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.346875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.390625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.4375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.484375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.53125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.578125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.671875 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.765625 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.8125 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.859375 0.250 0.000
-0.411 -0.902 -0.128	-0.061 -0.113 0.992	2.90625 0.250 0.000

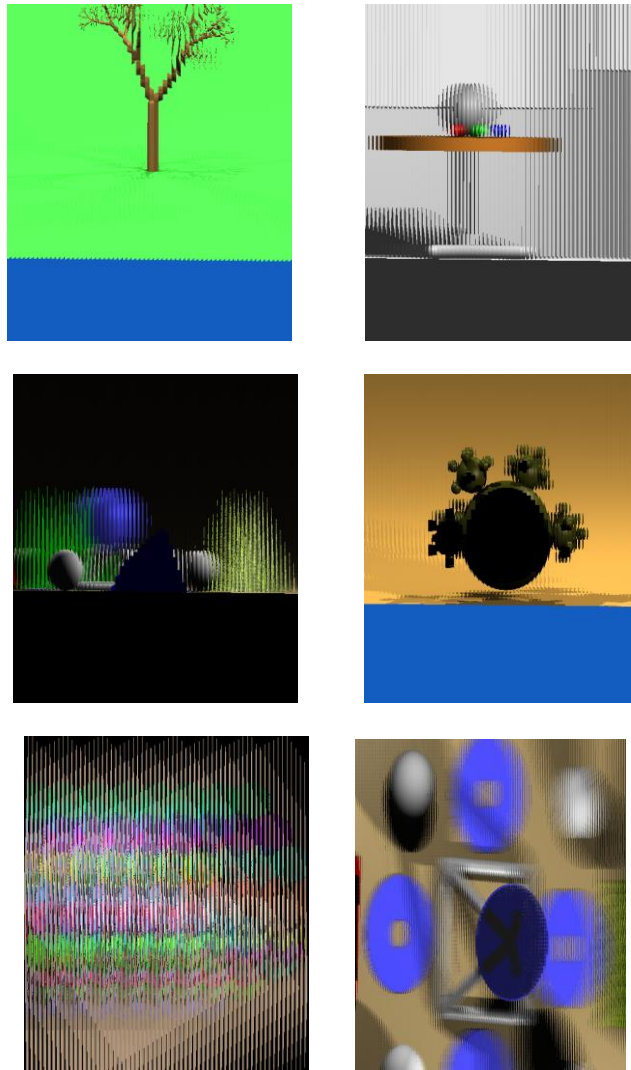


Figure17. 3D integral images scenes are generated by using a camera parameters file.

## CONCLUSION

This paper presents a new multiprocessor ray tracing system software tool to allow cylindrical lens to move on the x axis direction. In conclusion, we are able to develop a viewing camera file format method. The results have demonstrated that micro images can be generated through a cylindrical lens using multiprocessor ray tracing system and displayed on commercially available multi-view auto-stereoscopic display.

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