Lens View Rendering For Efficient Computer Generation Of 3D Integral Images

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■ **Abstract:**

3D Holoscopic imaging is a technique that use one single camera aperture where it consists of micro-lens array type in the rendering process, that leads to avoid eye fatigue. The paper presents a novel algorithm that addresses the challenge of reducing the computational time required to generate photo-realistic still 3D integral images based on multiprocessors ray tracing system. The proposed approach combines information from multiple micro-images with the first micro-image being fully ray-traced and the subsequent ones generated through re-projection by using spatial coherence between adjacent micro-images. This allows reusing of results obtained through one micro-image to computer generate the neighboring micro-image and hence to avoid ray tracing all the pixels. The algorithm deals with micro-images of a still image separately and apart from the first micro-image which is fully ray traced, all other the micro-images are generated using information obtained from the correspondent micro-image in the cylindrical-lens immediately prior to it. Subsequent, test results show the important impact that the new integral lens view algorithm has achieved saving approximately (13 % - 47 %), more than its normal execution speed regardless the complexity of the scene, and the number of computations. In the case of a complex nature scene such as tree scene a significant saving up to (41 %) and saved up to (6.057) seconds is achieved. Whereas, the saving in such as teapot, room, small-balls, and primitives scenes are between (25 %, 39 %, 47 %, and 27 %) respectively. Promising results obtained are making a real impact on the various applications such as virtual reality, 3D computer games and architectural visualization are certain now.

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Keywords: Acceleration 3D Integral Images, Real-time Computer Generation content of Integral Images, Computer Graphics, Spatial Coherence, Ray Tracing, 3DTV.

■ **المستخلص:**

تقنية الصور المتكاملة ثلاثية الأبعاد، تستخدم بؤرة واحدة وحيث إنها تتكون من عدة عدسات متصلة على هيئة مصفوفة أثناء عملية التقاط وإظهار الصورة. وكل عدسة من تلك العدسات تلتقط الصورة المصغرة بزاوية رؤية مختلفة قليلا عن العدسة المجاورة. وهذه الميزة وغيرها لهذه التقنية تقود إلى عدم الإعياء والإجهاد للبصر خلال المشاهدة. هذه الورقة البحثية تقدم لأول مرة خوارزمية جديدة تسمى» مشاهدة العدسة لكفاءة تكوين الصور في الزمن الحقيقي بين العدسات الاسطوانية الصغيرة« التحدي المتعلق بتقليل زمن المعالجة وعمليات الحساب المستغرقة من أجل إنتاج الصورة المتكاملة وذلك بتسريع يقترب من الزمن الحقيقي المعتمد على خوارزمية تتبع الشعاع للمعالجات المتعددة التي تستغرق ليس بالبسيط لأنها تقوم بحساب انتقال الضوء وتقاطعه مع الشي في موقع معين لأخذ ألوان ذلك المكان والمشهد ككل بتتابع. هذه الورقة تدرس عملية إعادة استخدام البيانات المتحصل عليها بواسطة خوارزمية تتبع الشعاع أي إعادة إسقاطها في الموقع المحدد الجديد بعدما تم تحديد موقع جديد باستخدام معاملات العدسة وهي تكون على هيئة متجهات. النتائج العملية أظهرت تحقق تسريع في تكوين الصورة المصغرة الاسطوانية بأربعة اضعاف مقارنة بإنتاج الصورة الثلاثية بين مجموعة من الإطارات. لقد تم استغلال عملية الترابط بين العدسات الاسطوانية المصغرة وكذلك تم استخدام خوارزمية تتبع الاشعة المتعددة.

● **الكلمات المفتاحية:** خوارزمية تتبع الشعاع للمعالجات المتعددة، الزمن الحقيقي لتكوين الصور المتكاملة ثلاثية الابعاد، الرسومات الحاسوبية، الترابط بين الصور الأسطوانية المصغرة، شاشات العرض ثلاثية الابعاد.

■ Introduction

The proposed algorithm is introduced a novel approach by combining fully ray traced and reprojection generated micro-images. This hybrid technique offers a potential solution to decrease the computational burden associated with generating 3D integral images. The process, which is referred it as reprojection, is to overcome the issue of ray tracing transport light problems of intersection points that related to pixels of each cylindrical-lens and hence the rendering execution time is decreased. The proposed integral imaging lens view algorithm accelerates integral ray tracing by a factor of four times when compared to fully ray tracing all micro-images in a single integral image.

visible degradation and distortion caused by lens view algorithm are treated using z-buffered projection and 3D interpolation while only missed 3D pixels are used ray tracing algorithm again. The *z-buffer* algorithm is used to ensure that the closest point image is mapped onto the pixel image. Finally, the micro-image is generated through the cylindrical lens (1-5). The proposed *IILVA* life cycle and pseudo code processes are illustrated in Fig. 1and Fig. 2. The Fig. 1 shows the developments stages of the new algorithm is started from the first cylindrical lens which is fully generated using integral ray tracing algorithm. The point image array is developed in order to save 3D information. The reprojection process is reprojected the point image into pixel image.

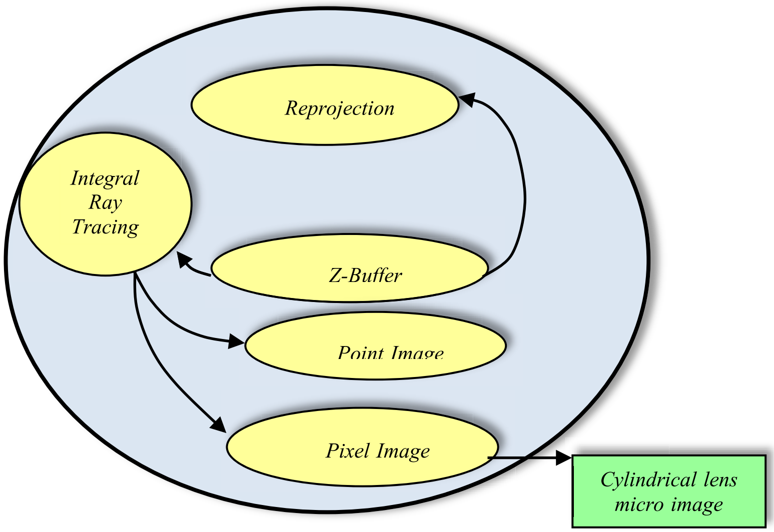


Fig.1. Rapid integral ray tracing using integral imaging lens view algorithm.

```
While not end of camera file
  {
     Get position of 3D camera
   If first cylindrical lens use 3D integral ray tracing algorithm to
      generate first Microlens (microimage)
   If position of 3D integral camera changes
    reproject image points of previous rendered micro-image onto
       new image pixels plane
  }
```

Fig.2. Pseudo code of integral imaging lens view algorithm.

■ Computer Generation Of Holoscoic Images Using Parallel Ray-Traced System

Computer generation of 3D integral images also refer it as 3D Holoscopic images has been addressed in several literatures (6-33). Computer generation of 3D Holoscopic images is extremely valuable where 3D Holoscopic images can be replayed onto a LCD monitor by overlaying it with a lenticular sheet, Fig. 3. modelled the optical system of 3D Holoscopic images and applied it inside a ray-traced renderer. Due to the nature of the recording process of 3D Holoscopic images, some features changes in the camera model used in standard ray traced. For lenticular sheets, each lens acts like a cylindrical camera. A number of pixels are associated with each micro-lens from the sub-micro-image Fig. 3. Each lens records a sub-micro-image of the scene from a slightly different angle to the neighbor lens as seen in the Fig. 4. For micro-lenses arrays each micro-lens acts like a cylindrical camera according to the structure of the cylindrical-lenses, as shown in Fig. 3 and Fig. 4. the lenticular lenses or the micro-lenses, a pinhole model is used. In the case of lenticular sheets, the pinhole is formed a straight line parallel to the axis of the cylindrical-lens in the vertical direction y axis. For every pixel, a primary-ray is sent. The recording way of the primary ray draws a straight line going forward towards the image plane and backward away from the image plane. Similarly, primary rays of neighbor micro-lenses are sent to same directions parallel to each other. Therefore highly correlated sub-images are generated that is a feature of integral imaging.

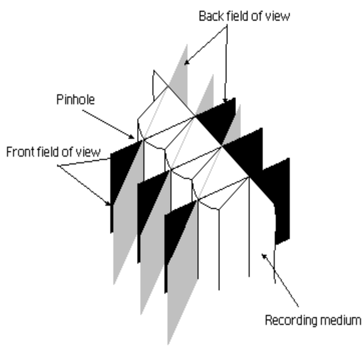


Fig. 3. Lenticular Microlens sheet model in holoscopic ray tracer.

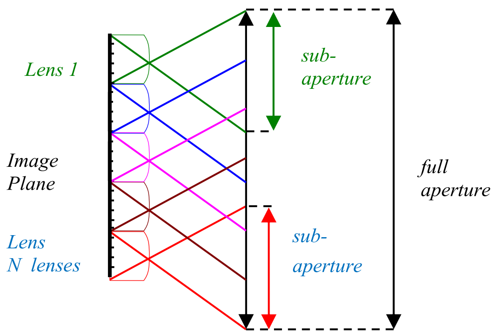


Fig. 4: Sub-aperture and full aperture micro-lenses.

The special character and structure of the micro-lens and the Holoscopic 3D camera model in the ray-traced affects the way that primary rays are sent through as well as the spatial-coherence amid the rays.

■ Acceleration Of Integral Ray Tracing Techniques For Generation Of 3D Integral Images

A small amount of work has been done in terms of speeding up the execution of computer generation of integral images. Recently, three existing state-of-the-art techniques addressed reducing running time for fast generating 3D integral images were reported (30,31,32). The first technique of speeding up ray-traced is to decrease the tests of intersection points for shadow-rays numbers provided on the shadow cache technique (30,31,32). The second technique seized the beneficial of temporal coherence between consecutive 3D Holoscopic images which allows the usage of information from one frame to generate the next frame. Thus avoiding ray tracing a large number of pixels and hence reducing the processing time (31). The third technique takes advantage of the spatial coherence (5).

■ Lens View Rendering Algorithm For Efficient Computer Generation Of 3D Integral Images

The paper addresses a practical concern in computer graphics the time-consuming nature of generating photo-realistic 3D integral images. the algorithm significantly reduce the rendering time, making it beneficial for various applications, including virtual reality, computer games, and architectural visualization. This allows reusing of results obtained for one micro-image to computer generate the neighboring micro-image and hence avoiding ray tracing all the pixels. The proposed algorithm treats micro-images of a still image individually and apart from the first micro-image which is fully ray traced, all other the micro-images are generated using information obtained for the correspondent micro-image in the cylindrical lens immediately before it. The process, which is referred to as reprojection, reduces the intersection points tests associated with ray-traced 3D pixels in every cylindrical lens (micro-image) and hence the rendering execution time is decreased. The proposed integral imaging lens view algorithm accelerates integral ray tracing by a factor of four times when compared to fully ray tracing all micro-images in a single integral image. Graphical distortion and degradation occurred by re-projection are sort it out using z-buffered projection and 3D-interpolation but the fully ray-raced used to generate 3D missed pixels. In the rendering part of ray-traced algorithm, rays that shape the scene are used to catch intersection points hit the objects in the scene. The intersection points are being projected against the 3D Holoscopic image plane. The output projections process is defined the pixels of the 3D-image. The 3D projection process could be represented by matrix multiplication of 3D camera matrix C and the 3D world coordinates (X, Y, Z, 1) of the 3D intersection point, that projected against the 3D image plane or project plane:

$$\begin{bmatrix} wx \\ wy \\ wz \\ w \end{bmatrix} = C \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} \quad (1)$$

Whereas (x, y, z) are the 3D image coordinates of the projection plane where w indicates as a scale factor. (x, y) is the 3D pixel place in the 3D image. The image plane is far away at Z distance towards the projection centre and it must be constant to all 3D pixels.

■ Camera Matrix

The field of computer graphics is embedded the use of pinhole camera with perspective projection in their 3D cameras. Perspective projection projects the points against the 3D image plane alongside that spawns from a single 3D point, named the center of 3D projection. Obviously, the objects of more distant of centre of projection to be smaller whereas, the objects that closer to the centre of projection to be larger. 3D Camera matrix comprises of 3D projection matrix and transformation matrices that transform the scene from the coordinate to coordinate of the viewing camera. Begin with the image plane at distance d away towards the origin of camera coordinates, that representing the centre of projection of the 3d-camera, and a 3D point p is projected against the image plane. Calculate $P_p = (x_p, y_p, z_p)$ the perspective computer graphics projection of P, against the image plane at z = d, triangles similarity to that shown in Fig. 5, are used to implement the equations.

$$\frac{x_p}{d} = \frac{x}{z} \qquad \frac{y_p}{d} = \frac{y}{z} \tag{2}$$

Now, multiplying each side of the equation by d we get

$$x_p = \frac{x}{(z/d)} \quad x_p = \frac{x}{(z/d)} \tag{3}$$

The d distance is just a scale factor applied to x_p and y_p. All values of z allowable except z=0. The points that projected will be behind the centre *of projection on negative z axis or between the centre of image plane. The transformations can be expressed as 4 × 4 matrix as following:*

$$M = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/d & 0 \end{bmatrix} \tag{4}$$

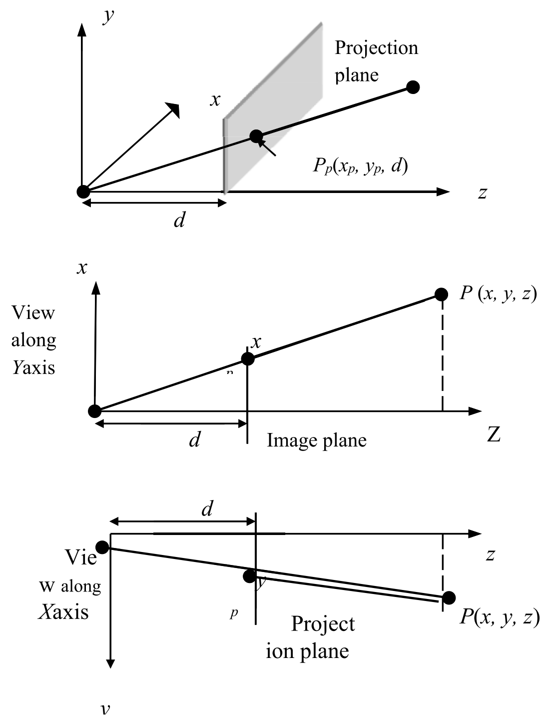


Fig. 5. Perspective projection[47].

Now, multiply the point $P = \begin{bmatrix} x & y & z & 1 \end{bmatrix}^T$ *by the matrix M we get the homogeneous point* $\begin{bmatrix} X & Y & Z & W \end{bmatrix}^T$:

$$\left(\frac{X}{W}, \frac{Y}{W}, \frac{Z}{W}\right) = \left(x_p, y_p, z_p\right) = \left(\frac{x}{(z/d)}, \frac{y}{(z/d)}, d\right) \quad (6)$$

The above equations are the outcomes of equation 2 and define the location of the 3D pixel of the projected point P.

$$\begin{bmatrix} X \\ Y \\ Z \\ W \end{bmatrix} = M \cdot P = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/d & 0 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \quad (5)$$

Equation 5, z/d *is defined as W. Now, to divide* $[X \quad Y \quad Z \quad W]^T$ *by W and in order to drop the fourth coordinate.*

■ Integral Imaging Lens View Algorithm Calculations

In order to implement this novel algorithm some essentials 3D Holoscopic images geometrical calculations must be achieved. micro-lens horizontal resolution of the projection plane is expressed as *MHR* and the micro-lens vertical resolution is expressed as *MVR*, where *PSX* is the 3D pixel size in the *x* coordinate, in both horizontal and vertical directions, and *MLP* is expressed as lens-pitch.

The number of pixels behind a Microlens, *NML*, is defined as:

$$NML = MLP / PSY \quad (7)$$

The Microlenses per still 3D holoscopic image frame, *NMF*, is defined as:

$$NMF = MHR / NML \quad (8)$$

the lens-width is defined as MLW, lens-depth MLD, and focal-length is defined MLF.

$$MLW / MLP = MLD / MLF \quad (9)$$

$$PXS = MLW / NML \quad (10)$$

$$PSY = MLW / NML \quad (11)$$

MLWI is the width of 3D holoscopic image frame is expressed as:

$$MLWI = PSX \times MHR \quad (12)$$

Where MLI is the length of 3D holoscopic image frame is defined as:

$$MLI = PSY \times MVR \quad (13)$$

MLPA is defined as the aperture width of the Microlens, in order to prevent overfilling of micro-images by providing a physical boundary that restricts the incident rays projected on the image plane.

$$MLD = MLPA \times MLP / MLP \quad (14)$$

The distance *d* must be control in order to correctly fill the Microlens filed. If the cylindrical-lens aperture is positioned then *d* from it to the cylindrical-lens sheet is greater than *d* then the aperture in microlens will not be overfilled. Because of the width of image and the aperture being smaller than lens-pitch of the cylindrical sheet. If the distance *d* between cylindrical lens sheet and cylinderical aperture is equal to *d* then the micro-images are perfectly filled. That is there should be no overfill effects, such as multiple images, and no under filling effects, such as dead areas between the micro-image zones see Fig. 6. If the rays incident on cylindrical lens sheet are not limited then the micro-image fields will always be overfilled. There are some advantages of designing the 3D Holoscopic image allowing us to work on each micr-olens separately than the next neighboring one in terms of the focal length, number of micro-lenses and pixels, micro-image with and length.

■ Reprojection In Integral Ray Tracing

The core idea of the hybrid algorithm addressed is to generate a still 3D integral image. Reprojecting the pixels generated from the previous cylindrical lens onto the next cylindrical lens through 3D camera matrix C of the new cylindrical lens against the image plane of the new lens. The cylindrical lens is represented by one camera matrix. This sample process has saved enormous amount of ray traced computational burden associated with intersection tests and shadow procedures and significantly reduce the running time of the fresh cylindrical lens. The process where the pixels of the new cylindrical lens are calculated is summarised in Fig, 6. Originally, normalizing and transforming the scene to the camera view coordinates. The sequences of transformations shows below.

1. Translate the origin of the scene coordinates through the translation matrix T to the origin of the micro-lens view.

2. Rotate the scene coordinate through the rotation matrix R such that its normal vector becomes the z axis, its right vector becomes the x axis, and its upper vector becomes the y axis.

3. Scale the volume containing the scene via the scaling matrix S in order to accommodate the dimensions of integral image window and the distance by which the image plane is separated from the origin of the camera.

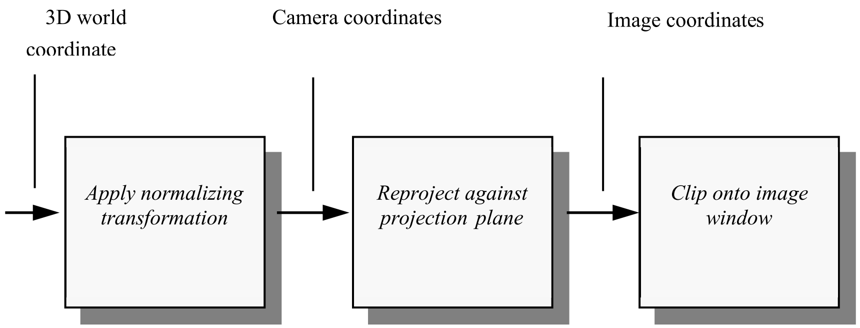


Fig. 6. Implementing of 3D scene view.

Step one is achieved by applying the translation matrix T:

$$T = \begin{bmatrix} 1 & 0 & 0 & -c_x \\ 0 & 1 & 0 & -c_y \\ 0 & 0 & 1 & -c_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad (15)$$

Where (c_x, c_y, c_z) is the origin of the camera view.

Step two involves applying the rotation matrix R:

The row vectors perform step two are the unit vectors rotated by R onto the x, y, and z axes [47].

The scene is rotated against the x, y, z axes of the camera, consequently.

$$R = \begin{bmatrix} U_x & U_y & U_z & 0 \\ V_x & V_y & V_z & 0 \\ N_x & N_y & N_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad (16)$$

Where U, V, and N are the unit vectors along the X, Y, and Z axes respectively.

Step three is achieved by applying the scale matrix S:

The image plane is upright to the z axis that spawns at the middle of the image window, and has length L and width K. In addition to that the image plane is a distance d away from the origin of the camera. In step three the volume containing the scene is scaled by matrix S in order to meet these parameters.

S is expressed by:

$$S = \begin{bmatrix} \frac{1}{K} & 0 & 0 & 0 \\ 0 & \frac{1}{L} & 0 & 0 \\ 0 & 0 & \frac{1}{d} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad (17)$$

The sequences of transformations as implemented to a desire scene previous integral projection. Multiply the three matrixes generate the normalization transformation matrix N:

$$N = S.R.T \qquad (18)$$

The camera matrix is then produced by multiplying the integral projection matrix and MI the normalization transformation matrix N:

$$C = M \times N \qquad (19)$$

scene points are mapped by The camera matrix C of the new cylindrical lens from the 3D world coordinates *(x, y, z, 1)* onto the image coordinates $(x_p, y_p, z_p, 1)$ of the new lens as follows:

$$\begin{bmatrix} W\,x_p \\ W\,y_p \\ W\,z_p \\ W \end{bmatrix} = C \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \qquad (20)$$

This generate the new cylindrical lens without the need for ray-traced them again and hence, increase the speed of generating 3D integral images, and save a major vast number of rendering for intersections tests and shadow. The final stage is to check whether x_p and y_p is within the cylindrical lens boundaries or outside the boundaries. If any one of them is outside the micro-image boundaries, the reprojected point will be discarded. Otherwise, it will be recorded in the new micro-image. The same routine is repeated again to generate a new micro-images use the information leftover from prior to micro-images Fig.7.

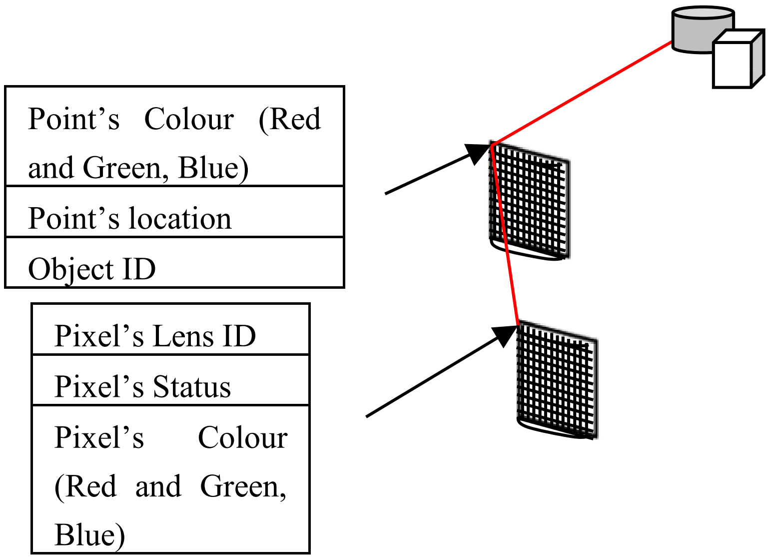


Fig. 7. Pixel image and Point image.

■ Holoscopic Images Lens View Algorithm

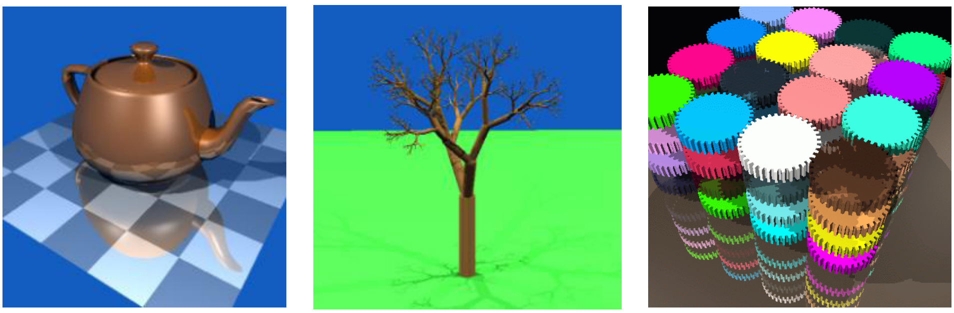
Essentially, still 3D Holoscoic image contains of array of micro-lenses. Every cylindrical-lens acts like a separately 3D camera. Integral ray-traced is used to produce the first micro-image through the first cylindrical-lens. Unidirectional camera sets to get a new location of cylindrical-lens. Obtain a new location of micro-lens is simply by known the width of micro-lens *MLW*. That allows defining the translate of the camera alongside the *x* optical axis and hence the position of the new micro-lens. The micro-image of the second micro-lens is generated by reprojecting points of the previous micro-image in first micro-lens through associated camera as described. The recursive procedure is repeated for the remaining cylindrical lenses. The point at which the ray hits the object is called, intersection point. Therefore, the reprojecting technique needs particular data for each pixel in the previous micro-image to produce the currently micro-image. Integral ray-traced is adapted to allocated two dimensional arrays that represent the *pixel- image* and the *point-image* respectively. The key values of the two arrays are linked up through their position in the arrays. Every element of the point-image contains of the position of an intersection point, the *IDN* of the object intersected, and its associated color data. Every element of the *pixel-image* contains of *IDNP* of an associated micro-lens, the color of the pixel, and status. The status of a pixel represents the flags of the colour is developed in the integral ray tracer software by three conditions: the first condition is to '0' the color of a newly produced point, the second condition is to '1' the color of a reprojecting point, the third condition is to '-1' there is not projected point against this pixel. Mainly, the first cylindrical lens is fully ray tracing prior to the points being reprojected using the explained previously projecting onto the adjacent new cylindrical lens's image plane with respect to the new viewing position. Multiply every point *P* from the previous cylindrical lens by the new camera matrix of the new cylindrical lens yields the pixel location in the new lens's coordinates. Therefore information of the point *P* is saved in this location in the new point-image of the current cylindrical lens. The colour of the point is then saved in the corresponding pixel in the pixel-image with the status flag set to '1'. The new point-image is first initialized by set the colour to black and set the status of the flag of pixels in the pixel-image to '-1'.

■ Holes Or Blank Regions

3D Pixels have not points projected against them are named 3D missed pixels. They appear as black holes or blank regions in micro lens and their flags equal to '-1' that means there is not 3D point is projected against associated the 3D pixel. 3D missed pixels are the result of firstly, occluded areas in the previous micro lens that should appear in the new micro lens that are missed (2,4,31). Secondly, The fresh new micro lens appears an areas that have not been mapped by the previous micro lens. Overcome this problem the 3D missed pixels are ray traced to produce their intersection 3D points and their colours (2,4,5). The same procedure is repeated using the 3D points of the current cylindrical lens in order to generate the new next cylindrical lens (2,4,5,31).

■ -Experiments and Results

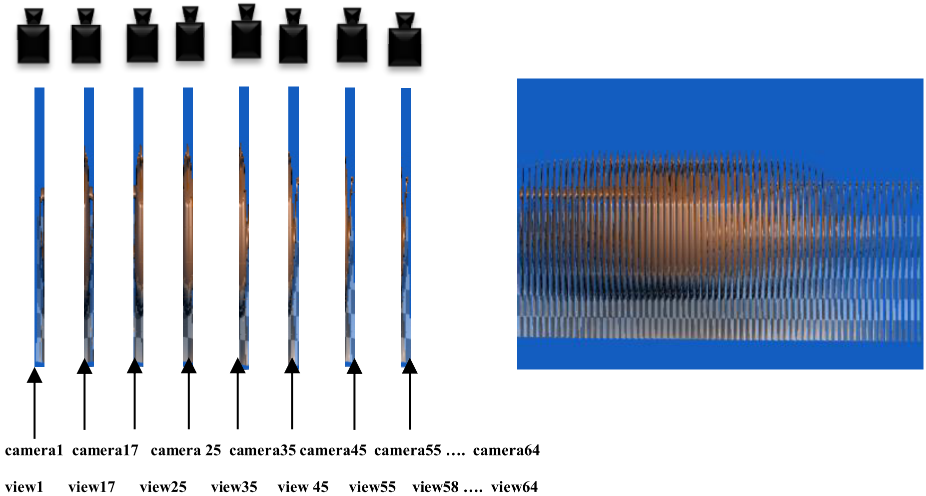
Experiments have been conducted on unidirectional camera on different nature of scenes. The different scenes tested are shown in Fig. 8. The resolution of the tested scenes is set to 512 H × 512 V pixels. The integral ray-tracing algorithm and integral imaging lens view algorithm decreasing computation time depends on the complexity of the scenes. Subsequent, test results show the important impact that the new integral lens view algorithm that has been achieved saving approximately (13 % - 47 %), more than its normal execution speed regardless the complexity of the scene, and the number of computations. In the case of a complex nature scene such as tree scene a significant saving up to (41 %) and saved up to (6.057) seconds is achieved. Whereas, the saving in scenes such as *teapot*, *room*, *small-balls*, and *primitives* scenes are between (25 %, 39 %, 47 %, and 27 %) respectively.



(a) Teapot scene (b) Tree scene (c) Gears scene

.[**Fig. 8**: Tested scenes [34

The integral ray tracing algorithm and integral imaging lens view algorithm have been reduced the rendering computation time depending on scene complexity. Fig. 9. Shows different 3D integral imaging frames of the test scenes. Tables 1, Table 2 and Table 3, show the details of scenes tested.



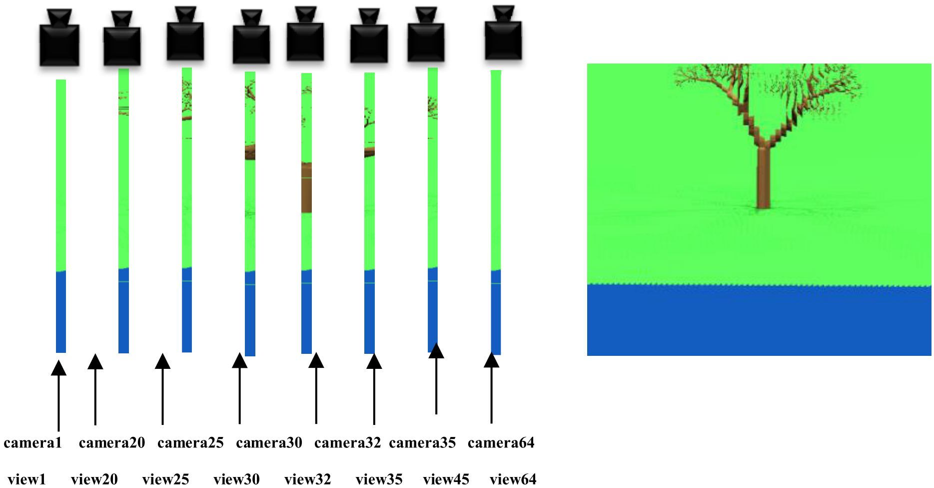


Table 1. Information of tested scenes.

Scenes	No. Objects	No. of Light Sources	Number of Planes	Number of Spheres	Number of Polygons
Teapot	*2330*	*2*	*0*	*0*	*0*
Room	*28*	*1*	*6*	*12*	*0*
Small-balls	*7385*	*3*	*1*	*7381*	*0*
Tree	*8199*	*7*	*0*	*0*	*0*
Primitives	*40*	*2*	*1*	*9*	*0*

.**Table 2.** *Shows details of scenes tested*

Scene Names	Microlens pitch	MicroLens focal- length	Number of cylindrical- lenses	Number of objects	Number of pixels behind per cylindrical lens
Teapot	2.116667	6.8	64	2330	8
Room	2.116667	6.8	64	28	8
Sc98	2.116667	6.8	64	40	8
Small- balls	2.116667	6.8	64	95	8
Tree	2.116667	6.8	64	8199	8

Table 3: *Renderings time of different frames used integral ray-traced algorithm and integral imaging lens view algorithm.*

Scenes	*Total rendering time of 3D integral image using fully integral ray-traced algorithm (in seconds)*	*Rendering time frame using integral imaging lens view algorithm (in seconds)*	*Total saved rendering time after use integral imaging lens view algorithm (%) in sec) and)*
Teapot	*3.000*	*2.253*	*% sec 25 0.747*
Room	*2.000*	*1.218*	*% sec 39 0.782*
Small-balls	*2.000*	*1.063*	*% sec 47 0.937*
Primitives	*2.000*	*1.455*	*% sec 27 0.545*
Tree	*14.734*	*8.677*	*% sec 41 6.057*
Gears	*5.000*	*4.343*	*% sec 13 2.125*

Initially, the first micro-image of frame for every scene tested is generated by fully integral ray tracing without the need of using of the integral lens view algorithm. Due to the different scene complexity, the computation times needed for ray tracing a scene are differs from scene to another. Table 3 shows the rendering timings for the same scenes 3D integral imaging frames generated using fully integral ray-tracing algorithm and the integral lens view algorithm. The significantly reduce of the execution timings that have been saved as shown in Table 3, (13% - 47%) reduction in the ray-traced timing for different nature scenes is achieved by used the lens view technique when compared to fully ray-traced depending on the complexity of the scene. Integral imaging lens view algorithm consumes for instance 2.253 second for photo-realistic still 3D integral image of teapot scene depends on the scene *and the time for ray tracing of different scenes. The new technique that is developed also saves up to (6.057) second of computation time of Tree scene.*

■ Conclusion

The primary objective of significantly reducing rendering running time for generating 3D integral images is defined and is supported throughout the paper. The main idea of integral imaging lens view is to take full advantage of the spatial coherence which is inherent in integral imaging. In this sense, 3D information obtained for cylindrical lens is reused to generate the new cylindrical lens and hence avoiding ray tracing again a large number of pixels. The implementation of integral imaging lens view algorithm addressed a practical concern in computer graphics the time-consuming in details considering the three main stages of the proposed new algorithm: application of transformations, normalization into viewport, reprojection plane, and clip against view volume.

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