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Extracting Geographic 3D Integral Images Data from Raster Maps

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Abstract—Holoscopic 3D imaging (H3D) technology also known as integral imaging is a true 3D imaging technology. It offers the simplest form that is capable of recording and replaying the true light field 3D scene in the form of a planar intensity distribution, by employing Microlens array. Despite it uses the same characteristics of holographic, it records the 3D information in 2D form and display in full 3D with optical component, without the need of coherent light source and confine dark fine. In addition, it facilitates postproduction processing such as refocusing. This makes it more practical approach for real-time 3D image capture and display. In this paper, a new method of extract 3D integral images data from raster maps. The *R2V* is an advanced raster to vector conversion software system is mainly used in order to generate geographical 3D integral images. Experimental results are extremely satisfactory and for the first time it is proved that, Geographic 3D Integral Images is generated. It means that, a new certain approach enables GIS applications of using 3D integral images is now established.

Keywords— Computer graphics; Geographic 3 D integral image; Multiprocessor ray tracing system; Raster Maps; GIS

I. INTRODUCTION

In addition to the research work, a commercial product called R2V from Able Software is an automated raster-to-vector conversion software package specialized for digitizing raster maps [1][2]. Exploiting the previous work on generating 3D integral images [9-22] and utilize from raster maps. The method is based on a 3D integral imaging multiprocessor ray tracer [11] containing 3D integral imaging parser, 3D unidirectional camera model, and R2V.

II. 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 is recorded on a 2D medium and can be replayed as a full 3D optical model. However, in contrast to holography, coherent light sources are not required for integral imaging. This conveniently allows more conventional live capture and display procedures to be adopted.

All integral imaging can be traced from the work of Gabriel Lippmann [3], where a micro-lens sheet was used to record the optical model of an object scene. The micro-lens sheet was made up of many micro-lenses having the same parameters and the same focal plane. In the arrangement, the recording film is placed at the focal plane of the micro-lens sheet, as illustrate in Figure 1. Following the film development, a full natural colour scene with continuous parallax can be replayed using another micro-lens sheet with appropriate parameters. The replayed image is spatially inverted as shown in Figure2

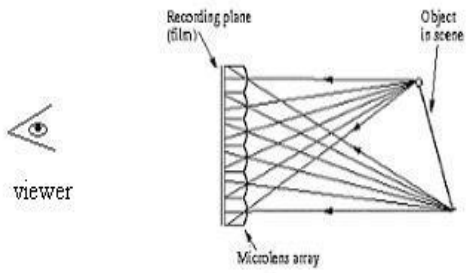


Figure 1: The recording of an integral image [3-8].

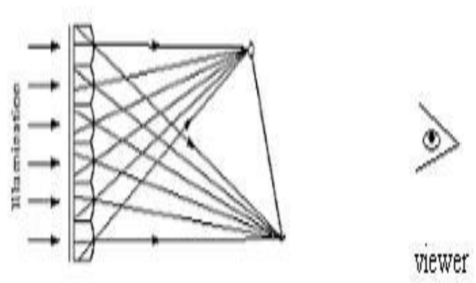


Figure 2: The replay of an integral image (The viewer perceives a spatial inverted 3D scene)[3-6].

To overcome the problem imposed by the pseudoscopic (spatially inverted) nature of the integral image, a modification to the Lippmann system was proposed by Ives 1931, in which a second recording process is introduced before replaying, as shown in Figure 3. When the second-stage photograph is replayed, a 3D image with correct spatial depth (orthoscopic) can be observed, see Figure 4.

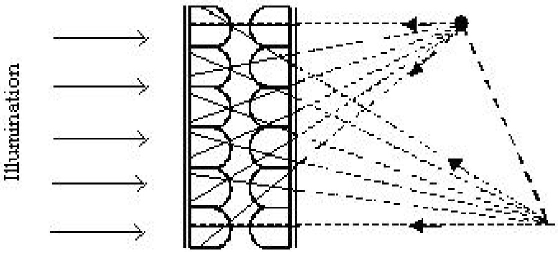


Figure3: A second stage recording of integral photograph [3-6].

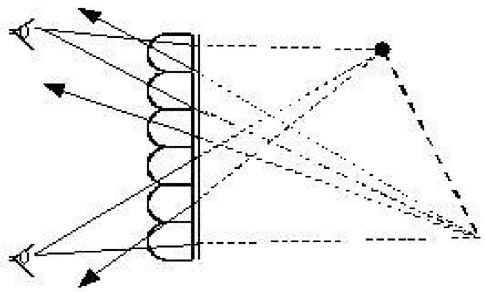


Figure 4: Replay and viewing of the orthoscopic image scene[3-8].

The two-stage recording process can produce an orthoscopic 3D scene with corrected spatial position. However, substantial image quality degradation is introduced due to the distortions introduced by the micro-lenses and film emulsion, stray light, etc. To overcome this problem, a two-tier network as a combination of macro-lens arrays and micro-lens arrays was reported by Davies and McCormick [4-8]. The two-tier network works as an optical “transmission inversion screen” which overcomes the image degradation caused by the two-stage recording process and allows direct spatially correct 3-D image capture for orthoscopic replay. Theoretically, this network is able to capture object space from 0.3m to infinity. In consequence, the integral photographic technique pioneered by Lippmann has been improved. With recent progress in micro-lens manufacturing techniques, integral imaging is becoming practical and prospective 3D display technology and hence is attracting much interest.

III. An Advanced Integral Imaging System

The optics of an advanced form of integral imaging system, that is employing a two-tier optical network was developed and has been described in detail [4-8]. The optical arrangement, shown in figure 5, comprises two macro-lens arrays placed equidistantly behind and in front of an auto-collimating transmission screen (ATS). The ATS is made up of two microlens arrays separated by their joint focal distance. The recording plane is a photographic plate whose position coincides with the focal plane of another microlens array.

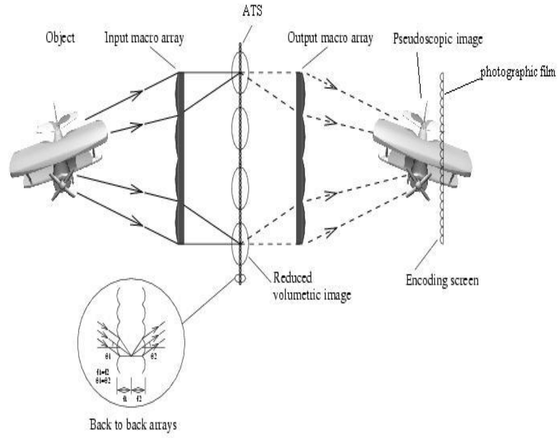


Figure 5: The advanced integral imaging system [3-6]

The optical transmission process of the advanced optical system is illustrated in Figure 6. The input macro-lens array first transmits the compressed object space to or near the central double micro-lens screen (ATS). The screen inverts the spatial sense of each intermediary image and simultaneously presents these spatially reversed 3D optical models to the corresponding output macro-lenses. The output macro-lenses array then re-transposes the optical model to the correct spatial location. The final integrated optical model before recording, formed by the second macro-lens array, is a true 3D optical 1:1 reconstruction of the original object.

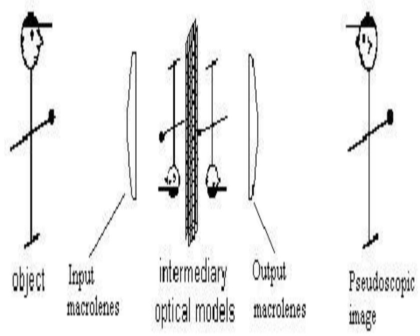


Figure 6: The optical transmission within the advanced integral imaging system [3-8]

The II is recorded on a film using a microlens array put after the two-tier optical network. Each microlens of the recording array samples a fractional part of the pseudoscopic scene, many micro lenses record directional information of the scene from different viewing angles. Therefore, parallax information for any particular point is spread over the recording plane. The angular information is further recorded by a film placed at the focal plane of the microlens array. This recorded II can be replayed by overlaying it with a microlens array having the same parameters.

In the above outlined capture and display processes, microlens arrays are used in both the encoding and decoding of the planar intensity distribution. The arrays used for this purpose typically comprise square-based spherical lens-lets, which are capable of encoding the object scene with continuous parallax in all directions. A section of such a lens array is illustrated in

Figure 7a. It is also possible to record and replay integral 3D images using lenticular sheets, which comprise many thin cylindrical lenses, as shown in Figure 7b. Integral images recorded in this way possess parallax only in one direction. It is worth mentioning that the integral image produced by the lenticular sheet is not the same as multi-view image with lenticular screen display. In the multi-view display system, the lenticular sheet is used merely for spatial de-multiplexing of multiple separate views of an object scene. To distinguish this difference, the term unidirectional integral image (UII) is used in the thesis to represent the image generated by integral imaging technique using lenticular sheet. The term Omni-directional integral image (OII) is consequently used to represent the integral image formed using the square based spherical microlens arrangements in recording.

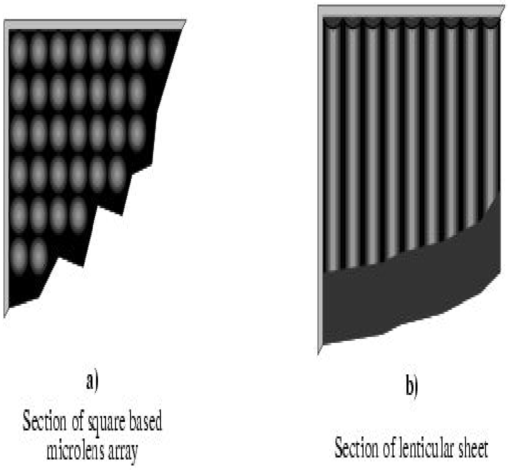


Figure 7: Diagrammatic representation of the lens array [3-8].

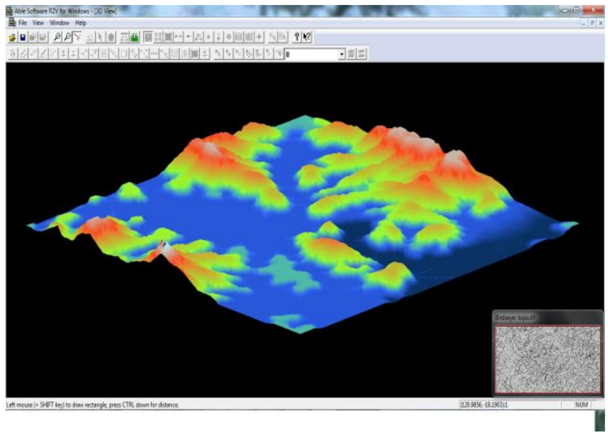
IV. Geographic 3D Integral Images For Multiprocessor Ray Tacing System

R2V for Windows is an advanced raster to vector conversion software system. The software is well suited for applications in Geographic Information Systems (GIS), Mapping, Computer Automated Design (CAD), and scientific computing. The entire raster to vector conversion process is fully automatic and needs no human intervention. You display the scanned image on the screen and you select the vectorization command.

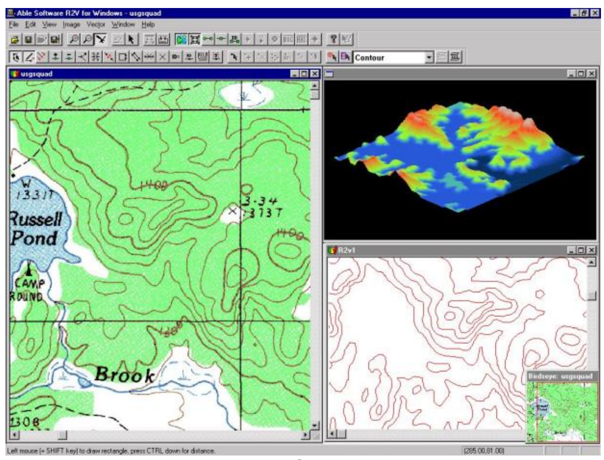
The raster image file formats supported are tagged image file format (*.tif), GeoTIFF (TIFF file with geo-referencing extension), Windows Bitmap (*.bmp), JPEG (*.jpg), GIF (*.gif), PNG (*.png), RLC (*.rlc), and raw image files (*.hdr). The currently supported image types include 1-bit bi-level, 8-bit grayscale, 4-bit palette, 8-bit palette color, and 24-bit true color. 16-bit grayscale images are not supported in the current version. The currently supported formats include: Arc/Info Generate file format (*.gen, *.arc), Shape File format for ArcView (*.shp), MapInfo vector format (*.mif), CAD drawing exchange file format (*.dxf), IGES (*.igs), MapGuide file (*.sdl), and 3D XYZ formats (*.xyz).see figure 8.

One of the biggest challenges is being 3D model file format as there are many 3D modeling application available in the market and support different file formats e.g. .3Ds, .max, .dsf, .ma, .obj, .stl, .dat, .nff, .wrl and many more shown in

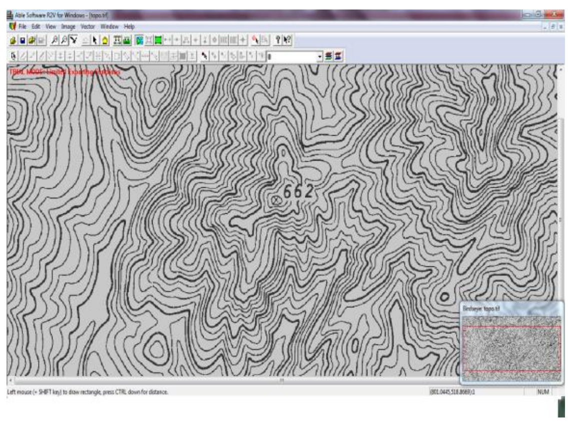
The question is how to support/accept various 3D model file formats and generate Geographic 3D integral images Data. Plug-in tool that will allow interfacing the computer generation of 3D Holoscopic graphics software with commercially available software tools such R2V software. in the environment of C, C++ and Matlab programming languages and the second based *Tachyon* ray-tracing software tool[9][14][16][19-23].



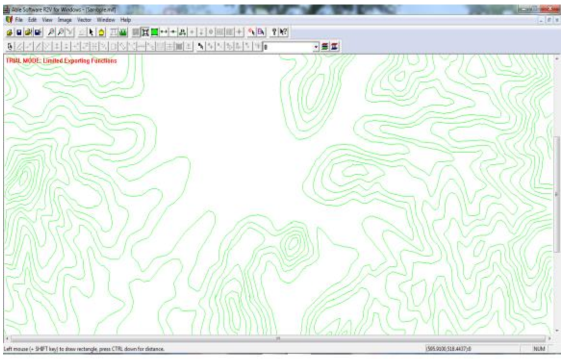
a



b



c



d

Figure 8 a-d: Raster map is generated by R2V software.

V. Experimental And Result

The results are extremely satisfactory and for the first time it is proved that geographic 3D integral images can be generated through multiprocessor integral ray tracer using commercially available R2V software package as second part. In this paper, a unidirectional is used. See Figures 9-11. *699* frames

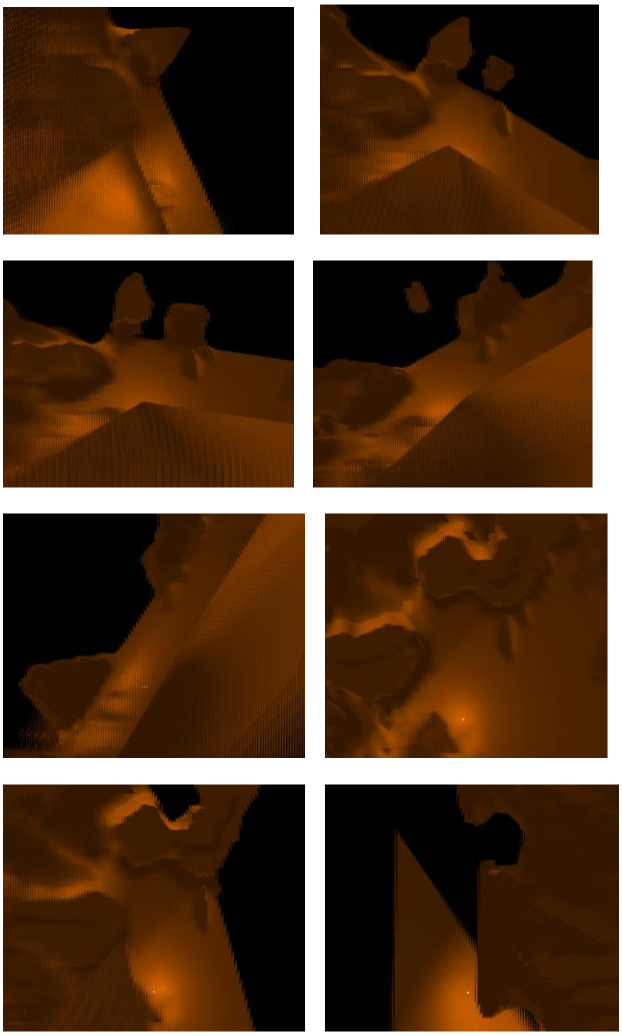


Figure 9: Raster map of Geographic 3D integral images.

```
void camerasetup(camdef * camera, flt zoom,
   apivector center, apivector viewvec, apivector upvec) {
    vector newupvec;
    vector newviewvec;
    vector newrightvec;
    VCross(&upvec, &viewvec, &newrightvec);
    VNorm(&newrightvec);
    VCross(&viewvec, &newrightvec, &newupvec);
    VNorm(&newupvec);
   newviewvec=viewvec;
   VNorm(&newviewvec);
   camera->camzoom=zoom;
   camera->center=center;
   camera->viewvec=newviewvec;
   camera->rightvec=newrightvec;
   camera->upvec=newupvec;
  }
```

Fig. 10. Pseudo code for 3D integral images camera setup [11,16].

```
errcode rc = PARSENOERR;
 rc |= GetString(dfile, "BEGIN_SCENE");
  rc |= GetString(dfile, "RESOLUTION");
 fscanf(dfile, "%d %d", &xres, &yres);
 rt_scenesetup(scene, "/tmp/outfile.tga", xres, yres, 0);
 rc |= GetString(dfile, "CAMERA");
 rc |= GetString(dfile, "FOCALLENGTH");
 fscanf(dfile, "%f", &a);
 focalLength=a;
 rc |= GetString(dfile, "LENSPITCH");
 fscanf(dfile, "%f", &a);
 lensPitch=a;
 rc |= GetString(dfile, "LENSPIXELS");
 fscanf(dfile, "%d", &lensPixels);
 rc |= GetString(dfile, "APERTUREDISTANCE");
 fscanf(dfile, "%f", &a);
 apertureDistance=a;
 rc |= GetString(dfile, "SIZE");
 fscanf(dfile, "%f", &a);
 size=a;
 rc |= GetString(dfile, "ZOOM");
 fscanf(dfile, "%f", &a);
 zoom=a;
 rc |= GetString(dfile, "ASPECTRATIO");
 fscanf(dfile, "%f", &b);
 aspectratio=b;
 rc |= GetString(dfile, "ANTIALIASING");
 fscanf(dfile, "%d", &antialiasing);
 rc |= GetString(dfile, "RAYDEPTH");
 fscanf(dfile, "%d", &raydepth);
 rc |= GetString(dfile, "CENTER");
 fscanf(dfile,"%f %f %f", &a, &b, &c);
 Ccenter.x = a;
 Ccenter.y = b;
 Ccenter.z = c;
 rc |= GetString(dfile, "VIEWDIR");
 fscanf(dfile,"%f %f %f", &a, &b, &c);
 Cview.x = a;
 Cview.y = b;
 Cview.z = c;
 rc |= GetString(dfile, "UPDIR");
 fscanf(dfile,"%f %f %f", &a, &b, &c);
 Cup.x = a;
 Cup.y = b;
 Cup.z = c;
 rc |= GetString(dfile, "END_CAMERA");
 camera.Setup(zoom, Ccenter, Cview, Cup, focalLength, lensPitch,
lensPixels, apertureDistance, size);
 rt_camerasetup(scene, zoom, aspectratio, antialiasing, raydepth);
 return rc;
}
```

Fig. 11. Pseudo code for 3D integral images camera parser [11,16].

VI. CONCLUSION

This paper presents a method that adapted Multiprocessor ray tracing system in order to first time generation of Geographic 3D integral images based on R2V software as a second part of the complete packaged developed that certainly leads to a new application of integral images that has not been investigated before such Raster maps.

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