Errors reducing method of Laser 3D scanner

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ABSTRACT:

This paper presents the factors that influence the form scanning processing by using the laser: light ambient, scanning surface, motion axial, focal length of the camera. This paper will present the method to reduce the error of the environment by using the camera calibration algorithms and the coordinate movements. This errors reducing method to solve the problem from local to genera: from solving errors created by the curve of the cameras to the laser-line width, to the dark gray threshold of the images by the camera aperture and coupling 2-movement axis to scanning-coupling more effectively.

Keywords: Laser line, 3D scanner, OpenCV.

1. GENERAL INTRODUCTION

3D Laser Scanner is a combination of a moving axis and a scanning ray. Therefore, if there is not a good coordination, the asynchrony will appear and cause errors. In addition, when the laser ray is projected on the surface will cause reflections effective. If it is not handled, we will not be able to scan objects. CCD camera has certain flatness in the work area; we need to flatten the whole surface, to avoid focal curves generated by the focal distance.
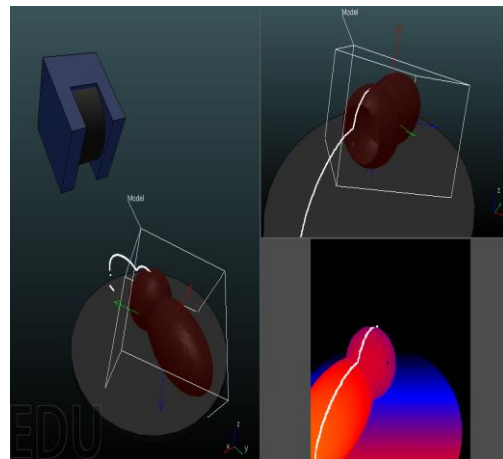

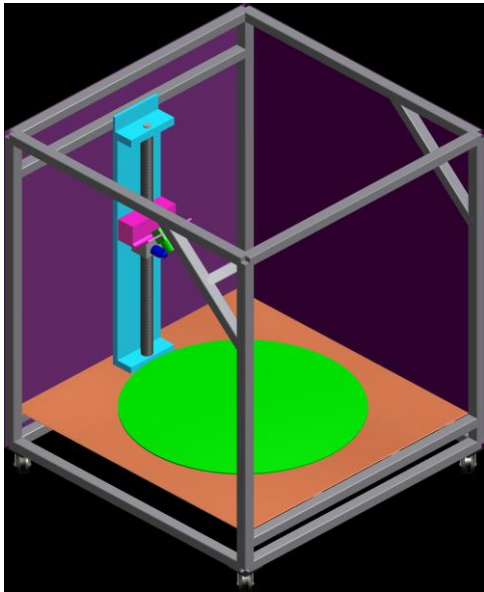**Figure 1-a**. Model of scanner rotation form: Simulating the design

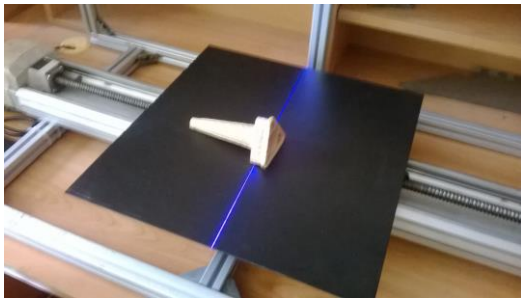**Figure 1-b.** Model of scanner rotation.

Figure 1-c. Model of scanner rotation form: Reality model

2. ERRORS REDUCING METHOD

To scan accurately the objects, we need:

- Feedback the rotating position syncing with camera.

- Adjusting the parameters of images extracted from camera

- Reducing the errors of capturing images when laser capture is projected to the object by using light aperture parameters adaptation self-configured.[4]

With the model in the citation, Laser and space environment aren't integratedly filtered. The model of integrated filter groups includes:

- Laser filter.

- Cameras filter.

- Continuously reading data from encoder to identify the frames while other models do not use this method.

- Coupling data-arrays bases on rotation mechanic model, reducing time and reducing errors better than just only coupling by software.

2.1 The synchronization values method

On moving axis, servo motor will be arranged with constant velocity controller [2]. Encoder signals are feedback continuously to the software and synchronized with image data obtained. The Open CV software turns into image continuously capture mode. We will allocate more time for the scanning position, so if the video capture mode does not respond promptly, we still have time enough to collate and process [5].
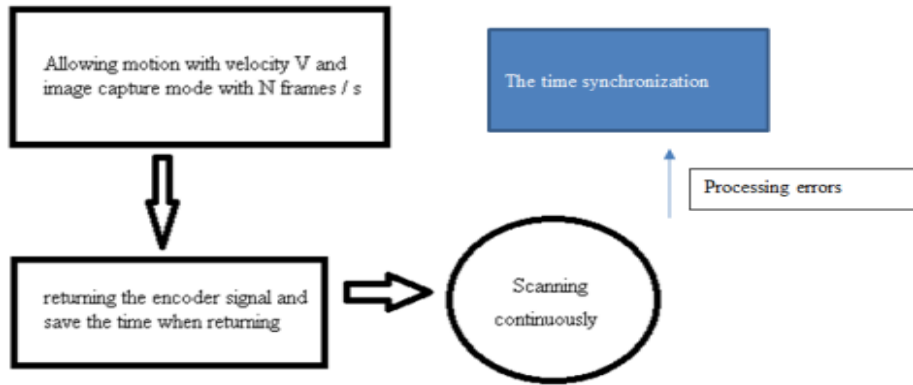
Figure 2. The capturing image time synchronized processing and encoder signals blocks diagram

2.2 Adjusting camera

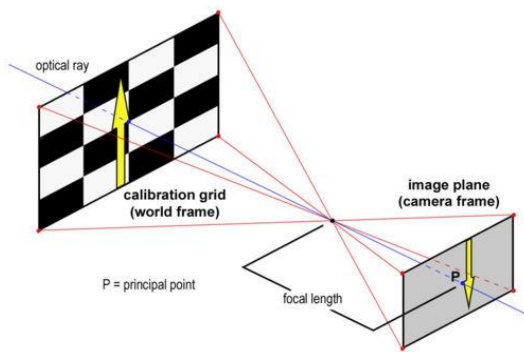Because CCD camera has only one flat certain area, so we need to stretch flatly the scanning area.

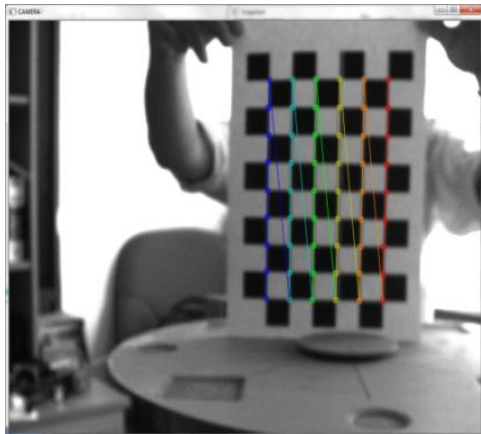**Figure 3-a**. Chessboard image set in front of camera.

Figure 3-b. Points of the chessboard indentifing image
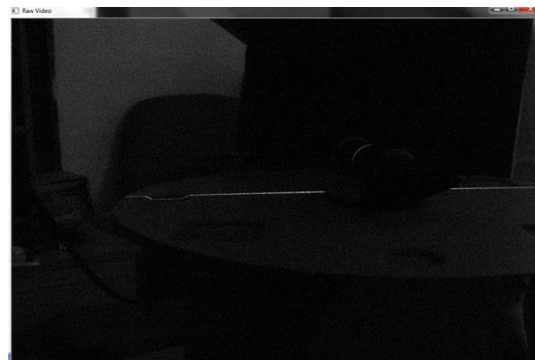
Figure 3-c. Flatly stretched before-processing image

Figure 3-d. Flatly stretched after-processing image

2.3 Processing algorithm

To filter out the effects of our environment and light, we need combine ithe image processing algorithms and the DirectX to configure the capture of the camera. First, to get the 2D curve of the objects, we need to set the following filters [3]:
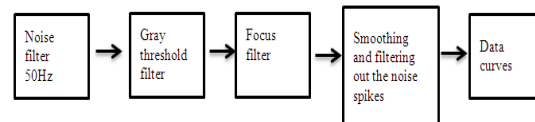

Figure 4. The filtering processes of program

50Hz noise filter: to filter 50Hz noise, we need interactive camera hardware, namely DirectX used to configure the properties of the camera.

Gray threshold filter: when the lasers data was existed, we will set the threshold to remove points that are not the laser (the laser is brighter).
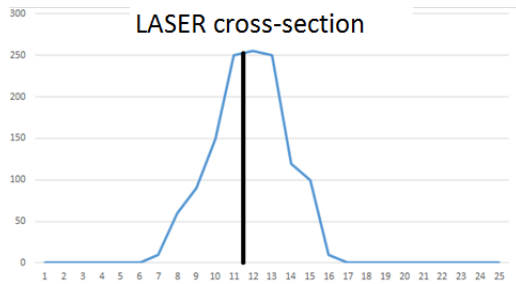

Figure 5. The threshold of lasers description

The barycentric processing functions of the program:

```
for (x = x1; x <x2; x++)
{
c=0;t=0;
for (y = y1; y <y2; y++)
                {p[0]=dst_img_gray-
imageData[dst_img_gray->widthStep * y + x ];
  if (p[0]>50)                            {
                                c+=y*p[0];
                t+=p[0];
                dst_img_gray-
  >imageData[dst_img_gray->widthStep * y + x
]=0;                }
  }
  if(t!=0)
  {
  y=(c/t);// tọa độ trọng tâm
```

dst_img_gray->imageData[dst_img_gray->widthStep * y + x]=255;

```
  }
```

showx->imageData[dst_img_gray->widthStep * (x/4)+z]=255;

```
  }
```


Figure 6 - a. Image before barycentric filtering

Figure 6 - b. Image after barycentric filtering

Smoothing and filtering out spikes:

After performing above processes, we will have a laser curve on a black background, but there will be some thorny points, the task of the algorithm will remove that spikes.

With this method increased the precision: 1mm to 0.05mm. [Figure 6-a & Figure 6-b]. The thickness of the Laser line decreased markedly.

$$\frac{The\ thickness\ before\ adjusting}{The\ thickness\ after\ adjusting} > 20$$

Surfaces of objects scanning method

Set up the initial speed
Moving the translational axes to zero origin
Zoom in the object to specific level

Confirm the shift step of the transitivity axes and the rotion axes

↓

Start to move with a steady velocity

Continuously transmit the coordination of the optical ruler

↓

Continuously capture imagine

Attribute each imagine with a obtained transitivity axes coordination parameter

↓

Handling 2D cuts which correspond to transitivity axes coordinations
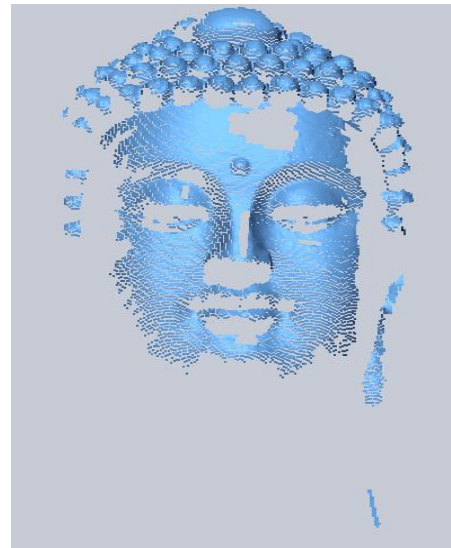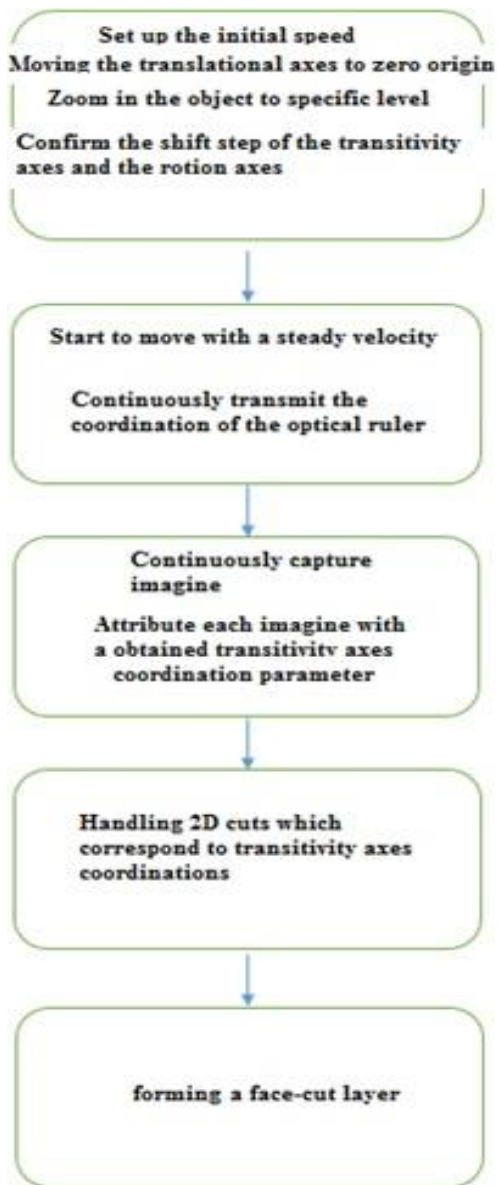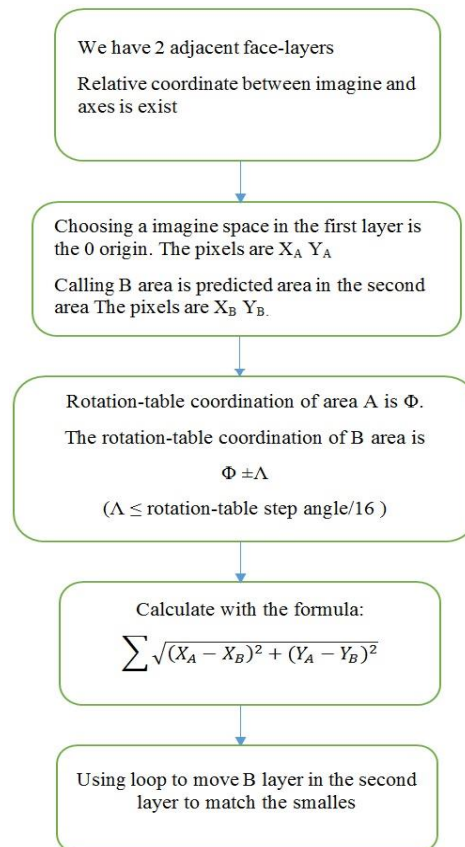
↓

forming a face-cut layer

Figure 7. Surface data image collected from scanner

Coupling method - reducing errors:

We have 2 adjacent face-layers

Relative coordinate between imagine and axes is exist

↓

Choosing a imagine space in the first layer is the 0 origin. The pixels are X_A Y_A

Calling B area is predicted area in the second area The pixels are X_B Y_B.

↓

Rotation-table coordination of area A is Φ.

The rotation-table coordination of B area is

$$\Phi \pm \Lambda$$

($\Lambda \leq$ rotation-table step angle/16)

↓

Calculate with the formula:

$$\sum \sqrt{(X_A - X_B)^2 + (Y_A - Y_B)^2}$$

↓

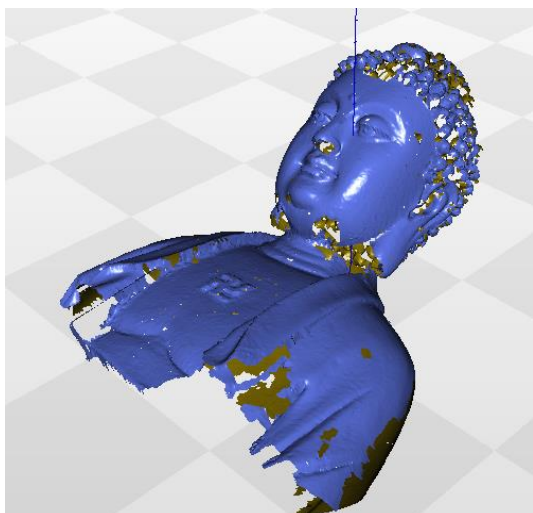Using loop to move B layer in the second layer to match the smalles

Figure 8. Datas image after coupling

3. CONCLUSION

This article presents a general design model 3D scanner by using Laser Line and basic algorithms. The taking photos principle and apply filters help us get the pixel and input object model correctly.

With integrating filters and coordinating mechanical mechanic-motion axis offsetted errors by the user set as coupling. This is a new direction in the application of offsetting errors by optical, real space and processing algorithms.

Phương pháp giảm sai số trong máy quét 3D bằng tia Laser

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TÓM TẮT:

Bài báo trình bày những yếu tố ảnh hưởng tới quá trình quét mẫu bằng tia Laser: ánh sáng môi trường, bề mặt quét,trục chuyển động, tiêu cự camera. Bài báo sẽ đưa ra phương pháp để có thể giảm những sai số từ môi trường sinh ra bằng các thuật toán hiệu chỉnh camera và phối hợp chuyển động. Phương pháp giảm sai số ở đây giải quyết vấn đề từ cục bộ tới tổng thể: từ giải quyết sai số do độ cong sinh ra camera, tới độ dày đường Laser, tới ngưỡng xám tối của ảnh bằng độ mở sáng camera và việc kết hợp 2 trục chuyển động để quét ghép ảnh hiệu quả.

Từ khóa: Laser line, 3D scanner, OpenCV.

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