

# IMPLEMENTATION OF A NEW METHOD FOR MAKING RAPID AND RELIABLE EPIPOLAR IMAGES WITHOUT USING CONTROL POINTS

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## ABSTRACT

Epipolarization is the most important constraint used in automatic dense matching for increasing speed and reliability of matching method. There were many methods for making epipolar images. Most of these methods, which need camera calibration and camera specifications, have been explained in the literature. But in our method we do not need camera specifications. We have calculated relative orientation elements. We have changed images according to these elements, which mean rotation, translation and scale changing of images. We have changed geometry of images, but images are consisted of geometry and radiometry properties. Then we should change radiometric properties so that new images will be created. For these reasons we resample each image. New images are epipolar. We have tested this method on stereo mouse and tooth images taken with a 3.2 Mega pixel digital camera. The main advantage of this method is its independency to camera characteristics in any exposure position. Preparing control points is one of the hard stages in some fields such as medical applications. Therefore this stage will be eliminated. Stereoscopic viewing, Relative measurement and three-dimensional model are the main products easily created by this method. One of the most important applications is in medical applications. We do not need control points and without making any problem for the patient we measure. This method is possible even with a non-metric digital camera. This method is fast and accurate therefore it can be used in animation and many other applications. We have solved interior orientation parameters before we have started our procedure.

## 1. INTRODUCTION

For increasing the speed of matching process, images should be epipolar which means corresponding objects are elongated of each other. After epipolarity of images, each area is reduced to a linear area. Therefore mismatching probability is reduced and computation is reliable. Hardware, based or software based methods exist for generating epipolar images. In hardware based method, CCD cameras should be installed in a stable and elongated position. The vertical movement is zero. This installation reduces our movement ability. Software based method is an image based or object based method. In both methods, control points are required. In some instances such as relative calculations or 3D reconstruction without control points, measuring is possible. Production of control points in medical cases is a difficult task for the patient.

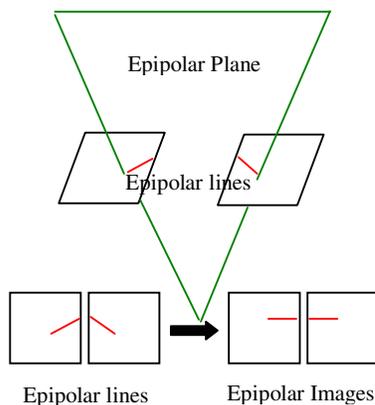


Figure1. Geometry and radiometry correction

Then we decided to design an epipolarity method without control points. If a constraint is exerted on images, which means two corresponding image points with two projective centers of images have to construct a plane which intersects two image planes in two lines, then these lines would be epipolar lines. By rotating each image around perpendicular lines of each image plane, two lines are elongated with each other. After these processes, two images are corrected according to the geometry, and then radiometric correction is done. Therefore, corresponding lines are elongated with each other.

## 2. CORRECTIONS

In our method, geometric and radiometric corrections should be done for generation epipolar images. In the geometric correction, the below process is done;

- 1- interior orientation
- 2- relative orientation or making epipolar plane

Conformal transformation is used for interior orientation. For producing epipolar plane constraint, four points (two corresponding image points and two projective center points) should be in the same coordinate system. Equations 1, 2, and 3 express the relation between the original image and the epipolar image.

$$\begin{vmatrix} bx & by & bz \\ x' & y' & z' \\ x'' & y'' & z'' \end{vmatrix} = 0 \quad (1)$$

$$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = R \begin{pmatrix} x1 \\ y1 \\ f1 \end{pmatrix} \quad (2)$$

$$\begin{pmatrix} x'' \\ y'' \\ z'' \end{pmatrix} = R' \begin{pmatrix} x2 \\ y2 \\ z2 \end{pmatrix} \quad (3)$$

Where:

$x1, y1, x2, y2$  are image coordinate of corresponding points,  $b_x, b_y$  and  $b_z$  are parallax parameters, and  $R, R'$  are the rotation matrices.

Only six or more corresponding image points are needed for solving these parameters. By exerting these parameters on each image, geometry correction is done. Linear method is used for radiometric correction which produces radiometric correction.

### 3. RESULTS

To obtain required images, two images have been taken by "Olympus C-740" a digital camera with 50 mm focal length from a mini mouse in a normal photography network. Accuracy of results is proved with line to line comparison of result images.

Figures 2 and 3 show original and epipolar images from left and right sides of the mini mouse respectively.



Figure2. Left and right original images.

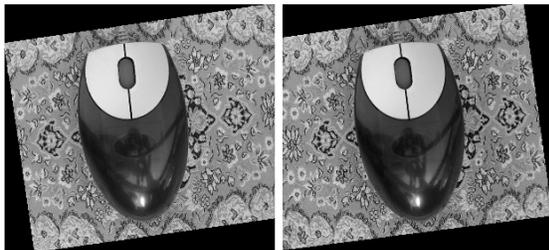


Figure3. Left and right epipolar images.

### 4. ANALYSIS

Results have shown that all lines are elongated with each other. In this method, only two simple matrices (equation 1, 2) should be calculated that is to prevent heavy calculations on each pixel. Therefore, the speed of this method is high and by combining two other methods, we can have higher speed. Relative distances, 3D reconstruction and depth of points (distance between each object point to digital camera in the exposure time) are obtainable by matching all image points.

### 5. CONCLUSION

Results of these methods have shown that without control points and hardware facilities, epipolar image can be produced. Then this method has a lot of applications in many fields (such as in mine, robotic or medical fields) especially in lack of control points or hardware facilities.

### 6. REFERENCES

Marr D. and Poggio T. 1976.: Cooperative computation of stereo disparity. *Science*, 194:283–287.

Schenk T., Li J.C., Toth C., 1991: Towards an autonomous system for orienting digital stereo pairs, *PE&RS* (57) 8, 1057-1064.