Object reconstuction from 2d drawing sketch to 3d object

by Rossi Passarella

Submission date: 13-Feb-2020 04:50PM (UTC+0700)
Submission ID: 1256712163
File name: Object_reconstuction_from_2d_drawing_sketch_to_3d_object.pdf (535.15K)
Word count: 1613
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Computer Engineering and Applications Vol. 5, No. 3, October 2016

Object Reconstruction from 2d Drawing Sketch to 3d Object

Rossi Passarella[1], Osvari Arsalan[2]

1Department of Computer Engineering, Faculty of Computer Science, Universitas Sriwijaya
2Department of Informatics Engineering, Faculty of Computer Science, Universitas Sriwijaya
Jln. Raya Palembang-Prabumulih km 32, Inderalaya, Ogan Ilir, Sumatera Selatan, Indonesia
passarella.rossi@unsri.ac.id

ABSTRACT

Design engineer in the early phase of building up another product is typically using a freehand sketching to communicate or illustrate the idea in the form of orthographic projection. This orthographic projection is based on viewpoint. A translation from 2D drawing view point to 3D models is needed to help engineer to imagine the product preview in 3D. This procedure includes a tedious, so that automation is needed.

The way to deal with this reproduction issue begin straightforwardly from 2D freehand portraying, by using the camera, the 2D drawing is captured and then transferred to a Personal Computer. Inside the computer, the image is processed with filtering to find the view point zones. The view point zone than separate to 3 zones, each zone consists of the pixel coordinate. This coordinates are used to generated and processing of 3D voxel Image according to the form of geometries. A case study is presented in order to emphasize and discuss the proposed method.

Keywords*:* Freehand sketching, viewpoint, 2D drawing, 3D models**.**

1. INTRODUCTION

Visual methods of correspondence will regularly be most effective ways of offering info on the shape, composition and associations of the object's elements. One of area that use visual methods is engineering information, this consists of official detail specifically of considered, recorded and also transmitted in visual (nonverbal language). In other words, visual methods for outline depiction utilized inside mechanical engineering that may fall into the class of general design sketching [1]

Even so, to create fast, good intuitive and well perceptive from visual input, a conceptual interface should develop according to graphic input.

The sample of graphic input in industrial engineering is the freehand sketching (handmade drawing), the freehand sketching has one of visual methods that using by engineering designer (in the early phase of the advancement of new item) to develop and communicate their idea, it also has remained of the most capable and intuitive tools utilized at the conceptual design stage due to the information drawing delivered by freehand sketching such as a shapes of Freeform lines and curves as shown in Fig 1.

Inside the freehand sketching, the designer sometimes needs to illustrating the object's using the viewpoint, the viewpoint is a critical point in this paper, the viewpoints are devided into 3 sectors which are front point, side point and top point. The illustration of this viewpoint is shown in Fig 2.

The freehand sketching is tentative according to design engineer, if the design engineer fill its already final, the accurate model is desired, and recreated 3D model from the sketch.

The aim of this paper is developing an automated machine that can construct the freehand sketching of 2D drawing to 3D image by using a coordinate of pixes and viewpoint (orthographic projection).

The automation of this process called 3D retrival from 2D drawing.

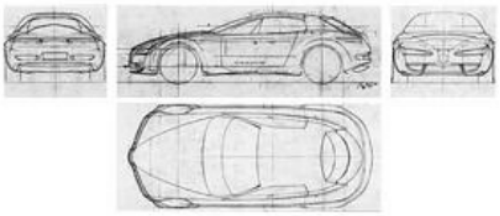

FIGURE 1. Illustration of freehand sketching in the automotive industry [2].

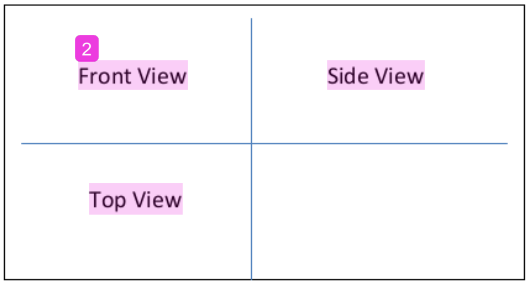

FIGURE 2. Viewpoint zone in freehand sketching

2. METHODOLOGY

Building a machine that can transfer 2D drawing to 3D model's in the computer is proposed in this paper, several hardware, and software are needed, respectively. To justify the needed of the component, the tree algorithm is used [3]. The resume of detail component is shown in Table 1.

TABLE 1.
Material that used for Industrial Object Reconstruction

Hardware	Software
Camera	Operating system : Windows 8
Personal Computer	Visual studio 2010 ultimate Microsoft .NET framework Language C#
LED	
Black box	

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The camera captured the freehand sketching inside the black box, to maintain the contrast, the LED was applied within the black box [4]., the image then sends to the personal computer (Fig.3).

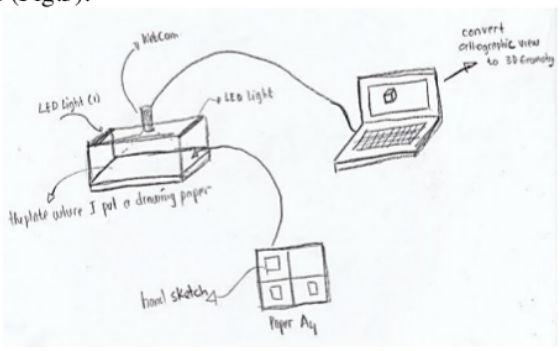

FIGURE 3. Conceptual design of the industrial objects reconstruction from 2D drawing

The method is organised based on a set of phase which described in the pursuing list:

1. To convert the original image into binary image using Otsu's method [5]
2. Find an outer frame that representing an area viewpoint zone of the original image [6].
3. Separating branches by means of approximately intersection detection (Fig. 5)
4. Find the coordinate pixel for each braches
5. Determine the length, high and breadth from viewpoint zone
6. Compute an affine transformation
7. Apply the transformation of the model to new image.
8. Use a verification procedure.

Herewith a several method in 2D affine transformation was used, such as Translation, rotation, scale and skew. To do this, the object should represent by the pixel coordinates.

Normal coordinates for 2D objects in Image shown in eq (1).

$$P = [x, y]^t = \begin{bmatrix} x \\ y \end{bmatrix} \quad (1)$$

Sometimes object 2D need to scaling. To do this, the eq. (2) is applied. Other thing is rotation is also needed, by applying eq.(3) the 2D object can be rotating.

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} C_x & 0 \\ 0 & C_y \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} C_x & * & x \\ C_y & * & y \end{bmatrix} \quad (2)$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos \emptyset & -\sin \emptyset \\ \sin \emptyset & \cos \emptyset \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} x \cos \emptyset & - & y \sin \emptyset \\ x \sin \emptyset & + & y \cos \emptyset \end{bmatrix} \quad (3)$$

Another consideration is translation in 2D object. However 2 X 2 matrixes doesn't work for translation, here's where homogeneous coordinates are needed as shown in eq.(4)

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & x_0 \\ 0 & 1 & y_0 \\ 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x + x_0 \\ y + y_0 \\ 1 \end{bmatrix} \tag{4}$$

In this paper, 3 affine transformations such as rotation, scaling and translation are applied in one formula as shown in eq. (5),

$$\begin{bmatrix} X_w \\ Y_w \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & X_0 \\ 0 & 0 & Y_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} s & 0 & 0 \\ 0 & s & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} cos\emptyset & -sin\emptyset & 0 \\ sin\emptyset & cos\emptyset & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix} \tag{5}$$

For the case study, let the industrial object that will reconstruction from freehand sketching is a piece of cube. The cube drawing sample is shown in Fig 4.

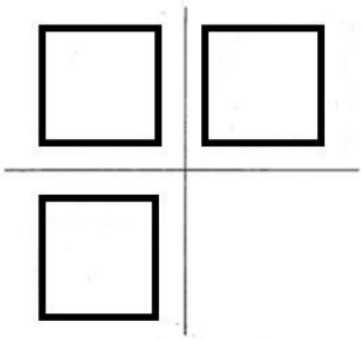

FIGURE 4. A sample of cube drawing in orthographic projection that used as case study

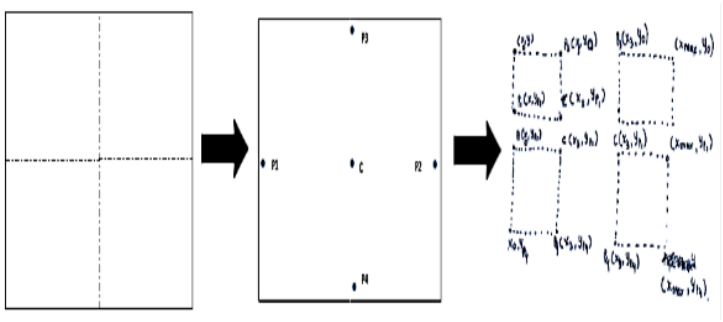

FIGURE 5. Conceptual design of the industrial objects reconstruction from 2D drawing

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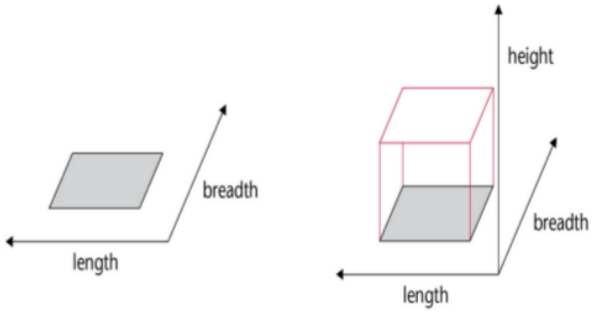

FIGURE 6. The illustration of developing 3D object from 2 D sketch in 1 viewpoint.

3. RESULTS AND DISCUSSION

The reconstruction methodology implemented with visual studio software by using C# language. Several visual displays are needed to help the programmer to verification the pixel coordinates. This visual display is place in left side

The Fig.7 shown the Image box is built to facility the image that took from camera (black box), this image than convert into binary image by using Otsu Method.

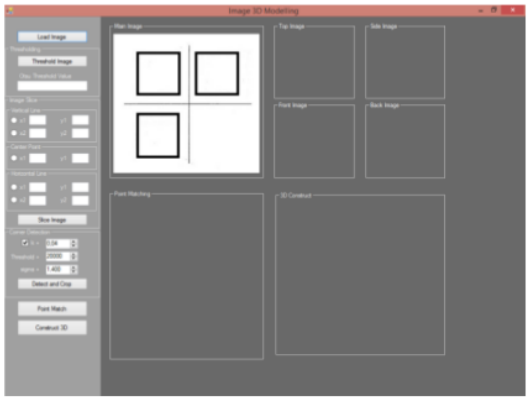

FIGURE 7. Input the image from camera

The next step (Fig.8) is finding the outer pixel that separate the object into front view, top view, and side view. This coordinate is critical for the next step which is slicing on Region of Interest (ROI) of the object as shown in Fig.9.

The Harris corner methods is applying for determine the ROI. The parameters are represent as k=0.04, threshold 20000, and sigma 1.400.

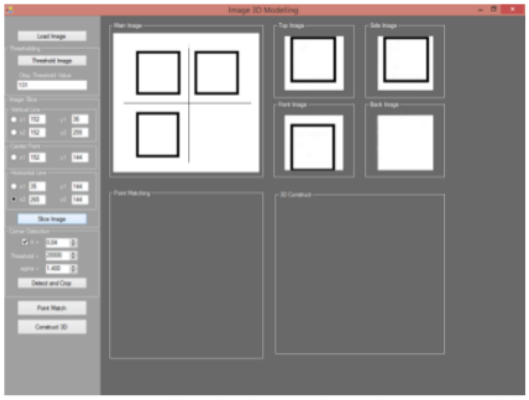

FIGURE 8. Slice the image into the proper sides

The next methods is matching the corner pixel coordinate between the point of view of the object, this point than construct into "L" shape as shown in Fig 10.

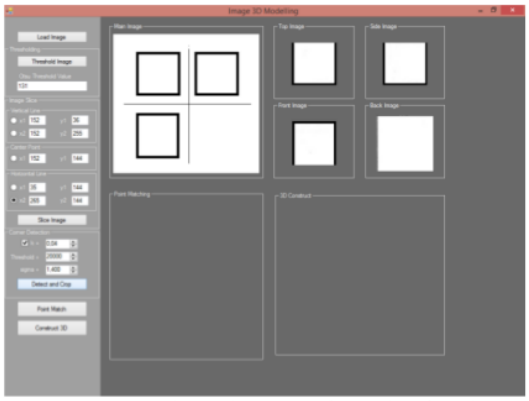

FIGURE 9. Region of Interest by using harris corner

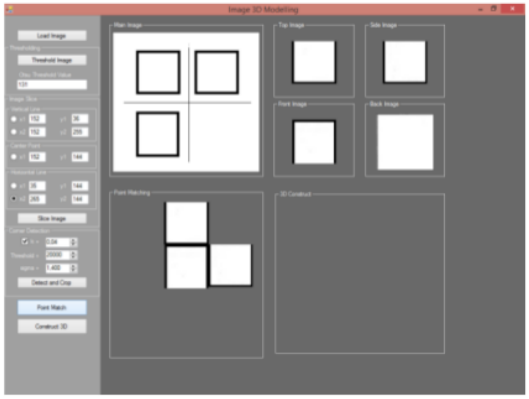

FIGURE 10. Matching the object side by the proper point

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The last step is reconstruction the object by using rotation, scale and skew methods. The reconstruction is focusing in the center of point and also the pixels coordinate.

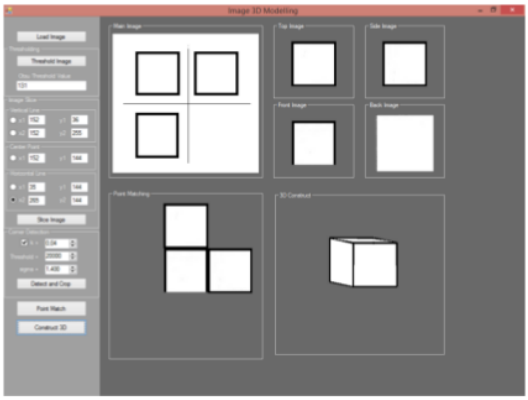

FIGURE 11. Reconstruction the object by rotation, scale and skew methods

The illustration of the steps construction is shown in Fig 12.

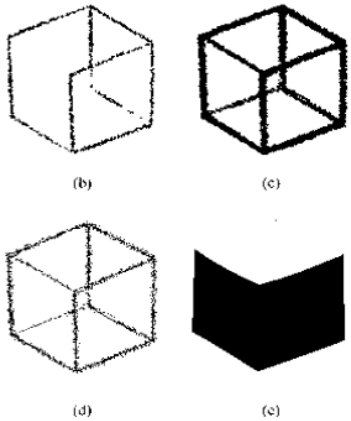

FIGURE 5. The illustration in reconstruction the object

4. CONCLUSION

Usually in Industry, 2D object is recognition by alignment and point interest. Another things, to handle objects that are mainly 2D are usually use Affine transformation. However verification is needed to add in procedure.

On this paper only the primitive object in 2D sketch was tried to develop 3D

ACKNOWLEDGEMENT

The author wishes to thank the other members of the lab. Automation industry and Nobelhunter research group at Faculty of computer science for their help

throughout the research of this work; in Ahmad Rifai and Sutarno who are provided many useful discussions.

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