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AN IMPROVED 3-SWEEP TECHNIQUE FOR CREATING 3D MODEL

โดย

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บทคัดย่อ

แบบจำลอง 3 มิติ มีการนำไปใช้ในงานสื่อต่างๆ อย่างแพร่หลาย เพื่อให้ผู้รับสื่อทำความเข้าใจได้ง่าย และมีความน่าสนใจในชิ้นงานมากขึ้น เช่น การจำลองสถานการณ์ สื่อการเรียนรู้ หรือสื่อบันเทิง ในการสร้างแบบจำลอง 3 มิติ จากภาพ 2 มิติ นิยมใช้เทคนิค 3 สวีพ ซึ่งเป็นเทคนิคการสร้างแบบจำลอง 3 มิติแบบกึ่งอัตโนมัติโดยที่ผู้สร้างต้องทำการลากพื้นที่หน้าตัดซึ่งเป็นฐานของวัตถุ เรียกว่าเป็นการสร้าง 2D-based profile จากนั้นลากที่รูปร่างตามความยาวของวัตถุ เพื่อให้ระบบสร้างแบบจำลอง 3 มิติต่อโดยอัตโนมัติ แต่ถ้าในภาพมีวัตถุมากกว่า 1 ชิ้นที่มีรูปทรงแตกต่างมาเรียงต่อกัน ทำให้ไม่สามารถสร้างแบบจำลอง 3 มิติได้ ที่มีรูปทรงใกล้เคียงกับภาพ 2 มิติเดิมได้

ดังนั้น ในโครงงานนี้จึงทำการพัฒนาการใช้เทคนิค 3 สวีพสำหรับสร้างแบบจำลอง 3 มิติจากภาพ 2 มิติ โดยในภาพวัตถุมากกว่า 1 ชิ้นที่มีรูปทรงต่างกันมาเรียงต่อกัน

Project Title	An Improved 3-Sweep Technique for Creating 3D Model
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ABSTRACT

3D model represents geometric data which is used in various tasks for easy understand and interesting such as simulation, educational media, and entertainment. Creating 3D model is a grand challenge, especially in case of different shape stacked objects. Therefore, this project introduces an improved 3-Sweep technique to construct the 3D model from two-dimensional images (2D images).

The proposed technique is based on a semi-automatic 3D model construction. That means users need to provide a cross section area of object called 2D-based profile and a body area to get main axis. Then create 3D model by reproducing 2D-based profile along the main axis. The proposed technique can construct the 3D model in different shape stacked objects while the existing 3-Sweep technique fails in this case.

ACKNOWLEDGEMENTS

This project comes from nothing to something by more than half year. From the beginning, this project is seen to impossible and many thing to learn in a short period of time. However, generous friends help and cheer me up to make me reach a goal. This work would not have been done without these sincere supporters.

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CHAPTER 1

INTRODUCTION

1.1 Research motivation and problem

Models in real life are the arts that convey the message, feeling and passion through many ways such as sculpture, craving and molding. The models in computer graphics are 3D objects that can be treated almost as physical objects. The models are able to light it different, rotate to look every side of it. In 2D objects, everything is drawn such as the angle of view, shading or even point of interest. However, some shapes of objects are hard to make by drawing or it can be the result of computer simulation, which is available in theory only.

Recently research entitled "3-Sweep: Extracting Editable Objects from a Single Image" is a technique to create 3D model by extracting 3D man-made objects from a single image. This technique provides users to recognize and position shape parts and computer then uses this information to complete a task. However, this technique still has limitations with shape and point of view in images.

This project aims to improve the 3-Sweep technique to decrease users work to deal with many different cylinder shapes. By combining 3-Sweep technique with hidden surface determination, we can solve shape selection with stacked object to create 3D models.

1.2 Objective

- To improve 3-Sweep technique for a stacked object in images.

1.3 Proposed framework

The overview of the proposed framework is shown in Figure 1.1. It consists of three main parts: object selection, 3D model construction and integration model. In the first part, object selection focuses on extracting information from a cross-section of body area. This part aims to set the boundary of the 3D model.

In 3D model construction part, a 3D model is made from cross-section (2D based profile) and object area information for creating 3D model from the cross-section through the end of body area. This process also reconstructs the incomplete cross-section.

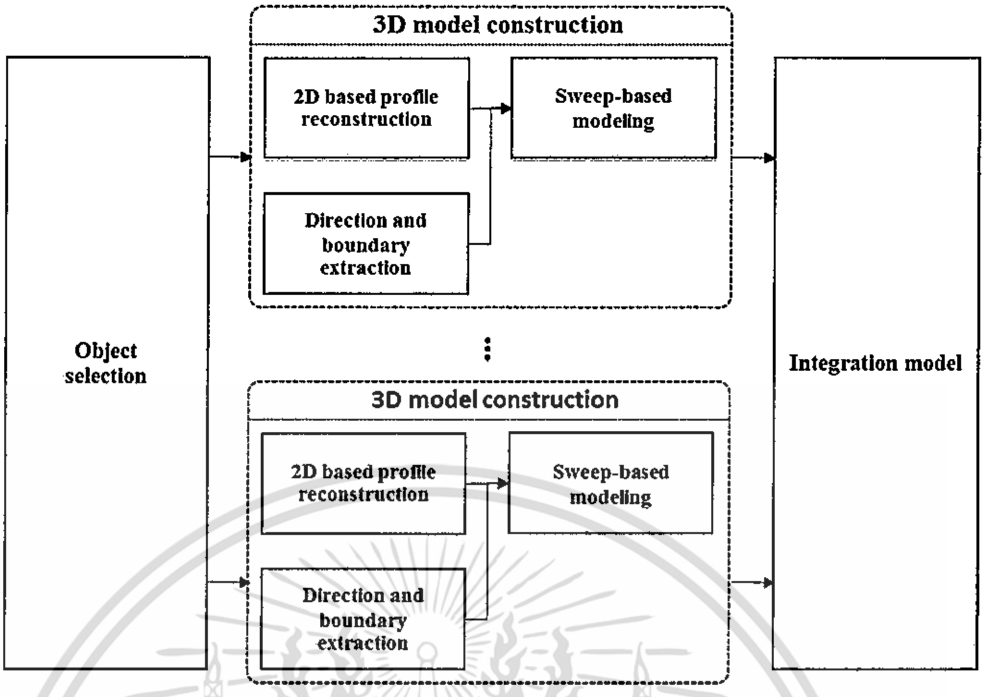

Figure 1.1 A framework of an improved 3-Sweep technique

In the latest part, integration model integrates the models from the earlier part. It makes a stacked model from different shapes. The final result of this framework is a stacked 3D model.

1.4 Scope

1.4.1 Terms of Definition

1.4.1.1 Basic shapes are rectangle, square, ellipsoid and circle.

1.4.1.2 A synthetic image is a 2-dimensional image generated by basic shapes.

1.4.1.3 An object is single shape image.

1.4.1.4 2D-based profile is a cross section area of the object.

1.4.2 Condition of 3D model construction

1.4.2.1 Input image is a synthetic image composed of more than one object.

1.4.2.2 Output is a 3D model.

1.4.2.3 A synthetic image does not have shadow and blur.

1.4.2.4 A user has to mark 2 points on 2D-based profile and the body of objects for 3D model construction.

1.5 Benefits

1.5.1 Create 3D model from a single image.

1.5.2 Improved 3-sweep limitation with unable to change shape while sweeping process.

1.5.3 For non-experience user in creating 3D model.

CHAPTER 2

THEORETICAL BASIS AND LITERATURE REVIEW

2.1 3-Sweep techniques

The main idea of 3-Sweep technique [1] is creating a 3-dimensional object from an image by choosing model shape and stroking 3 times. These strokes are sufficient for extracting information from an image. The line, which user draw to the nearest edge, is divided into 3 lines. First and second lines are used for setting length and width of a cross-section. The third line is the main axis of a model. The line is drawn near one side of the curve to the opposite side of the curve by the user to set a rough boundary. Then, the real edges are automatically searched for the end of line. This 3-Sweep technique is part of techniques to make a model from 2D images. The illustration of 3-Sweep technique is shown in Figure 2.1.

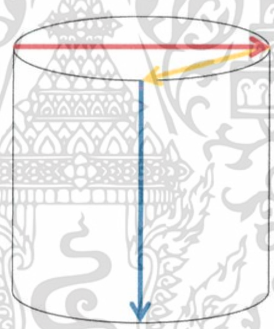

Figure 2.1 An illustration of 3-Sweep technique by using 3-steps

2.2 Sweep–based modelling

Sweep-based modeling is a technique to create a model from shape of given area. Sweep-based is extracted area from a given area. Then, This Sweep-based is used in create a model procedure by create a layer of a model along the main axis.

Sweep-based that extracted from image is called 2D-based profile. This 2D-based profile is from one end of object (cross-section). For create a model, 2D-based profile is duplicate along the main axis from cross-section level to the end of object boundary.

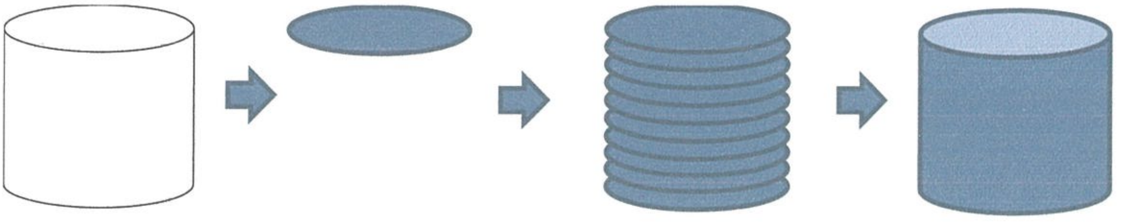

Figure 2.2 An illustration of creating a model from 2D-based profile

2.3 Geo–semantic constraint [2][3]

This constraint used to make a model fit the outlines in image and preserved property of geometric ratio. Constraints in geometric modeling divided into two systematic. Geo-semantic snapping is shown in Figure 2.3

2.2.1.1 **Parametric system**, a generic model is defined by using a set of parameters. It values in a system that objects can be used with same parameter and unique orders. But, there must be a unique ordering allowing the geometry to be constructed sequentially from previously determined elements.

2.2.1.2 **Variation systems**, not a generic model. It has various techniques to solve such as sequential constraint satisfaction, efficient representation, etc.

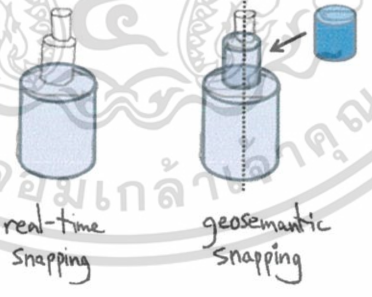

Figure 2.3 An illustration of Geo-semantic constraint snapping

This constraint allows our work to scale the Sweep based profile to fit the boundary. While scale based profile size preserves the ratio of a symmetric model. Each of based profile is scaled to fit the boundary at each level from the cross-section area to the end of main axis.

2.2 Hidden surface determination

Known as "hidden surface elimination" [4] or "visible surface determination", it is a challenged method to reconstruct a part of object that is occluded by foreground of a single image view. Hidden surface determination categorized in major ways as hierarchical of object in the image.

There are many ways to deal with hidden surface, such as reflecting the remained parts or recreating the lost parts that are calculated from the view point and other various techniques. The illustration of stack objects that part of surface is occluded is shown in Figure 2.4

Figure 2.4 An illustration of a stack object that surface is hidden

The proposed method, which object surface is partially occluded. The surface can be reconstructed by using reflection technique; that is, the visible part is substituted by the hidden part as shown in Figure 2.5.

Figure 2.5 Hidden surface reconstruction by using reflecting method

2.3 Hough transformation

A line in the image space can be expressed with two variables denoted by parameter (m, b) in the Cartesian coordinate system, where m and b are gradient line and y-axis intercept, respectively.

The Polar coordinate system can be expressed with two variables by parameter (r, θ), where r is length from line and θ is slope angle of line.

Hough transformation draw every line that perpendicular to origin point (0, 0) and plot to phased graph from line formula. Then, Hough transformations find peaks point from line formula (almost every line formula crossing together illustrate in red box), as illustrated by phase graph in Figure 2.6.

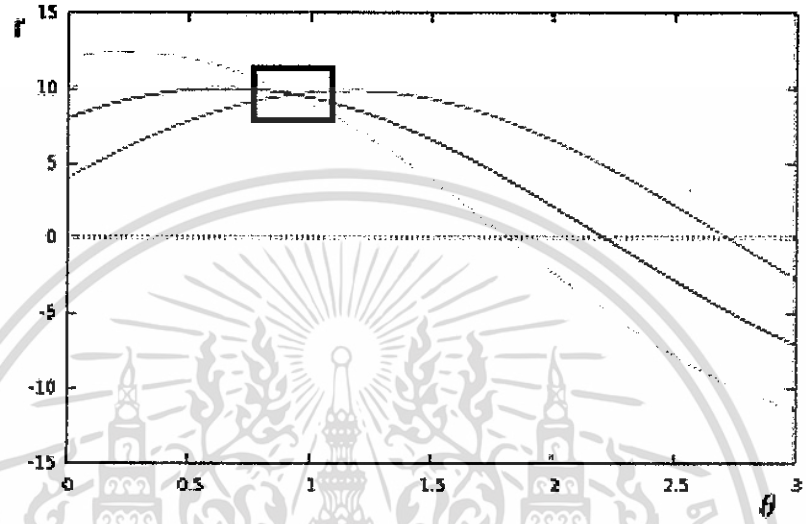

Figure 2.6 Phase graph of line formula

2.4 Literature review

3D modeling with a symmetric sketch is proposed by A. Shtof. A. Agathos. Y. Gingold. A. Shamir and D. Cohen-Or.[2]. This technique uses for sketching symmetrical image. For example, human face that left and right side is symmetrical. By user choose geometry shape, the algorithm is automatically fit the set of boundary. This technique is able to reconstruction other symmetrical side of the object that is not exposed in the image by assumption of symmetric.

Efficient texture mapping by homogeneous patch discovery is introduced by R. Vikram Pratap Singh and Anoop M. Namboodiri [4]. The algorithm in this technique is greedy algorithm to patch texture on mesh model. Then tilt the texture to match the expect texture on a model. This technique can help improve the result of mapping texture when compared to general mapping texture.

Modelling 3D animals from a side-view was presented by Even E., Loic B., Marie-Paule C., Frederic C. and Michiel van de P. [5]. This paper explains how to divide a part of model from a side-view sketch by using direct technique. Direct technique tries to infer 3D shapes from a single complex sketch by depicting complex silhouettes with loops, branches, cusps and T-junctions contour and to match a pair of suggestive contours.

Y. Zheng. H. Fu. D. Cohen-Or. O. Kin-Chung Au. Chiew-Lan T. [6] explained how to preserved structure of object. By setting the hierarchical group of models, the highest hierarchy is organized as the member under it. This work is preserved the ratio of a model without affect other model in same space. We can use to further develop in complex object.

Y. Gingold., T. Igarashi. and D. Zorin. [11] developed the Structured Annotations for 2D-to-3D Modeling application that allows user to place tools for correcting the fault created part. This application uses an ellipsoid and generalized cylinders as a primitive model to create 3D models. This tool can use in further development by integrating with our automatic detection and snapping model process.

E. T. oppe1., M. R. Oswald., D. Cremers. and C. Rother. [12] have explained a single view reconstruction by extending the object from the average height of image. The height of extending part is determined by intensity of shadow (depth map). Then, a model is mirror to

N. Kholgade., T. Simon., A. Efros. and Y. Sheikh. [13] developed application to make 3D model from single photograph using 3D model database. Objects in photograph are compared with object in 3D model database to find the resemble object.

Xiaoming Peng [14] has studies on color and shape detection using training data sets consisting of texture-less objects from many angles. This method can use in our project to made it more automatically.

CHAPTER 3

RESEARCH

This section explains the improved 3-Sweep technique framework. Figure 1.1 illustrates an overview of the proposed framework, which is composed of three main parts: object selection, 3D model reconstruction and integration model, which are explained in the following sections.

3.1 Object selection

The purpose of this part is to extract information from synthetic images. In the first stage, the user draws a 2D object profile, usually at one end of the shape. This illustrates in Figure 3.1 and, where white area is based profile detected in the input image. Steps of object selection are briefly stated as follows:

Step A: A user marks a cross-section area in image.

Step B: Do the same as Step A on body area in image.

Step C: Get boundary and area using Scan line algorithm.

Step D: Calculate boundary of cross-section and body area. The result is shown in Figure 3.3 and Figure 3.4

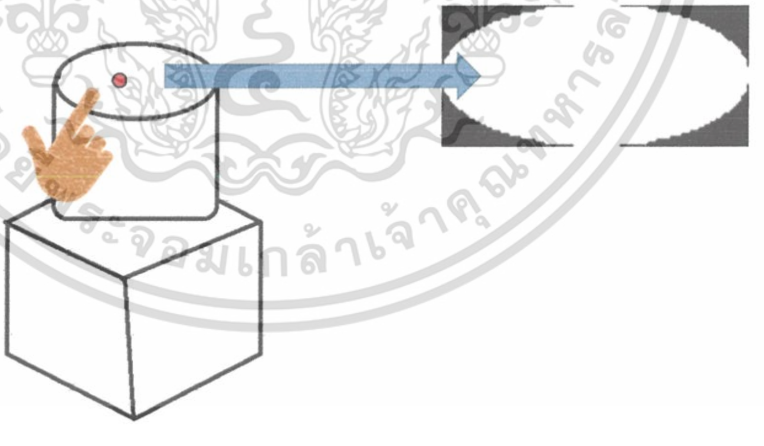

Figure 3.1 An illustration of user-mark at cross-section area

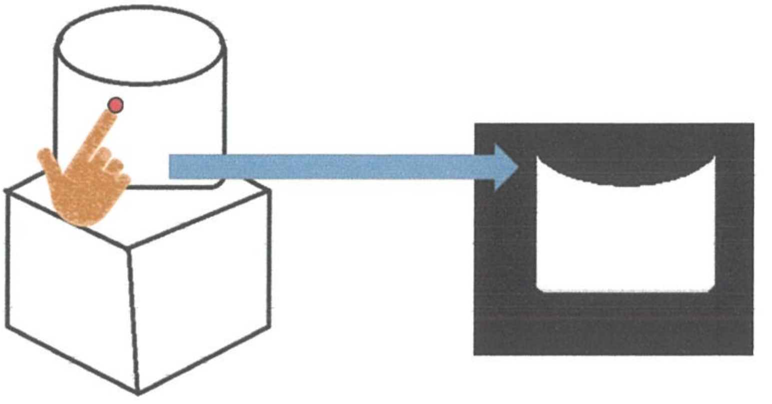

Figure 3.2 An illustration of user-mark at Body area

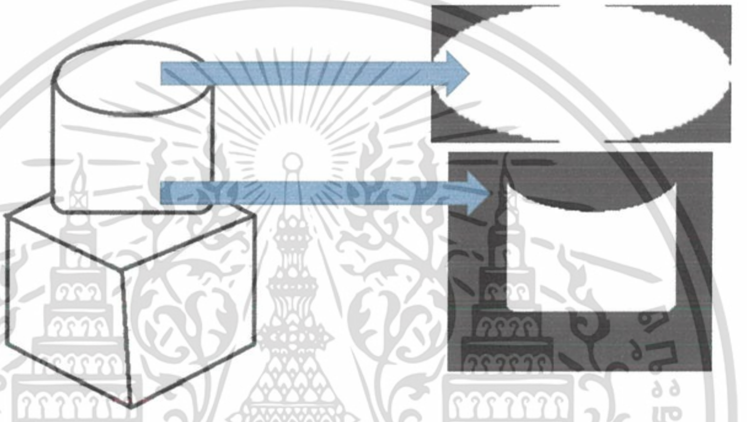

Figure 3.3 Result of object selection at cylinder

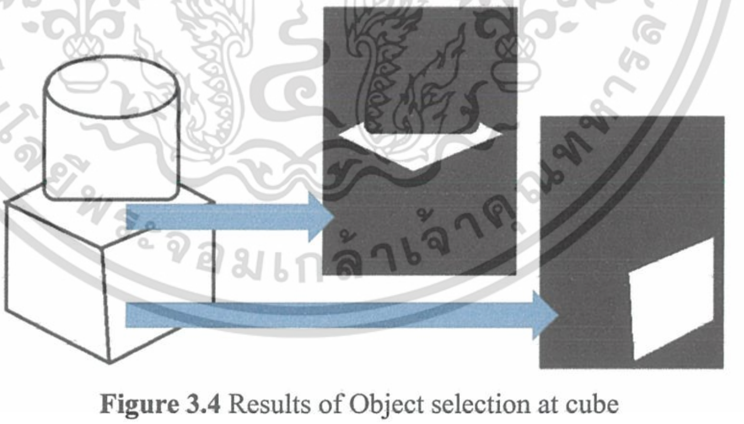

Figure 3.4 Results of Object selection at cube

3.2 3D model construction

The purpose of this part is creating a 3D object from object selection part. This part can be divided into 3 steps: 2D-based profile reconstruction, direction and boundary extraction, and sweep based modeling. Each part is described as follows.

3.2.1 2D based profile reconstruction

From object selection part, the cross-section area that is under other object requires to reconstruction as basic symmetry geometric. This can be done by using position shape in 3D by drawing its projection in 2D. To make it simpler, we assume that the loss area is symmetrical with remained area [12]. Then, reflect and replace the incomplete area. This simple method can reduce the number of unknown parameters. The result is demonstrated as Figure 3.2.

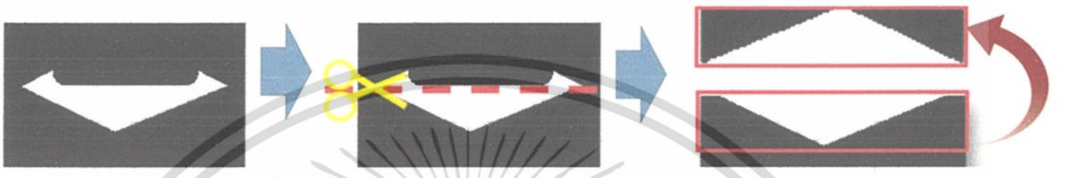

Figure 3.5 Hidden surface reconstruction by mirror half of visible surface area

If the reconstructed 2D-based profile has a silhouette, to eliminate it we fill the silhouette with data. The result is demonstrated as Figure 3.6

Figure 3.6 Reconstruct of 2D-based profile that has a hole after used reflect method

3.2.2 Direction and boundary extraction

This process focuses on extracting height and boundary of an object. Height and boundary are extracted using projection and Hough transformation techniques. The result is shown in Figure 3.9.

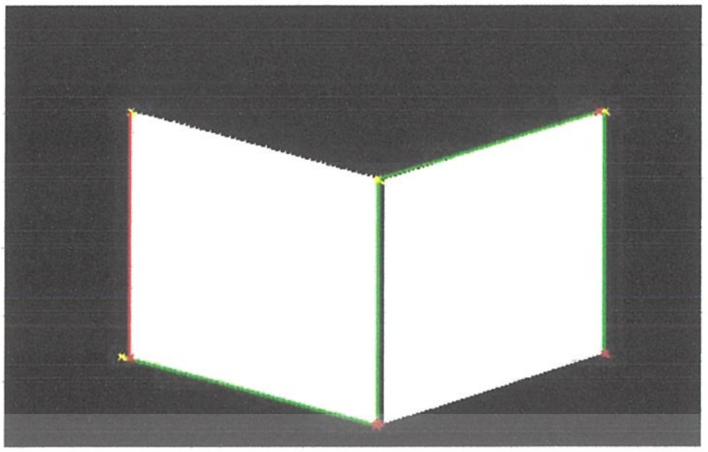

Figure 3.7 Result of extracted height of a model from input data

If object has visible side more than one side, this step uses condition of random search for another visible side at mean of height and width in cross-section area. Another body part can get from repeated object selection process at the other side. This step imitates user-marked at approximate point between boundary of the cross-section and current body. The result is shown in Figure 3.9

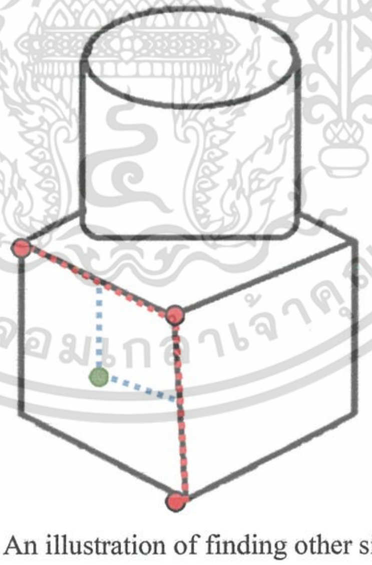

Figure 3.8 An illustration of finding other side of body

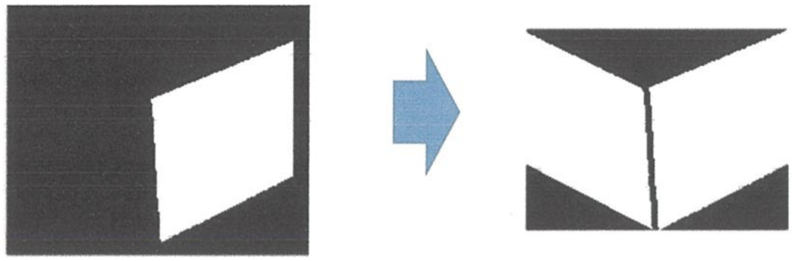

Figure 3.9 Result of finding the boundary of 2-side of object

3.2.3 Sweep-based modelling

The model is created by 2D profile, height and boundary constraint. Details are describe as follow.

Step A: Plot the profile at cross-section level.

Step B: move to next level.

Step C: Resize the based-profile to fit boundary using information from direction and boundary in extraction step.

Step D: repeat the process until reach the least boundary.

Even for generalized cylinder, the shape can be ambiguous due to the lack of depth in the image. We assume that the object is symmetrical. Then the 2D-based profile is resized to equal to the length between the object boundaries.

Illustration of this step is shown in Figure 3.10 and Figure 3.11. Result is shown in Figure 3.12

Figure 3.10 A cross-section area (Green square) and body areas (Blue squares)

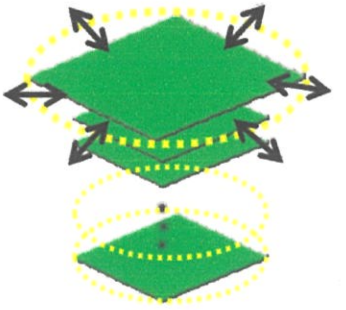

Figure 3.11 An illustration of Sweep based profile and resize step

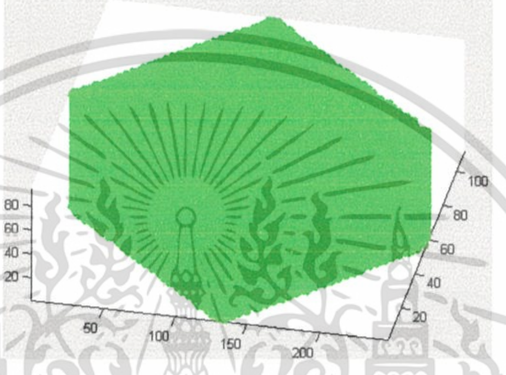

Figure 3.12 Result of 3D construction step

3.3 Integration model

Last section of the proposed method aims to stack each model together. The order of a model is checked. If the next model is near the previous model, these model is concatenated together Figure 3.13 is the result of this step.

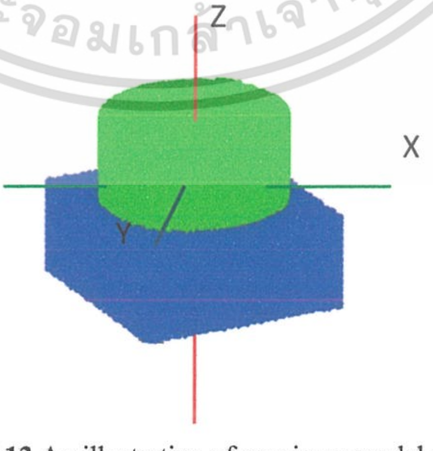

Figure 3.13 An illustration of moving a model to centre

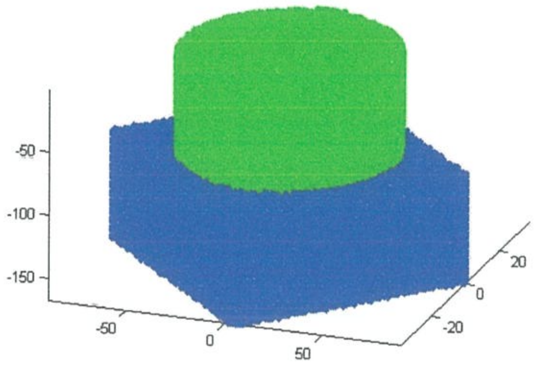

Figure 3.14 A result of integration model

CHAPTER 4

RESULT AND DISSCUSSION

4.1 Result of the proposed method

Input of our research is synthesis data in 2D drawing. The input image has black line and white background. The input image is on the left side and the result of the input image is on the right side.

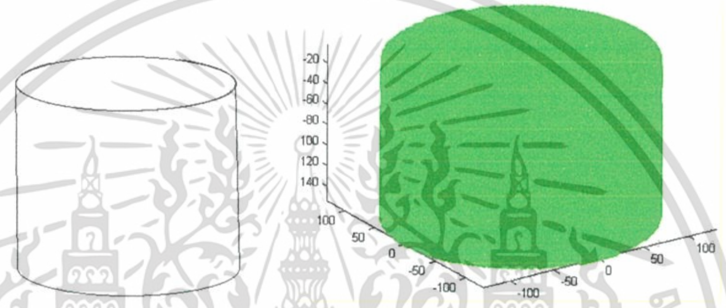

Figure 4.1 Input image with circular cylinder shape (left). Result from circular cylinder shape image (right)

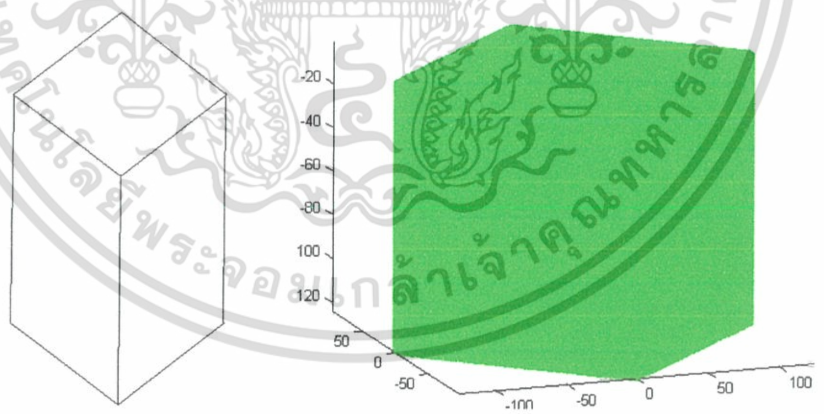

Figure 4.2 Input image with cube shape (left). Result of Input data with 2D drawing (right)

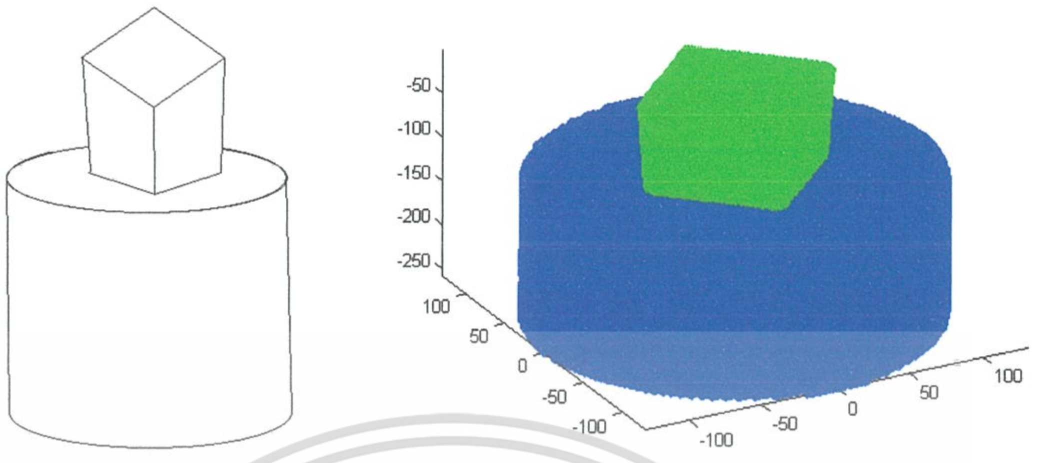

Figure 4.3 Input data with 2D drawing (left). Result of Input data with 2D drawing (right)

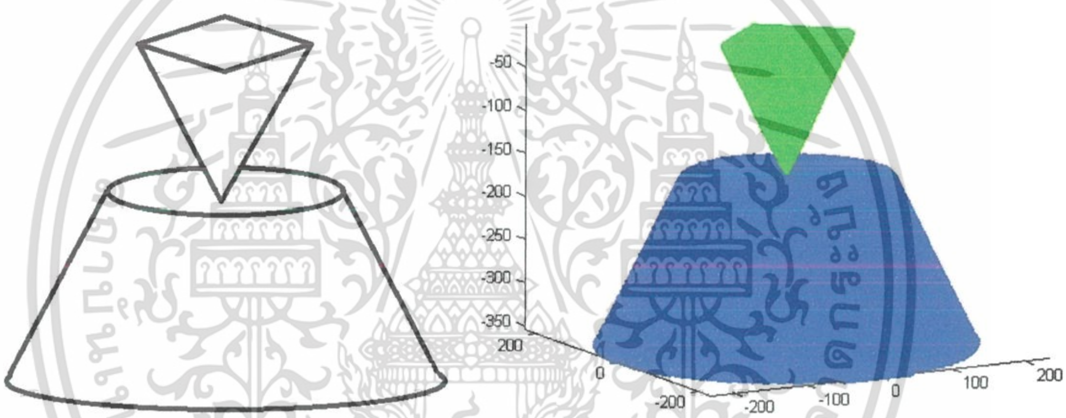

Figure 4.4 Input data with 2D drawing (left). Result of Input data with 2D drawing (right)

4.2 Limitations in our work

A limitation in our proposed method is the model height. From using Hough line as height of a model. If a model does not have the straight line in the body area, the result may get a shorter than the expected result.

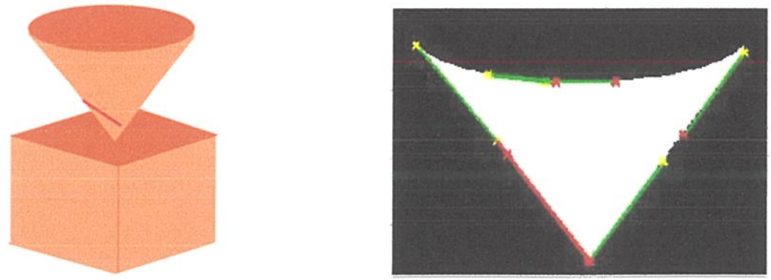

Figure 4.5 Input data with 2D drawing (left). Result of Hough line from input data (right)

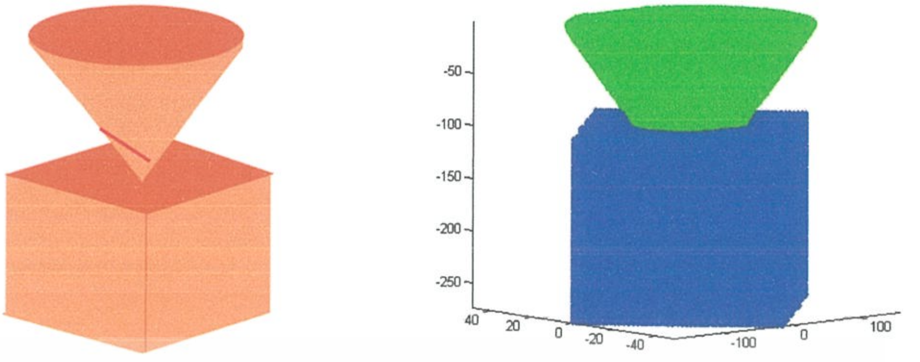

Figure 4.6 Input data 2D drawing (left). Result from input image (right)

In the boundary and direction procedures, the height of the model is shortened than expected due to shape of the object body. Furthermore, in 2D-based profile reconstruction procedure, the last result of 2D-based profile is upon to half-lower of cross-section area.

Figure 4.7 Input data with 2D drawing symmetric in left and right (left). Result of selected area.

Figure 4.8 Reconstruction procedure from image data in Figure 4.

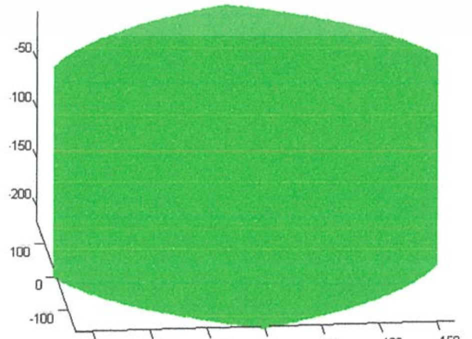

Figure 4.9 Result of input data from Figure 4. after reconstruction 2D-based profile

CHAPTER 5

CONCLUSIONS

5.1 Research conclusion

An improved 3-Sweep technique for creating 3D model is created by object selection, 3D model construction and integration model procedures. The result of this project is stackable 3D model using an improved 3-Sweep technique.

Choosing cross-section and body area of input image is done by users. Then, an image is marked a point that is used in improved 3-Sweep process. This point is a reference for object selection through integration model steps.

The proposed algorithm depends on input images. If an object of input image has textures-less, the 3D model will work well. On the other hand, if the object of input image has complicate textures. The result will have error due to unknown parameters.

5.2 Limitation

In the boundary and direction procedures, the height of model is shortened than expected due to shape of object body. Furthermore, in 2D-based profile reconstruction procedure, Result of the reconstructed 2D-based profile by reflects method is limited to surface that parallel on horizontal axis.

5.3 Recommendations for further research

Our algorithm heavily relies on image data. This algorithm can be improved by increasing precise shape detection with texture object. The result of shape detection can be applied to automatic detection from a single photograph.

This project does not include patching texture on 3D model due to algorithm sensitiveness.

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BIOGRAPHY

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Major Field : Software Engineering

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Mr. Nat Anuntalabhochai was born on May 25, 1992 in Bangkok, Thailand. He will received Bachelor's Degree of Sciences from Faculty of Information Technology, King Mongkut's Institute of Technology Ladkrabang.

AN IMPROVED 3-SWEEP TECHNIQUE FOR CREATING 3D MODEL APPLICATION

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ABSTRACT

3D model represents geometric data which is used in various tasks for easy understand and interesting such as simulation, educational media, and entertainment. Creating 3D model is a grand challenge, especially in case of different shape stacked objects. Therefore, this project introduces an improved 3-Sweep technique to construct the 3D model from two-dimensional images (2D images).

The proposed technique is based on a semi-automatic 3D model construction. That means users need to provide a cross section area of object called 2D-based profile and a body area to get main axis. Then create 3D model by reproducing 2D-based profile along the main axis. The proposed technique can construct the 3D model in different shape stacked objects while the existing 3-Sweep technique fails in this case.

Index Terms – 3-Sweep; 3D model; Sweep-based

1. INTRODUCTION

Models in real life are the arts that convey the message, feeling and passion through many ways such as sculpture, craving and molding. The models in computer graphics are 3D objects that can be treated almost as physical objects. The models are able to light it different, rotate to look every side of it. In 2D objects, everything is drawn such as the angle of view, shading or even point of interest. However, some shapes of objects are hard to make by drawing or it can be the result of computer simulation, which is available in theory only.

Recently research entitled "3-Sweep: Extracting Editable Objects from a Single Image" is a technique to create 3D model by extracting 3D man-made objects from a single image. This technique provides users to recognize and position shape parts and computer then uses this information to complete a task. However, this technique still has limitations with shape and point of view in images.

This project aims to improve the 3-Sweep technique to decrease users work to deal with many different cylinder shapes. By combining 3-Sweep technique with hidden surface determination, we can solve shape selection with stacked object to create 3D models.

2. RELATED WORK

2.1. 3-Sweep techniques

The main idea of 3-Sweep technique [1] is creating a 3-dimensional object from an image by choosing model shape and stroking 3 times. These strokes are sufficient for extracting information from an image. The line, which user draw to the nearest edge, is divided into 3 lines. First and second lines are used for setting length and width of a cross-section. The third line is the main axis of a model. The line is drawn near one side of the curve to the opposite side of the curve by the user to set a rough boundary. Then, the real edges are automatically searched for the end of line. This 3-Sweep technique is part of techniques to make a model from 2D images. The illustration of 3-Sweep technique is shown in Figure 1.

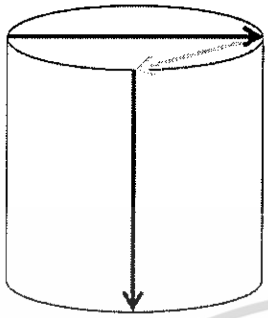

Figure 1. An illustration of 3-Sweep technique by using 3-strokes.

2.2. Sweep-based modelling

Sweep-based modelling is a technique to create a model from shape of given area. Sweep-based is extracted area from a given area. Then, This Sweep-based is used in create a model procedure by create a layer of a model along the main axis.

Sweep-based that extracted from image is called 2D-based profile. This 2D-based profile is from one end of object (cross-section). For create a model, 2D-based profile is duplicate along the main axis from cross-section level to the end of object boundary.

Figure 2 An illustration of creating a model from 2D-based profile

2.2 Hidden surface determination

Known as "hidden surface elimination" by Sutherland [1974] or "visible surface determination", it is a challenged method to reconstruct a part of object that is occluded by foreground of a single image view. Hidden surface determination categorized in major ways as hierarchical of object in the image.

There are many ways to deal with hidden surface, such as reflecting the remained parts or recreating the lost parts that are calculated from the view point and other various techniques. The illustration of stack objects that part of surface is occluded is shown in Figure 3

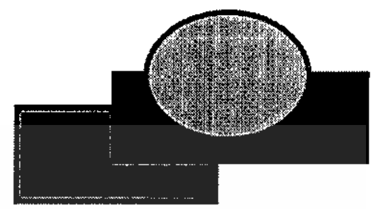

Figure 3 An illustration of a stack object that surface is hidden

The proposed method, which object surface is partially occluded. The surface can be reconstructed by using reflection technique; that is, the visible part is substituted by the hidden part as shown in Figure 4.

Figure 4 Hidden surface reconstructions by using reflecting method

2.3 Hough transformation line

A line in the image space can be expressed with two variables. For example:

In the Cartesian coordinate system: parameter (m, b) – m is gradient of line and b= y-axis intercept (where the line crosses over the y-axis)

In the Polar coordinate system: parameter (r, θ) – r is length from line and θ is slope angle of line.

Hough transformation line does draw a line in every angle to find which is possible. Then, choose peaks line that most of point in image is passing through it. Illustrated of choose peak point is shown in Figure 5

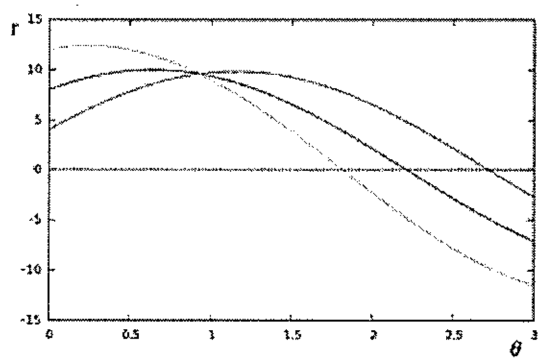

Figure 5 Phase graph of line formula

2.4 Geo–semantic constraint

This constraint used to make a model fit the outlines in image and preserved property of geometric ratio. Constraints in geometric modelling divided into two systematic.

2.4.1.Parametric system

A generic model is defined using a set of parameters. It values in a system that objects can be used with same parameter and unique orders. But, there must be a unique ordering allowing the geometry to be constructed sequentially from previously determined elements. This system is creating from formula of3D model shape.

2.4.2.Variational systems

This system is not a generic model. It has various techniques to solve such as Sequential constraint satisfaction, efficient representation, etc.

3. PROPOSED METHOD

In this section, our proposed method can divided into 3 main parts. As shown in figure 6

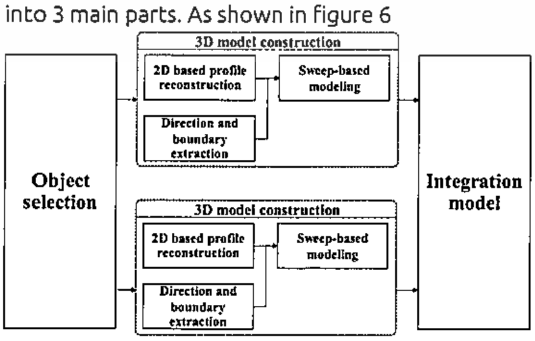

Figure 6 A Proposed method framework.

3.1 Object selection

The purpose of this part is to extract information from synthetic images. In the first stage, the user draws the 2D profile of object, usually at one end of the shape. Steps of object selection are briefly stated as follows, which are further described in detail.

Step A: A user mark cross-section area in image.

Step B: Do the same as Step A on body area in image.

Step C: Get boundary and area using Scan line algorithm.

Step D: Calculate boundary of cross-section and body area.

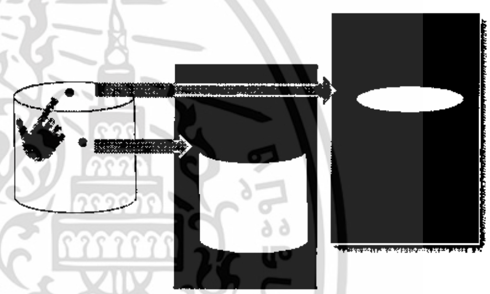

Figure 7 Result of object selection at cross-section and body area.

3.2. 3D model construction

The purpose of this part is creating a 3D object from information Object selection part. This part can be divided in to 3 processes: 2D-based profile reconstruction, direction and boundary extraction, and sweep based modelling techniques. This part described as follows.

3.2.1. 2D based profile reconstruction

From object selection part, the cross-section area that is under other object requires to reconstruction as basic symmetry geometric. This can be done by using position shape in 3D by drawing its projection in 2D. To make it simpler, we assume that the loss area is symmetrical with remained area. Then, reflect and replace the incomplete area. This simple method can reduce the number of unknown parameters. The result is demonstrated as Figure 4

If the reconstructed 2D-based profile has a silhouette, to eliminate it we fill the silhouette with data. The result is demonstrated as Figure 8

Figure 8 Reconstruct of 2D-based profile that has a hole after used reflect method

3.3.2 Direction and boundary extraction

This process focuses on extracting height and boundary of an object. Height and boundary are extracted using projection and Hough transformation techniques. The result is shown in Figure 9

Figure 9 Result of extracted height of a model from input data

If object has visible side more than one side, this step uses condition of random search for another visible side at mean of height and width in cross-section area. Another body part can get from repeated object selection process at the other side. This step imitates user-marked at approximate point between boundary of the cross-section and current body. The result is shown in Figure 10

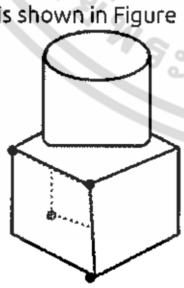

Figure 10 An illustration of finding other side of body

3.3.3 Sweep-based modelling

The model is created by 2D profile, height and boundary constraint. Details are described as follow.

Step A: Plot the profile at cross-section level.

Step B: move to next level.

Step C: Resize the based-profile to fit boundary using information from direction and boundary in extraction step.

Step D: repeat the process until reach the least boundary.

Even for generalized cylinder, the shape can be ambiguous due to the lack of depth in the image. We assume that the object is symmetrical. Then the 2D-based profile is resized to equal to the length between the object boundaries.Illustration of this step is shown in Figure 11 and Figure 12. Result is shown in Figure 13

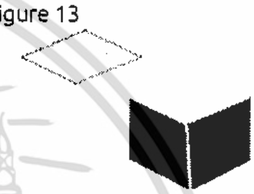

Figure 11 A cross-section area (Green square) and body areas (Blue squares)

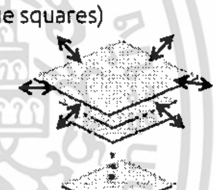

Figure 12 An illustration of Sweep based profile and resize step

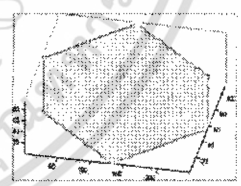

Figure 13 Result of 3D construction step

5.1. Integration model

Last section of the proposed method aims to stack each model together. The order of a model is checked. If the next model is near the previous model, these model is concatenated together Figure 14 is the result of this step.

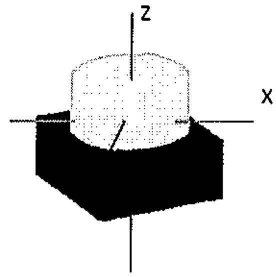

Figure 14 An illustration of moving a model to centre

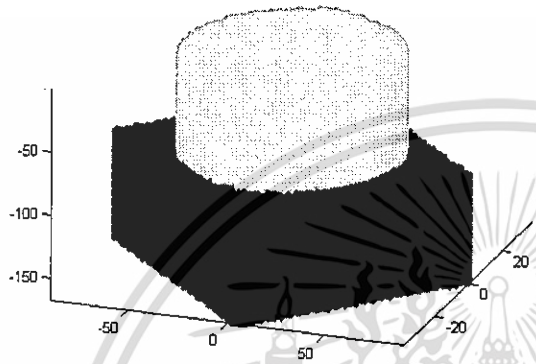

Figure 15 A result of integration model

4. EXPERIMENTAL RESULTS

The proposed method has been implemented in MATLAB language. The user can mark cross-section area and body area by clicking a point in image. The system provides a rotation tool for view 3D model in any angle.

Once the object has been modeled, the system is checked there is a model connects together or not.

Input of our research is synthesis data in 2D drawing. The input image has black line and white background. The input image is on the left side and the result of the input image is on the right side.

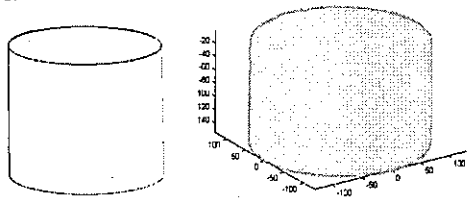

Figure 16 Input image with circular cylinder shape (left). Result from circular cylinder shape image (right)

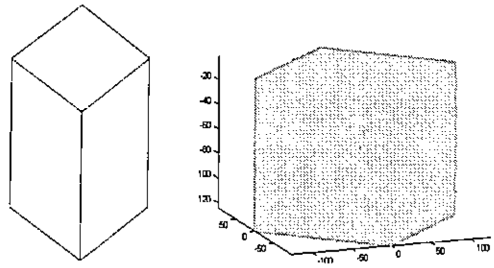

Figure 17 Input image with cube shape (left). Result of Input data with 2D drawing (right)

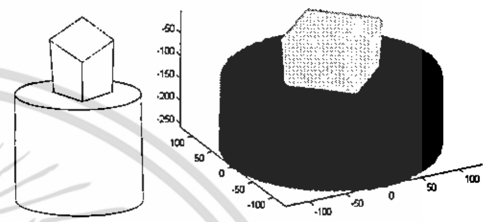

Figure 18 Input data with 2D drawing (left). Result of Input data with 2D drawing (right)

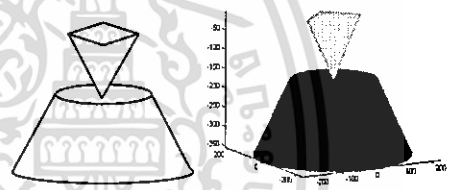

Figure 19 Input data with 2D drawing (left). Result of Input data with 2D drawing (right)

4.1.1. Limitation

A limitation in our proposed method is the model height. From using Hough line as height of a model. If a model does not have the straight line in the body area, the result may get a shorter than the expected result.

Figure 20 Input data with 2D drawing (left). Result of Hough line from input data (right)

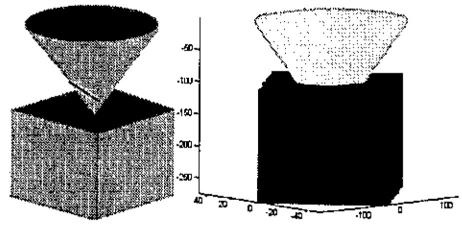

Figure 21 Input data 2D drawing (left). Result from input image (right)

In the boundary and direction procedures, the height of the model is shortened than expected due to shape of the object body. Furthermore, in 2D-based profile reconstruction procedure, the last result of 2D-based profile is upon to half-lower of cross-section area.

Figure 22 Input data with 2D drawing symmetric in left and right (left). Result of selected area.

Figure 23 Reconstruction procedure from image data in figure 22

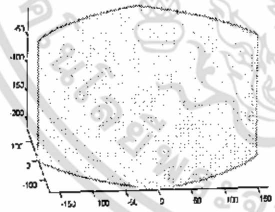

Figure 24 Result of input data from figure 22. after reconstruction 2D-based profile

5. CONCLUSION

Our proposed method is present solving limitation in 3-Sweep that cannot automatic fix hidden surface on stacked object. The 3-Sweep method has solved this limitation by used user as man-made detection to select model shape and setup rough boundary.

In contrary, our proposed method can break this limitation in symmetry stacked object. By process of 2D based profile reconstruction, the shape of a model can be any symmetric shape due to shape at cross-section area of object.

And our proposed method reduces user interaction from 3 strokes to simply mark 2 point in object. When compared to 3-Sweep method that cannot automatically change shape.

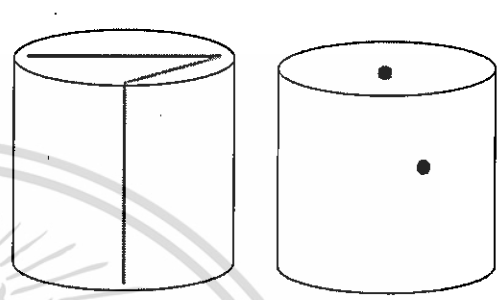

Figure 5.1 3-Sweep technique used user draw 3 lines to set width, length and height (left). Proposed method used user mark on cross-section and body (right)

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