International Journal of Electrical and Electronics Research ISSN 2348-6988 (online)
Vol. 2, Issue 3, pp: (79-82), Month: July - September 2014, Available at: www.researchpublish.com

SKELETONIZATION OF DEPTH IMAGES

Gauri Patil

M.Tech (Embedded Systems), SENSE School, VIT University, Vellore, India

Abstract: **Skeletonization proves to be a useful method for description of shape, pattern recognition, retrieving centerline of images, animation. Previously, skeletons were used to find shape of object components, now their use have been extended to many fields such as medicine, military, bio-imagery etc. In this paper we have proposed two thinning algorithms i.e. fast parallel thinning and watershed algorithm to find skeleton of depth image captured by TOF camera, which can be used in applications like games, medical field as a model. The fruitfulness of algorithm is proved by experimental results.**

Keywords: **Skeletonization, ToF camera, Thinning algorithm, dilation.**

1. INTRODUCTION

In digital image processing, the feature of shape plays an important role for analyzing the image. These features can be used to represent the object in image in compressed form. Skeletonization is one of the process to extract a feature of shape in region that represents the general form of object. Skeletons provide simple and compact representation of shapes which preserves the topology of object.It preserves the pattern and simplifies the extraction of feature and also skeleton extraction from elongated binary objects. Skeletonization finds its applications in exotic character recognition, fingerprint recognition, palm print recognition, signature verification also in shape deformation and retrieval. It has wide range of applications in medical field such as centerline extraction for blood vessels and tubular airways.

Our objective is to develop a method for extraction of skeleton of an image of human body using RGB and depth streams obtained from the TOF camera.

2. LITERATURE SURVEY

The result of an algorithm is dependent on the definition of connectivity. Different definitions of connectivity were presented. In [3], it is given that neighborhood of a voxel p will be connected if the connection strength of any pair in the neighbor of p is greater than p. A slightly different definition given in [2] considers the neighborhood of a voxel p, is connected if the connection strength of any pair in the neighbor is greater than both values of the pair even if these values are less than the value of p. While in [1] the condition was that it is greater than both the pair and p. Levi and Montanari [4] presented a gray scale skeleton which use a concept of gray scale distance. The gray scale distance is proportional to the addition of the gray levels that comes in its path. The skeleton becomes the set of all the points which does not belong to any minimal gray values from any other point to its background. The skeleton resulting from given algorithm does not guarantee the connectivity.

The algorithms based on topography of object were given in [3] .These were aimed at avoiding object distortion and reducing deformation on junctions of a skeleton.

3. PROBLEM DEFINITION

The skeleton can prove useful for an variety of applications. However, compared to 2D skeletonization, 3D skeletonizations are more feasible, since in this paper we are concerned about depth of image also. In case of 2D skeletonization we can obtain skeletons of distinct objects or images, but when two objects are placed nearby 2D vision can not tell exactly which object is closer and there arise problem to extract the particular object from image. Hence its skeletonization gives deformed skeleton and unstability along the junction of skeletons.

4. SOLUTION METHODOLOGY

The algorithms in image analysis revolve around the concept of thinning. The 2D skeletonization is not accurate in order to trace the movements. So in order to increase the accuracy we opt for 3D skeletonization based on depth image. For this different type of camera is used, which along with a standard RGB image, gives the depth information of the image. Using this camera as a sensor, we acquire the depth image and apply skeletonization technique to acquire the skeleton of the image primarily. The camera gives us the stream of RGB as well as depth image. The image acquired is then processed in MATLAB. In MATLAB, we apply a parallel thinning algorithm to the image so as to get a skeleton. The approach is based upon the repeated iterations of a removing process, that erodes the binary image until only one pixel thick image is obtained in the center of the high intensity region. The other method to apply skeletonization is using watershed algorithm. Watershed is a tool used primarily for image segmentation, but its usefulness is also found in skeletonization. It produces the contours for all possible values in the image. The result is a topographical surface. The topographical surface is filled till we get our skeleton. The physical system has 2 main elements: (a) a personal computer, used to run the software (b) a TOF camera.

This image can further be used as a basis for developing various applications such as games, biomedical imagery, medicine field etc.

5. DETAILS OF EXPERIMENT, ANALYSIS, MODELLING

We have used time of flight camera to obtain images. A 3D time-of-flight (TOF) camera operates by illuminating the scene with a modulated light source, and observing the reflected light. Phase shift between the illumination and the reflection is measured and translated to distance.

The distance measured is in the form of array. We use this array information to process our image. For this we use parallel thinning algorithm where structuring element is used in order to erode the pixels. The structuring element is a combination that has the coordinates of a number of points relative to some origin. The best suitable way of representation of an element is a small image on a

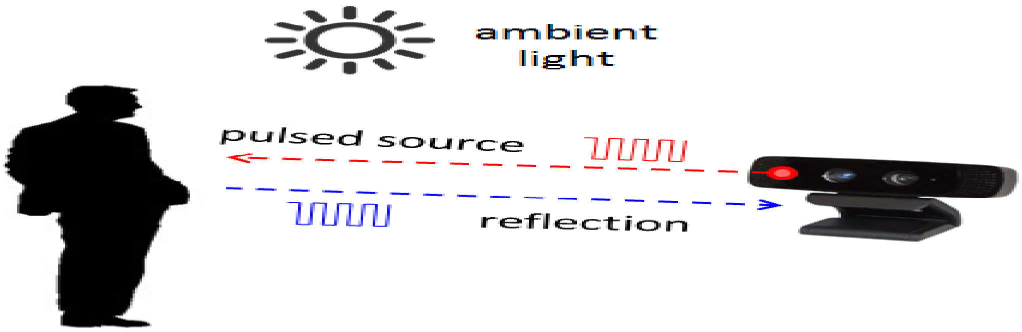


Fig. 1 TOF operation

rectangular box. Here, the 1's are considered as the foreground pixels while, 0's are considered as the background pixels. When any morphological process is carried out, the center pixel of the structuring element is mapped on to each pixel position in the image which will compare both the values of image as well as the structuring element.

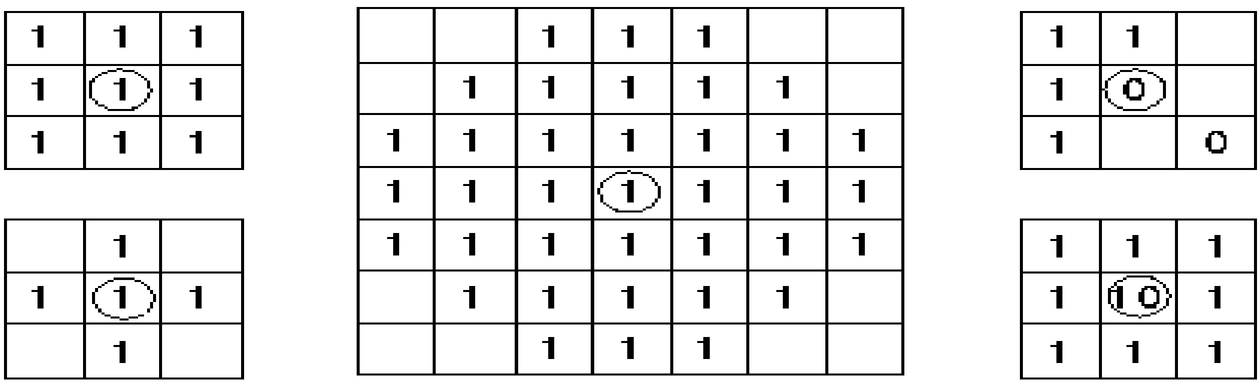


Fig. 2 Structuring Elements

This thinning algorithm proposed here considers 3x3 structuring element, considering center pixel as origin where every pixel is deleted only if; for pixels p(i,j),the number of non zero neighbors is between 2 to 6, the 0-1 transitions be 1.Then firstly applying P1 x P4 x P6 = 0 in odd iterations or P2 x P4 x P8 = 0 in even iterations. Secondly applying P4 x P6 x P8 = 0 in odd iterations or P2 x P6 x P8 = 0 in even iterations.

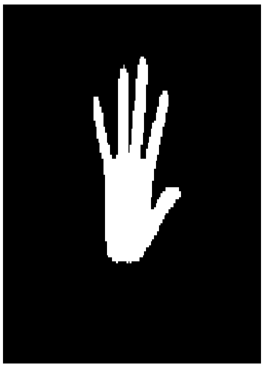
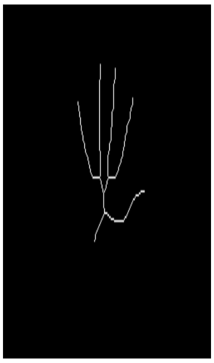
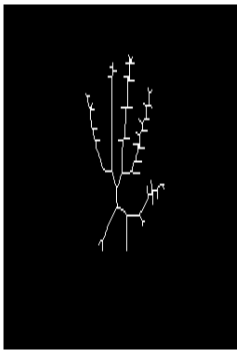
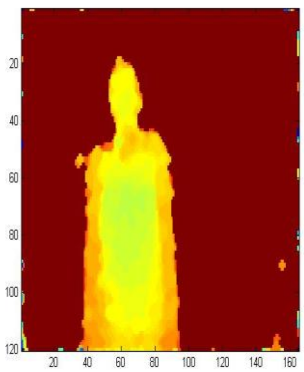
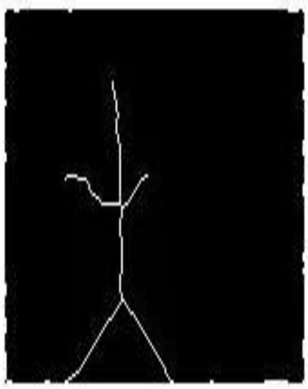
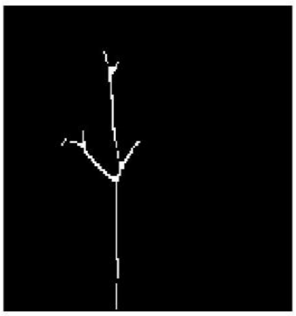
P_9	P_2	P_3
P_8	P_1	P_4
P_7	P_6	P_5

Fig. 3 Pixel map

In watershed method, the image wherein to apply watershed is a binary image. We convert the source image into binary image with respect to threshold. Then we take gradient of the image such that we will get the topographical image. In the next step distance transform is taken. Watershed is applied to this distance transform. The output of this step is a skeletonized image.

6. RESULTS

The two algorithms proposed here have been tested on images. Here we report images taken on two sets, the first set is depth image of human hand and the second and third sets are from database of images. The type of images also matters when applying these algorithms.

Original Image	Thinning Algorithm	Watershed
		
		

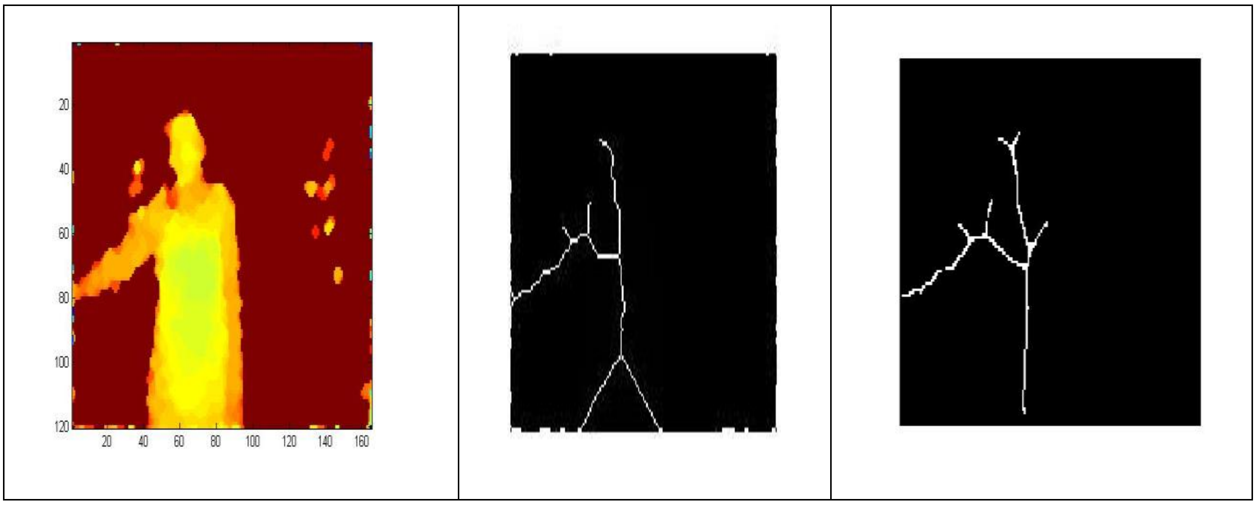


Fig. 4 Experimental Results

7. CONCLUSIONS

For several applications there are several advantages to thin the gray objects. In our paper, we have proposed the thinning algorithm for Depth images. We have also implemented the watershed algorithm for skeletonization. The parallel thinning algorithm is based on eroding objects iteratively by removing certain border voxels without affecting the connectivity. The watershed algorithm fills the region with background based on principle of dilation till there exist a centerline of image. These algorithms were applied on various depth images from different domains and acquired satisfactory results.

REFERENCES

[1] Abe, K., Mizutani, F. and Wang, C., "Thinning of grayscale images with combined sequential and parallel conditions for voxel removal", *IEEE Trans. on Systems Man Cybernetics*, vol. 24, no. 2, pp. 294-299, Feb. 1994.

[2] Padole, G V, and S B Pokle. "New IterativeAlgorithms for Thinning Binary Images", 20103rd International Conference on EmergingTrends in Engineering and Technology, 2010.

[3] Salari, E. and Siy, P. "The ridge seeking method for obtaining the skeleton of digital images", *IEEE Trans. On Systems Man and Cybernetics*, vol. SMC-14, no. 3, pp. 524-528, May/June 1984.

[4] Levi, G. and Montanari, U., "A gray-weighted skeleton", *Information and Control*, vol. 17, pp. 62-91,1970.

[5] Pavlidis, T. A "*Flexible Parallel Thinning Algorithm*." Proc. IEEE Comput. Soc. Conf. on Pattern Recognition and Image Processing. 1986.

[6] "Skeletal Tracking using Microsoft Kinect" Abhishek Kar Advisors: Dr. Amitabha Mukerjee & Dr. Prithwijit Guha Department of Computer Science and Engineering, IIT Kanpur Skeletonization & its applications *Kálmán Palágyi*

[7] G. Bertrand. A parallel thinning algorithm for medial surfaces. *Pattern Recognition Letters*,16(9):979.986, 1995.

[8] A transformation for extracting new descriptors of shape H Blum, Models for the perception of speech and visual form, 1967.

[9] Pavlidis, T. A Flexible Parallel Thinning Algorithm. Proc. IEEE Comput. Soc. Conf. on Pattern Recognition and Image Processing. 1986.

[10] Peleg, Shmuel, and Azriel Rosenfeld. "A Min-Max Medial Axis Transformation", IEEE Transactions on Pattern Analysis and Machine Intelligence, 1981.

[11] "Skeletonization of Depth Images" Anuja Khadse and Gauri Patil M.tech Embedded systems.