3D Scene Modeling with the help of Time of Flight Camera

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Neelam Memon[1], Wajiha Shah[2], Koonj Taggar[3], Zubair Ahmed Memon[4]

[1,2,3] *Department of Electronics Engineering, MUET, Jamshoro.*
[4]*Department of Electrical Engineering, MUET, Jamshoro.*

Abstract: Nowadays, the developing number of applications are based on accuracy and rapid 3D scene analysis. A lower estimated, quick and suitable alternative for depth data capacity are time-of-flight cameras. In this work, we explored the usefulness of a 3D Time-of-flight camera for our hand gesture recognition system. The purpose of our system is to observe different static hand gestures, to make projections, also to build the base of the gesture projections, and the intensity features of the image captured by the range camera are quite good enough to use them in the nearest neighbour algorithm for matching the gestures on to the base..

Keywords: *3D scene; Time of flight camera; Hand gesture, Gesture projections; Neighbour algorithm*

1. Introduction

Recently, earlier importance has been built in providing lower cost and firm Time-of-flight equipment's, which involves the possibility to change different areas of research, introducing many fields like visual computer graphics, and human machine Interaction(HMI) [1]. Gesture recognition is an area of wide research, accessing a range camera for capturing the intensity information. After some pre-processing operation, this intensity data is used for segmenting the hand and then detecting the hand in 3D slot [2], Gesture recognition depends on a 3D sensor, Intensity maps are acquired by a Time-of-flight camera, arranged specially for hand gestures recognition. We explored the usefulness of a 3D Time-of-flight camera for our hand gesture recognition system.

The objective of this paper is to choose few signals and catch them with the Time-off light Camera. We are employing the distance information to separate the hand from the background and to build its 3D image of gestures. For matching the gestures we make multiple results to check our algorithm. In this work the 3D range camera is engaged as our device, it gives us the objects of depth data in which its picture at every pixel value is of higher frame rate. The components of ToF cameras has proven to give special gain in numerous areas of research. We can also include applications involving humans, since a lot of work has been done in face, hand, and body recognition with applications to man-machine interfaces. These cameras are mostly useful in human settings in such a way that they permit avoiding physical touch, hardware and are eye-safe.

For time-of-flight cameras, the purpose to track movements of humans is quite simple, as they provide distance images in real time. It usually allows modern communications with user devices for example, in televisions and other electronic devices. Another interesting advantage is to use this sort of cameras for interacting games especially in video games console. In this work the TOF camera captures the hand gestures. Image variations are implemented on the RGB (Red, green, blue) image to change it into gray image and then gray image is being converted into binary image [3]. The results are analyzed to consider these gestures on MATLAB using convex-hull approach considering the fact that 3D scene analysis is possible in many different ways to observe as shown in Fig.1.1.

2. Related Work

A lot of research has been done to study an extensive literature on 3D Gesture modelling and recognition involving several research domains including image processing, 3D data estimation, pattern recognition and machine learning. 3D appearance of shapes communicating a critical component of an article format and movement acknowledgment. The exact 3D structure presents articles and human body parts from force information maps, distinctive territories of exploration made a profundity map-based recognition of hand signal and numerous other human action confession. RGB-based acknowledgment of hand motion generally requires an unmistakable foundation, which sees its application. Therefore, a Time of Flight (ToF) camera which is successfully useful connected with another RGB camera to observe few plain gestures of hand [3]. Hence, for modeling a 3D image of substance in depth, it is capable to

Corresponding author Email address: *neelam10es122@gmail.com*

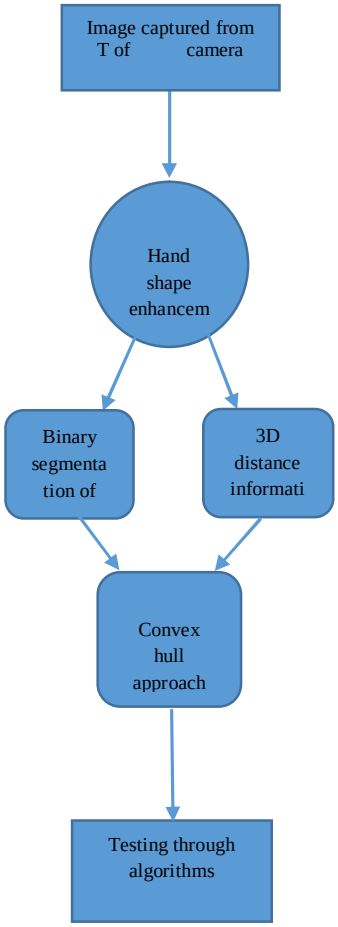


Figure 1.1 Block diagram of a system

add its outer contour, different appearances of patterns in 3D surface properties like jerks and grooves gives us very high discriminative information. The authors concluded that the interface for 3D scene modeling has been designed, which depends on recognizing different hand gestures.

3.TOF Camera / Propose Architecture / 3D range camera

We are focusing on 3D time-of-flight sensor so we will be discussing about this camera and its features, uses related to our field of research. There are several forms of obtaining 3D information from images. Some techniques are capable of directly extracting 3D data from 2D single view images under certain can efficiently maintain accurate and reliable 3D images. Here at present, we are managing the 3D Time-of-flight (ToF) range camera, which serves us reliable 3D spatial data and also color/gray scale images subsequently [5]. As Time-of-flight (ToF) range cameras provide intensity data according to component which makes it fit perfectly for the background likewise segmenting its background, mostly the intensity data characterize the secondary object as its background in further more essential way as compared to the light intensity value. This range camera is used as a gray-scale camera, it grants to build a grayscale image producing lengths for their objective of finding better appearances to be followed. The 3D time-of-flight sensor which is useful for our system that is a Photonic mixer device named as PMD (vision) camboardnano component by 19k having a picture element of 160x120 photonic mixer device (PMD) sensor pattern [7]. It gains width information by using the fundamental principle of time-of-flight with effective brightness through an unseen inflected close to infrared light. This camera capacities inside its casing rate of greatest 15 fps. The PMD vision camera was utilized with a 12 mm lens developing in a parallel perspective of around 30◦.

To accomplish the visual representation of a 3D Time-of-flight camera, the width data is capable of producing a gray-scale image. It prepares a matrix as its output matrix in which every point shows the 3D coordinates as (x,y,z). As time-of-flight cameras merge spaced images in real time, it will be quite simpler to record action of individuals [3]. It grants different communications with user devices as in televisions. PMD technologies implemented slightly combined 3D depth cameras for close-range gesture regulation of user devices as for example all-in-one devices such as PCs and laptops. As 3-D range camera is engaged as our device, it gives us the objects of depth data in which its picture at every pixel value is of higher frame rate. Time-of-flight approach resolved its 3D points of distance by inflected infrared light, the phase shift among the reflected and reference signal is planned by a sampling and correlating approach for each pixel value, hence its length is measured by the time shift.

A time-of-flight camera has become outstanding in the recent years. It has already been applied in various counts of applications such as game controlling, upper body gesture recognition, robot navigation mobile human-robot teaming and many other.

4. System Description

We are describing about gestures and their methods through which we are enhancing our segmentation, we are using convex hull approach for further developments, Hand detection and segmentation is a necessary component for recognizing gestures as shown in Fig. 4.1. Therefore, a 3D range camera is employed as our apparatus in this area of research [8]. As this approach is applied to five simple static hand gestures captured by the Range (Time-of-flight) camera to recognize, and these gestures will provide us further processing about 3D image projection.

Firstly we will be needing some gestures to plot them on MATLAB in order to find distance information from the available pixels as shown in Fig.4.2. Furthermore we should plot these gestures on three 2D planes by

orthographic projection to obtain the values of coordinates. After that for scanning hand pattern, a database used to be well-established. As we would have to build the base of their gesture projections by taking/setting different gestures [7]. Next important thing is to convert the image into binary image by taking its frames then setting the threshold values in order to make it even more meaning full and once this threshold value is set then we would apply this convex hull approach. Several different approaches have been taken for gesture modeling tasks. Our main goal is to focus on human to machine interaction i-e; (HMI), hence the device would be capable of identifying the gestures which are being made by human beings [9]. Convex hull works as an envelope around the hand, Whenever the convex hull approach is placed against the contour of the hand shape analysis, it creates a set of contour spots of that hand image within the hull and also It applies smaller set of points to make the hull carrying all of its contour spots from the inside as well as on the outside of the hull and maintain the property of convexity [6] as shown in Fig. 4.3.

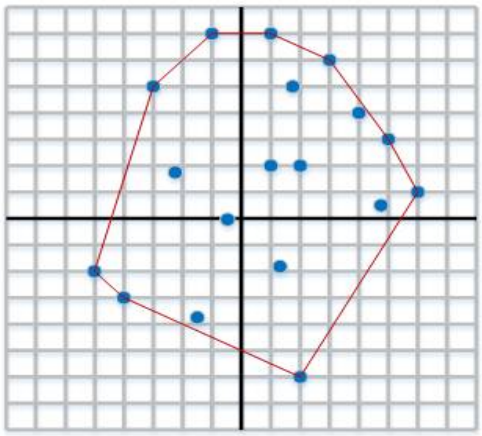


Figure 4.3. Example showing convex hull in red

Figure 4.1. Convex hull of the image

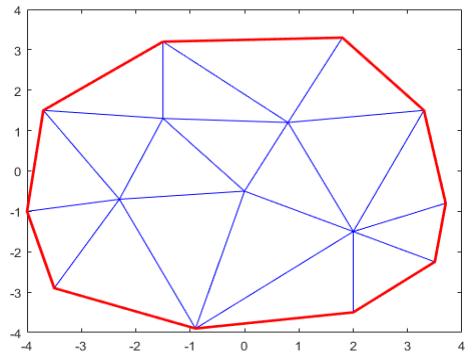
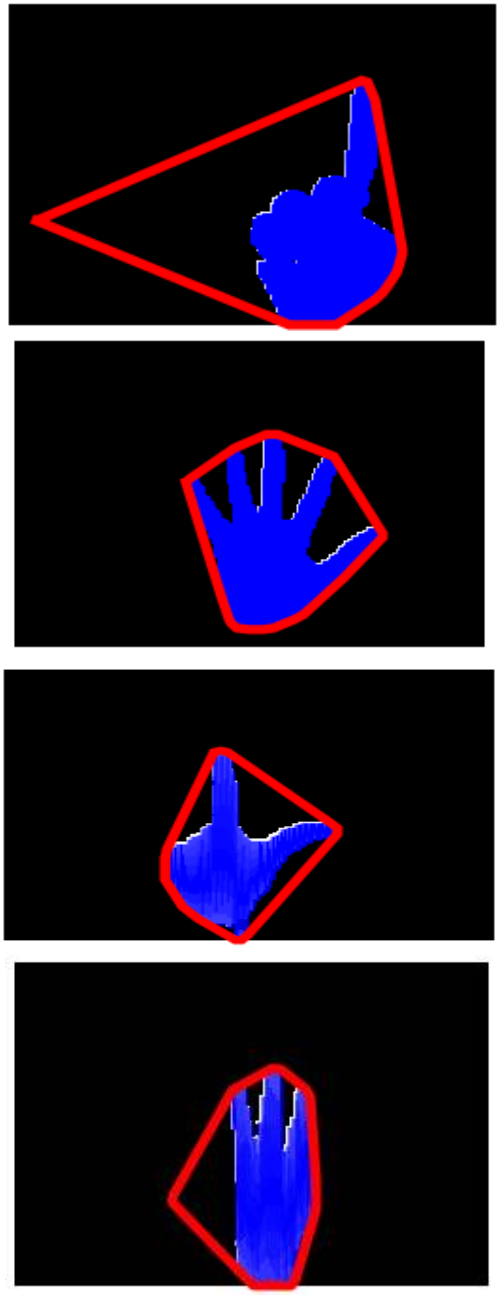


Figure 4.2. 3D structure of convex hull in MATLAB



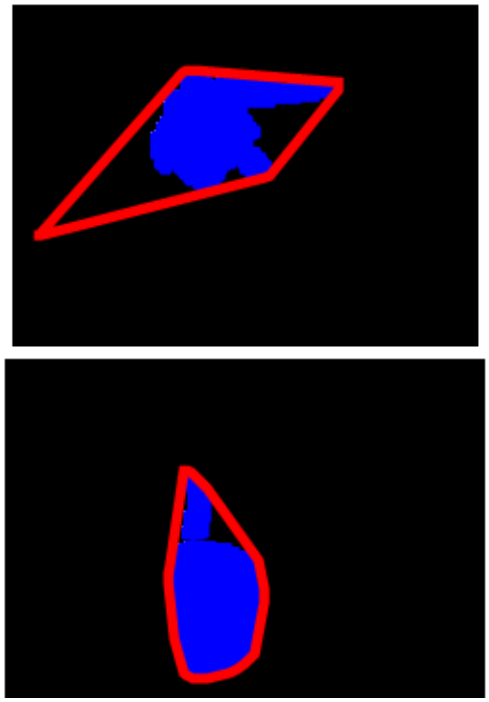


Figure 4.4: Gestures after applying convex deficiency

5. Convexity Defects

The concept of convexity defect is showed in the figure below, which can be understood as concativity areas with respect to the convex hull.

Whenever we tired the convex hull approach over the contour of the hand, it will set the value of contour points on the hand inside the hull. It valued small set of points to plan the hull for adding all of its contour points within or in the hull and continue the property of convexity. This matters the generation of faults in the convex hull with reference to the contour tired on hand [6]. The set of values for each irregularity in the style of vector is provided by the convexity defect. The starting and ending point of the vector contains the point of the line of defect in the convex hull. These points specifies indices of the coordinate points of the contour as shown in Fig. 4.4.

6. Recognition of Gestures and Tests

We proposed our own algorithm for recognizing these test images of gestures onto the database.Our target is to recognize hand gestures for obtaining its 3D projections and its method for computing the feature vector which represents the gesture. We are making our own database of images captured by tof camera and using these gesture images as a set of training in our algorithm, this exact database could be useful for testing purpose. The algorithm that we are using for our hand gesture database is quite simple. It depends on convex deficiency method through which we observe our data of images. The hand gesture database is the image containing multiple hand gesture and hand posture illustrations. It has been established to identify our new gesture which is desired. .Firstly we are putting these gesture images one by one in training process after that its tests these images accordingly, in the second step it will start to test these images of gestures to identify which is our required one from them. This method can be done through MATLAB coding and in that particular code we started a loop in which we are able to calculate their norm vector value i-e: n(i), basically we are measuring the convex deficiency for every gesture and in the end it combines the number of objects ie: z1 and z2 to get their

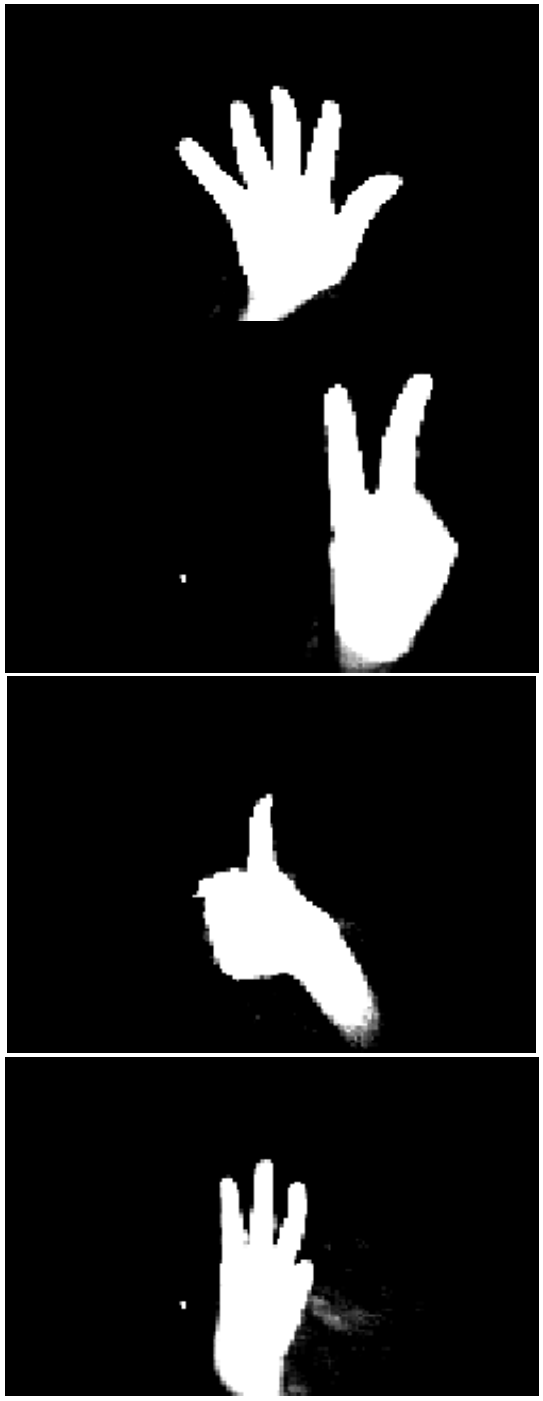


Figure. 6.1. Tests and Results

norm value denoted by z and this process will be continued until we get desired vector value for our test images as shown in Fig. 6.1.

7. Conclusion

Our system occupies a 3D Time-of-flight camera as Tof camera which gives us depth information at real time, we captured different images of gesture through this camera showing different functions by hand. Our goal is to recognize these gestures on MATLAB using convex-hull approach considering the fact that 3D scene analysis is possible in many different ways to observe. We have described a 3D real time hand gesture recognition system, taking advantage of a range camera, 3D tracking and hand segmentation becomes easy and invariant to the changes in the environment, and also we are including the recognition of more types of hand shapes for testing robustness. As convex hull approach provides us accurate defects of hand gestures, so gestures can be easily determined by training data set. Our recognition of 3D scene analysis is done through these steps in our implementation: first learning, then training and then testing. Next there is a simple algorithm which considers the test images to be recognized for creating a database of images of gestures required, and in that we are using different methods like convex deficiency of gestures to obtain its norm vector value for the required images in database. We have various number of applications in this area of research like in automotive sector, gaming, and consumer electronics also in advertising different fields especially with digital signage, because as humanity moves forward, our nature and environment will be more reactive towards us. In future we can make many business productivity applications as in more natural way using this growing technology evolution.

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About Authors

Neelam Memon received her B.E degree from Mehran University of Engineering and Technology, Jamshoro, Pakistan, and enrolled in M.E at Mehran University of Engineering and Technology, Jamshoro, Pakistan. Her research area is in image processing.

Dr. Wajiha Shah received her B.E degree from Mehran University of Engineering and Technology, Jamshoro, Pakistan, and M.E from Mehran University of Engineering and Technology, Jamshoro, and the PhD degree from Vienna University of Engineering and Technology,Vienna, Austria.

Koonj Tagar received her B.E degree from Mehran University of Engineering and Technology, Jamshoro, Pakistan, and enrolled in M.E at Mehran University of Engineering and Technology, Jamshoro, Pakistan. Her research area is in image processing.

Dr. Zubair Ahmad Memon received her B.E degree from Mehran University of Engineering and Technology, Jamshoro, Pakistan, and M.E from Mehran University of Engineering and Technology, Jamshoro, and the PhD degree from Mehran University of Engineering and Technology, Jamshoro, Pakistan.

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