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Construction of 3D image form 2D image using Stamp Perception

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Abstract: In this paper, we propose a novel method for constructing a 3D image from the 2D image. 3D images are very meticulous and provide immense details about each element, which can help in communicating the information with ease and allow viewers to understand design in a lot better way. Many researchers work for a display that projects 3D images in a way that makes them visible from all angles and does not require extra accessories. A stamp is a group of pixels that forms a rectangle or square objects which would generate the depth of field for the pins to realign into the 3D image. This work gives a methodology to create a 3D image from the 2D image.

Introduction

In an image, objects low or directly in front of us are perceived as closest to us and are in the foreground. They are larger, clearer, and brighter than those "behind" them. Objects at a medium distance are perceived as mid-ground; they are in the middle of the frame. Objects farthest from us, in the background, are usually higher in the picture; they seem less clear, and their colors are less intense than those in both the foreground and middle ground.

The stamp creates three-dimensional images using the intensity of the image. 3D modeling is a technology through which three-dimensional images of any given object can be created. The product design process has become easy with 3D modeling as we can create three-dimensional images virtually for any object no matter how gigantic or micro it is. This very fact helps to create an exquisite design for any product (e.g. orthodontic diagnosis) [4].

3D means three-dimensional, that is, something that has width, height, and depth (length). Our physical environment is three-dimensional and we move around in 3D every day [7]. Humans are able to perceive the spatial relationship between objects just by looking at them because we have a 3D perception, also known as depth perception. As we look around, the retina in each eye forms a two-dimensional image of our surroundings and our brain processes these two images into a 3D visual experience. There are high expectations for the further development of three-dimensional display technology [10].

The accuracy which 3D models contain is unparalleled and no other conventional modeling or visualizing approach can be as accurate as 3D modeling.

Literature Review

Three-dimensional (3D) images represent a physical body using a collection of points in 3D space, connected by various geometric entities such as triangles, lines, curved surfaces, etc. The fundamental difference between 2D and 3D model is the inclusion of the third coordinate – depth [3]. This information can be acquired by various means ranging from stereoscopy (use of two specifically aligned cameras) to laser scanning of the environment, while each of these techniques has their own advantages and disadvantages [1, 8].
In industry and manufacturing, 3D vision systems provide unprecedented precision and flexibility in control, measurement, and quality inspection. While these areas require different approaches to hardware construction and methods of 3D image acquisition, most of the image processing algorithms are used universally [3].

As an important part of digital image processing technology, the 3D construction technology has been widely applied in medical research, remote sensing and telemetry and virtual reality, etc. [9, 11]. With the development of 3D applications, face recognition and facial animation [5] becomes an important component of 3D content production [2]. Another exploring field is 3D printing technology. 3D printing has been a great impact in many industries such as medical science, engineering, aerospace, education and many more.

The invention of the tangible 3D image is created by MIT's Tangible Media Group using Microsoft's Kinect, a computer, a projector, and hundreds of small pins that move up and down using actuators [12]. The miniaturized version of this image could be used for a wide variety of applications across various industries. A similar tangible interface is already used in the field of architecture to create more realistic 3D images of buildings that simulate solar shadows and wind flow simulations.

Methodology:

Algorithm

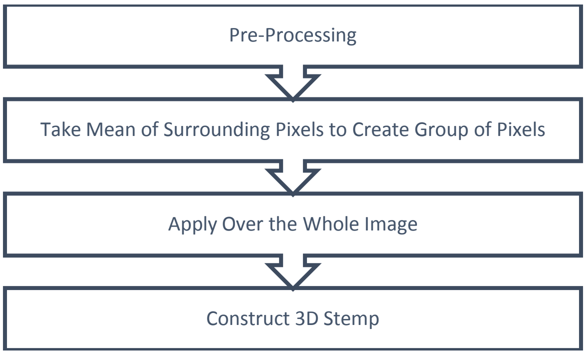


Image Pre-processing

Pre-processing is applied to images at the lowest level of abstraction and its aim is to reduce undesired distortions and enhance the image data which is useful and important for further processing. It is usually necessary and required for improving the performance of image processing methods like image transform, segmentation, feature extraction, and fault detection. This Step is focused on filtering and intensity adjustment as pre-processing methods.

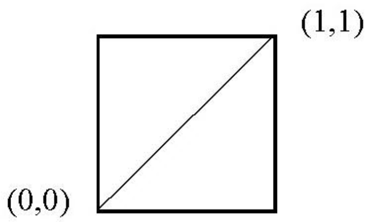
Stamp generation

The different heights of the group of pixels would create a 3-dimensional relief. A stamp is a group of pixels that forms a rectangle or square objects which would generate the depth of field for the pins to realign into the 3D image. In the stamp perception, we make a group of pixels by taking the mean value of surrounding pixels' intensity so that the pin intensity is higher than the intensity of neighboring pixels which represent the picture. Also, we changed the size of group pixels to change the size of pins used in the recreation of the picture. For a random variable vector A made up of N scalar, mean [6] is given by:

$$Mean = \frac{1}{N}\sum_{i=1}^{N} A_i$$

Construct 3D stamp

The basic idea behind this concept is to construct a polygonal "mesh" based on the intensity values of pixels in an image. That is, read an image and use the brightness of each pixel to generate and place triangles.
An image can be defined as f(x,y). Take a small square of four pixels from this image. Each one has an x and y coordinate, taken straight off the image. The lower left pixel is (0,0) and the upper right is (1,1). We generate two triangles in 3D space from these four pixels. In the diagram below, each of our four pixels is marked as an 'x' and we can draw two triangles.



Each pixel has an x and y already. So, we can write the vertices for two 2D triangles:

Triangle 1: (0,0) (0,1) (1,1)
Triangle 2: (0,0) (1,1) (1,0)

Now, we need to turn these 2D coordinates into 3D coordinates. We take each of our four pixels and calculate its brightness. We use this brightness, scaled into some appropriate range, as the Z coordinates.

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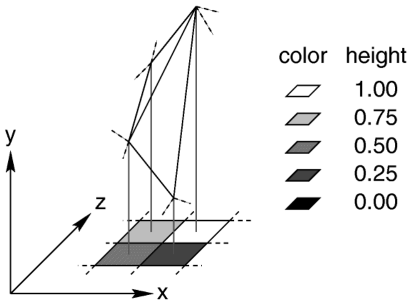
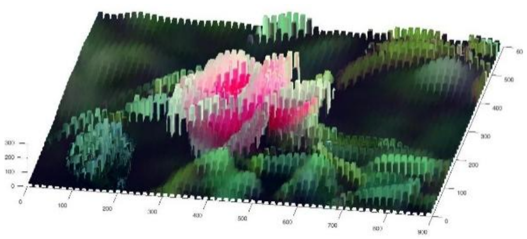


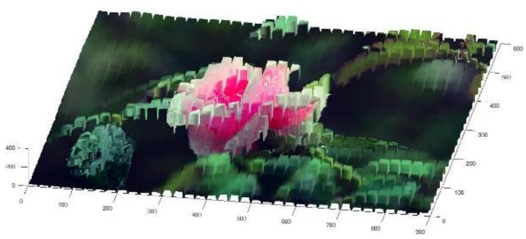
A square of four pixels and calculate the intensity of each pixel. Then, use these four intensity values as the four Z coordinates. We have two triangles in 3D space generated from four pixels. We do over the whole image and get a 3D image.

Results

(a)

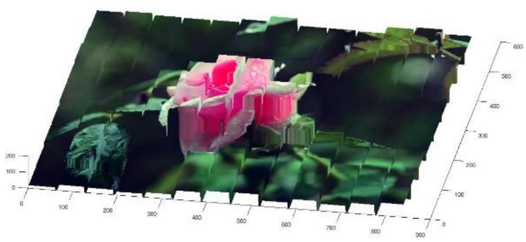


(b)



(c)

(d)



(e)

Figure 1.1 (a) Original Image (b) Stamp size 10x10 (c) Stamp size 20x20 (d) Stamp size 40x40 (e) Stamp size 60x60

Conclusion

As an important part of digital image processing technology, 3D construction technology has been widely applied in medical research, remote sensing, telemetry, and virtual reality, etc. This work enables us to visualized and understand the three-dimensional perception behind a two-dimensional image. Stamp method can be useful in the field of architecture to create more realistic 3D images of buildings that simulate solar shadows and wind flow simulations form a 2D image. The vast application of the algorithm can be explored further, which large potential to be used in a lot more areas than just for an aesthetic purpose.

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