COMPUTATIONAL PHOTOGRAPHY AND CAPTURE COMP0028

PROJECT PART-II: Multi-Perspective Imaging

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Multiperspective imaging is an interesting method of photography and imaging that lets us perceive the world beyond our single-perspective human viewing. One simple example of multiperspective vision, as compared to our regular vision, will be of a case where we are equipped with a field of view that allows us to see one object from all sides at the same time. Some of Picasso's works offer a tiny glance into what multiperspective viewing of a human face would look like.

Figure 1: Pablo Picasso's Bust of a Woman with A Hat. (Peter Schibli, Basel / © Succession Picasso / Artists Rights Society (ARS), New York)

For capturing multi-perspective images, many special types of cameras and optical devices are employed. If we move a regular video camera on a pre-decided path and extract the frames to create a 3-D stack, multiple variations of a 2-D multiperspective image can be created based on the user's choice. This is one of the simplest forms of multi-perspective imaging. Aerial and satellite imagery uses this method to capture photographs of the surface of the Earth in a 2D format while in an orbital path. The stack of images gives multiple orientations to explore a multi-perspective image from.

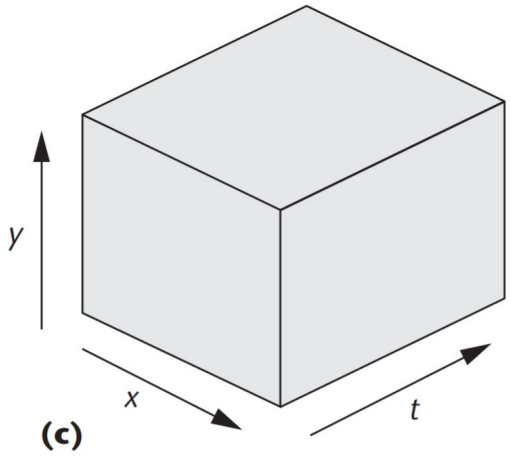

Figure 2: Image of a cube representing the stack of frames from a video. Image from [1]

In figure 2, the y-x slice represents images along the direction of increasing order of t i.e. time, a representation of frames stacked in an array. The slices can be obtained from any two dimensions which produce rich and illustrative results. In this project, I have explored the y-t slice of image stack to observe the multiperspective capture also known as Pushbroom. When a 2-D multiperspective image is created from the last column of x-orientation in the y-t slice, i.e. the front face of the cube with reference to Figure 2, we get what is known as the Pushbroom image.

PUSHBROOM IMAGES

Pushbroom images look quite similar to a regular perspective imaging but a pushbroom image incorporates the temporal transition in the column-wise pixel capture. This, therefore, captures the path of the camera by capturing the view-point change within a single image.

For creating pushbroom images, we work with the y-t slice of the image stack. Multiperspective pushbroom panorama, the main idea that I was working in this project, involves creating a panorama using the pushbroom image principle.

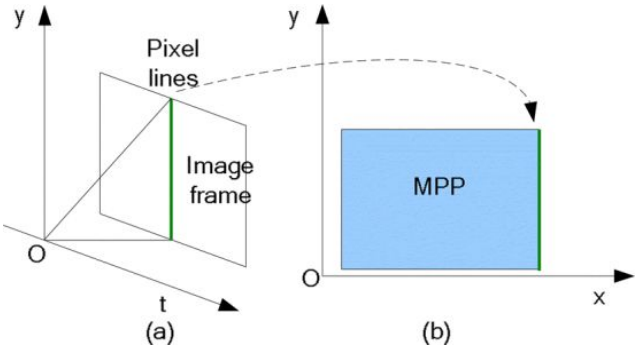

Figure 3: Description of how Multiperspective panorama is created from Image Stack. [2]

From a 3-D image stack Figure 3(a), a column of pixels is picked up in increasing. Usually, since image distortions are the least in the middle, a frame from around the center of the x-axis is used to create the Multi-Perspective Panorama (MPP). The pixel columns are assembled in an increasing order of time and an MPP is created.

For creating pushbroom panoramas, the video camera is moved linearly along the scene being captured, for example, out of the window of a car while moving along a street i.e. perpendicular to the direction of movement.

Since I couldn't capture data from outside due to lockdown, I used some old footage and made linear videos at home. One such video was a linear capture of a big patterned throw cover. The sample frames are shown below.

The Multi-Perspective Panorama for the pattern looked as follows -

Figure 4: Final Panorama of the Throw

Another video I captured was not on a linear path to see the effects on the panorama-

The panorama for a non-linear and a rotational trajectory of the above frames looked like-

Figure 5: Final Panorama. The non-linear path of capture creates distortions in the panorama.

PUSHBROOM PANORAMIC VIDEOS

The y-t slicing, when done over the image stack over increasing t while creating frames and viewed as a sequence along the x-axis, gives some very interesting results. It creates a rotational panoramic film which is a panoramic sequence that rotates from left to right with a viewpoint of standing in the center. The movies are in the Videos Panorama and consist of two videos, a panorama of the pattern throw and of a linear sky capture, which makes a 3D rotational effect. The Panoramic Pushbroom Videos, when created for videos that are captured in a rotational path, i.e., for example, moving a camera in a circle around an object with the camera facing inwards towards the object, can help produce cyclographs.

The code for the Pushbroom video panorama is named as viewer.m. The idea behind creating panoramic videos is from [1].

BIBLIOGRAPHY

[1] S. M. Seitz and Jiwon Kim, “Multiperspective imaging,” *IEEE Computer Graphics and Applications*, vol. 23, no. 6, pp. 16–19, Nov. 2003, doi: 10.1109/MCG.2003.1242377.

[2]W. Wei, G. Hui, Z. Maojun, and X. ZhiHui, “Multi-perspective Panorama Based on the Improved Pushbroom Model,” in *Second Workshop on Digital Media and its Application in Museum Heritages (DMAMH 2007)*, 2007, pp. 85–90, doi: 10.1109/DMAMH.2007.59.