Backprojection

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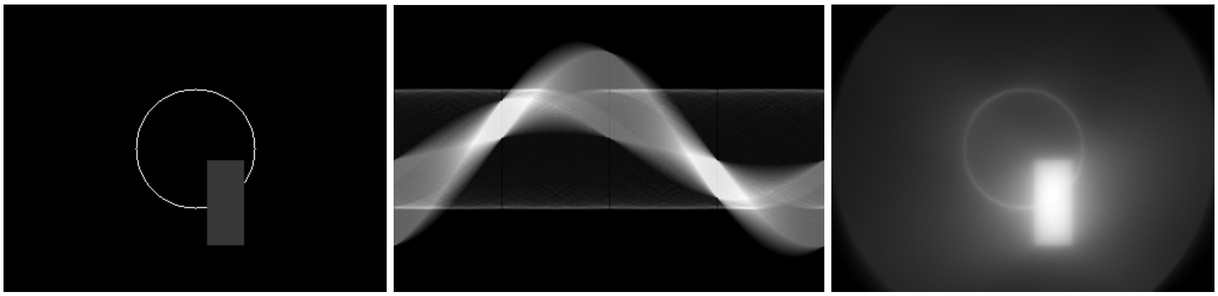

Figure 1: *Left:* Input image, *middle:* sinogram, *right:* backprojected image.

The goal of this exercise is to implement projection and backprojection algorithms to reconstruct an image from a finite number of projections[1]. A notable use of this technique is the reconstruction of computer tomography.

[1] Wikipedia. Tomographic reconstruction. `https://en.wikipedia.org/wiki/Tomographic_reconstruction`

Projection

To complete our task, we create an image as shown in Fig. 1 (*left*) (but you can create also other image to your liking).

What we do next, is to create projections of the input image in given number of angles ($\langle 0, 180 \rangle$, with step of 1). By projection we mean the sum of image pixel brightnesses along a line.[2] This projection creates a vector. Projecting the input image in different angles would be tedious, so we can use a little trick. We rotate the input image by the given angle and project the rotated image along the x-axis. In this way, we can store each projection as a vector and set of all projections as an image (see Fig. 1 (*middle*)). Such image is called sinogram.

[2] Don't forget that such sum can result in values greater than 255 and you have to set the type of `cv::Mat` accordingly.

Backprojection

From the set of vectors with each projection, we reconstruct the input image. First, we take each projection and reconstruct an image so that we copy the projection vector to each column of reconstructed projection image. Then we rotate this image by the angle the projection was taken from. Then we stack all such reconstructed projection images and sum values in each pixel to obtain the final image (see Fig. 1 (*right*) for the final result.

Note the clearly visible circle in the backprojected image.

References

Wikipedia. Tomographic reconstruction. https://en.wikipedia.org/wiki/Tomographic_reconstruction.