A Filter to Avoid the Aliasing Problem

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The aliasing problem appears when we display a mathematical object on the screen. It is interesting, the same problem not appears when we show a real-world scene. In this paper we consider the difference between the production of this two kinds of pictures and explain one way to avoid the aliasing problem.

When we want to display a mathematical object on the screen, we define a mathematical function that represents the desired object. Then, we take the samples of that function with which we evaluate the pixel values. In the case of a real-world scene, we record it by camera, then scan the photo (what is a sampling process again), and produce the pixel values. The main difference between that two processes is that we sample the different kinds of functions. The first ones **does not**, and second ones **does** satisfy the sampling theorem condition. An idea is to filter the function that represents the mathematical object **before sampling**, and make it to satisfy that condition.

Unfortunately, none of the well-known filter can be used. The digital filters cannot be used because they include the sampling process into themselves. The filters with infinite impulse response cannot be used because the filtering process will take very long time.

In this paper we explain the properties (defined in [1]) of a filter that can be used for this purpose. The filter properties in the frequency domain are chosen such that the components not satisfying the sampling theorem condition are suppressed enough and the others are used as much as they can be. The filter properties in the spatial domain are chosen such that enable efficient filtering, the sharp edges and invariation of the picture on rotation. Also, the filter should prevent a fine structure that doesn't exist on the desired scene.

In this paper it is explained a design of the filter. For the beginning, the design is done in a one-dimensional case by approximation with the orthogonal functions. It is explained why it is chosen such impulse response shape of the one-dimensional filter. It is shown the designed filter and its properties. Then it is explained the design of a two-dimensional filter from obtained one-dimensional one. It is shown the obtained two-dimensional filter and its properties. They are compared with the desired ones.

An experiment with filtering of the circles is explained.

References

[1] S. Hristov, M. Stanković, V. Veličković, "Exact" display of objects with real valued positions and dimensions, FILOMAT (Niš) 9:2 (1995), 251–259