3$^{\text{D}}$-Illusion Constructor

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Abstract—**Madonnari, one of the kinds of street art, is very popular in the world today. Drawings are made on a pavement and are deliberately distorted in such a way that an illusion of a three-dimensional object appears when the drawing is looked at from a certain point. It is remarkable that many painters use methods developed in the sixteenth century to make such drawings. Some graphical packages, for example Photoshop, allow to distort images in such a way that they can be seen correctly from a different point. However, such packages cannot be used to construct illusions at the junction of two plains, and a viewing point cannot be prescribed. We present a program which makes it possible to construct 3D illusions at the junction of two or three plains and to select a point, viewing from which produces a spatial effect.**

Image processing; computer graphics; graphic design; projective geometry; estimation

I. INTRODUCTION

Anamorphosis is an art of construction of deliberately distorted images which, when looked at from a certain point, regain their undistorted view. The art of anamorphosis was invented in China and brought to Italy in the sixteenth century. Probably one of the most spectacular and impressing examples of anamorphosis is Madonnari – one of the kinds of street art. Drawing are made on a pavement (we will call such drawings 3D-illusions) and are deliberately distorted in such a way that an illusion of a three-dimensional object appears when the drawing is looked at a certain angle. The central object of art in Italy in the sixteenth century was Madonna, which is the reason for the name "Madonnari".

This kind of art is very popular in our time; moreover, many businesses use 3D-illusions for advertising. Examples of such illusions is shown in Figure 1. Recently an experiment was started in Canada, in which the speed of vehicles is controlled by an optical illusion made on the road. (This experiment is conducted by the Fund of Traffic Security of British Columbia.)

It is surprising that many painters that draw illusions on a pavement use the same methods that were used 400 years ago by their predecessors. Some graphical packages, such as Adobe Photoshop, have a Perspective tool, which allows to construct 3D-illusions in a plane. However, this tool is designed to remove perspective distortions rather than to construct illusions that appear as a result of perspective distortions. For this reason it is not possible to prescribe a point, viewing from which produces an illusion. It is not possible either to construct an illusion from a number of images (or regions of images) that lie in different planes. Thus we are not aware of existence of a graphical package that is designed to construct 3D-illusions in a plane or a number of planes (although we investigate this question specifically). Despite simplicity of realization, we found the idea of creating such a graphical tool very interesting.

We present a program (a 3D-illusion constructor) written in C#, which allows to produce 3D-illusions in a plane.

Figure 1.   Examples of such illusions advertizing

II. MATHEMATICAL MODEL

Suppose that, in three planes, we want to obtain an illusion of the image in Picture. Consider a Cartesian system in the space (see Figure 2). Thus the problem is to construct a projection of the Picture plane to the coordinate planes.

Let (u_1, u_2) coordinates of a pixel in Picture plane, $(v_1; v_2)$ coordinates of a pixel in one of coordinate planes.

Our task is to obtain a projective transformation between two planes. Such transformation is a rational function of the form

$$u_i = \frac{k_i^1 v_1 + k_i^2 v_2 + d_i}{k_i^3 v_1 + k_i^4 v_2 + 1},$$

$$i = 1,2$$

(1)
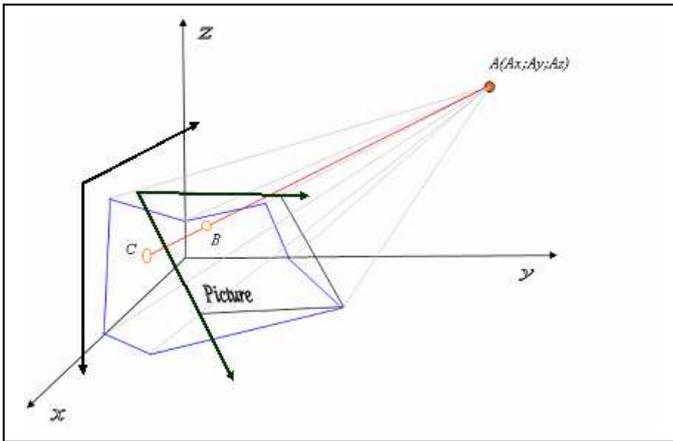
Figure 2.   a projection of the Picture plane to the coordinate planes

To find ten coefficients k_i^j, $i=1,2$ $j=1..5$ we have to know a set of five points (u_1,u_2) and a corresponding set of points (v_1,v_2). These sets can be found using geometric view. If we substitute these points in (1) we obtain a system of linear equations. The variables of this system are coefficients k_i^j, $i=1,2$ $j=1..5$ se in an equation.

Figure 3.   Resulting image

III.   PROGRAM DESCRIPTION

The program works with raster images. The user can give the coordinates of the point A and the size of the file, where the illusion will be constructed. After that the images can selected, which can placed in a 3D space, dimensions can modified, and they can projected to a plane (or planes), where the illusion is constructed. The output of the program is an image file. After the output image is printed and viewed from a certain point, an illusion appears.

The results obtained with the program are shown in Figures 3 and 4. If the image of Figure 3 is printed, cut angle and viewed at a certain point, this produces an illusion shown in Figure 4. We also note that this program allows to produce cards shown in Figure 5.
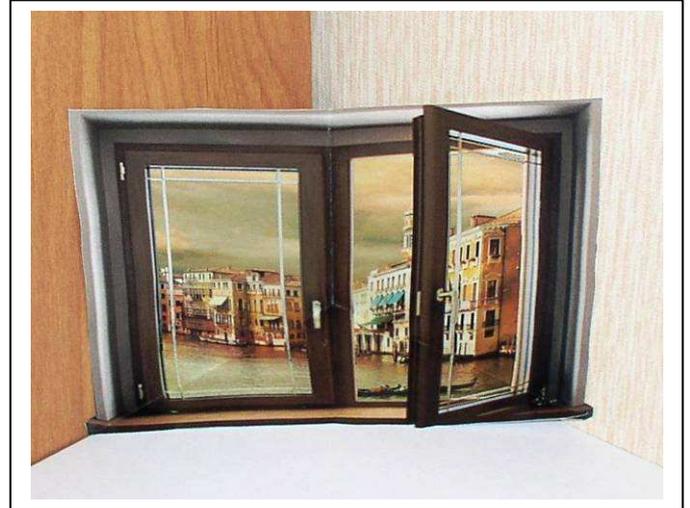

Figure 4.   Illusion image
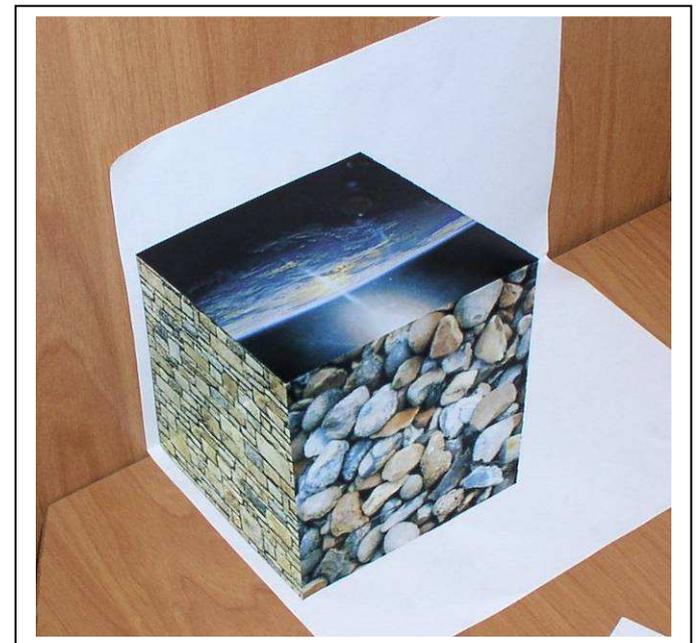
Figure 5.   Illusion card

[1]   Richard Hartley, and Andrew Zisserman, "Multiple View Geometry in Computer Vision," Cambridge University Press 2000, pp. 607