**M6 project – 2D Image transformation**

**Introduction (abstract):**

Image capture is to project a real world scene into an image. This projection make some distortion in the original scene, changing the perception of how we see the scene.

In this work, we explored the three main transformations that an image can suffer and we explained how we could express those transformation with a single matrix.

After the transformation analysis, we infere in a real problem transformation by two ways: first of all we compute an affine transformation of the original image and then we done a metric rectification. In the following sections we will explain in what consists these methods and how to apply them.

**Image transformation:**

Image transformation will be explored in this work in the 2D space, so changing the representation of images assuming suffer a transformation.

Before analyse the distortion of a real image we must understand in what a transformation consist and what kind of them can the points of the image suffer.

Any transformation can be written as a matrix, in the case of the 2D space, this is a 3 by 3 matrix, as for example:

*Generic expression of an homography (transformation matrix)*

We must know projective space is expressed in homogeneous coordinates. To pass from Euclidean coordinates (x,y) to homogeneous coordinates, we must add 1 as the third coordinate (x,y,1). Any vector that can be expressed as the linear combination between a scalar factor ‘s’ and a vector (x,y,1) is equivalent to that one.

The simplest transformation that we can apply to a point (excluding the identity transformation) is the isometry. This transformation consist in apply to each point on the image a transformation and a rotation (or just one of them). Having all the points in the new position, this transformation keeps the parallelisms in the image, the lengths and the angles. Having a angle ‘alpha’ and a translation vector ‘t’ (with two coordinates, the transformation matrix can be expresses as:

In the expression we have a matrix R, that is a 2 by 2 matrix, describing the rotation of the image and a translation vector ‘t’, described by the ‘x’ translation and the ‘y’ translation. The rotation matrix R (non-singular) is computed as:

Next transformation we can apply to an image and that no keeps the length of the objects in the image is that one that consist in a rotation and translation, but that implies a scale factor. This transformation is called similarity. The transformation matrix is very similar to the last one but includes a scale factor that affect to the rotation matrix as we can see:

As this transformation implies to basic transformation: isometry and scaling, similarity matrix can be expresses as a scalar product of two matrix: Hi (isometry matrix) and Hs (the scaling matrix):