

## 1 Affine transforms

Q1 : Rotation around  $p_0$

$$M = \begin{pmatrix} R & p_0 - Rp_0 \\ 0 & 1 \end{pmatrix}$$

Q2 :  $p_0 = \sum_i p_i / N$

Q3 :  $M^{-1} = \begin{pmatrix} 1/sR^T & -1/sR^T t \\ 0 & 1 \end{pmatrix}$

Q4 : Camera position:

```
mat3 O = transpose(mat3(view));
vec3 lastCol = vec3(view*vec4(0.0, 0.0, 0.0, 1.0));
vec3 positionCamera = - O * lastCol;
```

Q5 :

```
u_back = normalize(eye-center);
u_right = normalize(cross(up,u_back));
u_up = cross(u_back, u_right);
O = [u_right,u_up,u_back]
V = [O^T, - O^T eye; 0,1]
```

## 2 Deformation

Q1 : Translation deformer

```
for all positions p:
  dist = ||p-c||
  w = exp(-dist^2/r^2)
  t3D = O * vec3{t2D,0}
  p' = p + w * t3D
```

Q2 : Restricted to the normal direction

$$p' = p + w \text{ t2D.x (or t2D.y)}$$

**Q3** : Scaling

$$s = 1 + w \cdot \text{tr}.x$$

$$p' = s \cdot (p - c) + c$$

Rotation

R: rotation(axis,theta)

- theta = w \* tr.x

- axis: either normal n, or forward vector 0\*{0,0,1}

$$p' = R \cdot (p - c) + c$$