

Euclidean Transform SE(3)

```
im = imread('rect.png');
```

```
theta = 20/180*pi;
```

```
R = [cos(theta) -sin(theta);  
     sin(theta) cos(theta)];
```

```
p = [size(im,2)/2; size(im,1)/2];
```

$$\leftarrow R = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$$



Rotation around the center of image

Euclidean Transform SE(3)

RectificationViaEuclidean.m

```
im = imread('rect.png');
```

```
theta = 20/180*pi;
```

```
R = [cos(theta) -sin(theta);  
     sin(theta) cos(theta)];  
p = [size(im,2)/2; size(im,1)/2];
```

```
T = [R -R*t+t; 0 0 1];
```

```
im_warped = ImageWarpingEuclidean(im, T);
```

$$\leftarrow R = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$$

$$\leftarrow \begin{bmatrix} v_x \\ v_y \\ 1 \end{bmatrix} = \begin{bmatrix} R & -Rp + p \\ 0 & 1 \end{bmatrix} \begin{bmatrix} u_x \\ u_y \\ 1 \end{bmatrix}$$



Rotation around the center of image

Recall: MATLAB Efficient Image Transform

Distorted image

Undistorted image



```
[[X, Y] = meshgrid(1:(size(im,2)), 1:(size(im,1)));  
h = size(X, 1); w = size(X,2);
```

```
X_n = (X-px)/f;  
Y_n = (Y-py)/f;
```

```
r_u = sqrt(X_n.^2+Y_n.^2);
```

```
L = 1 + k * r_u.^2;
```

```
X_dist_n = X_n.* L;  
Y_dist_n = Y_n.* L;
```

```
imUndistortion(:,:,1) = reshape(interp2(im(:,:,1), X_dist(:), Y_dist(:)), [h, w]);  
imUndistortion(:,:,2) = reshape(interp2(im(:,:,2), X_dist(:), Y_dist(:)), [h, w]);  
imUndistortion(:,:,3) = reshape(interp2(im(:,:,3), X_dist(:), Y_dist(:)), [h, w]);
```

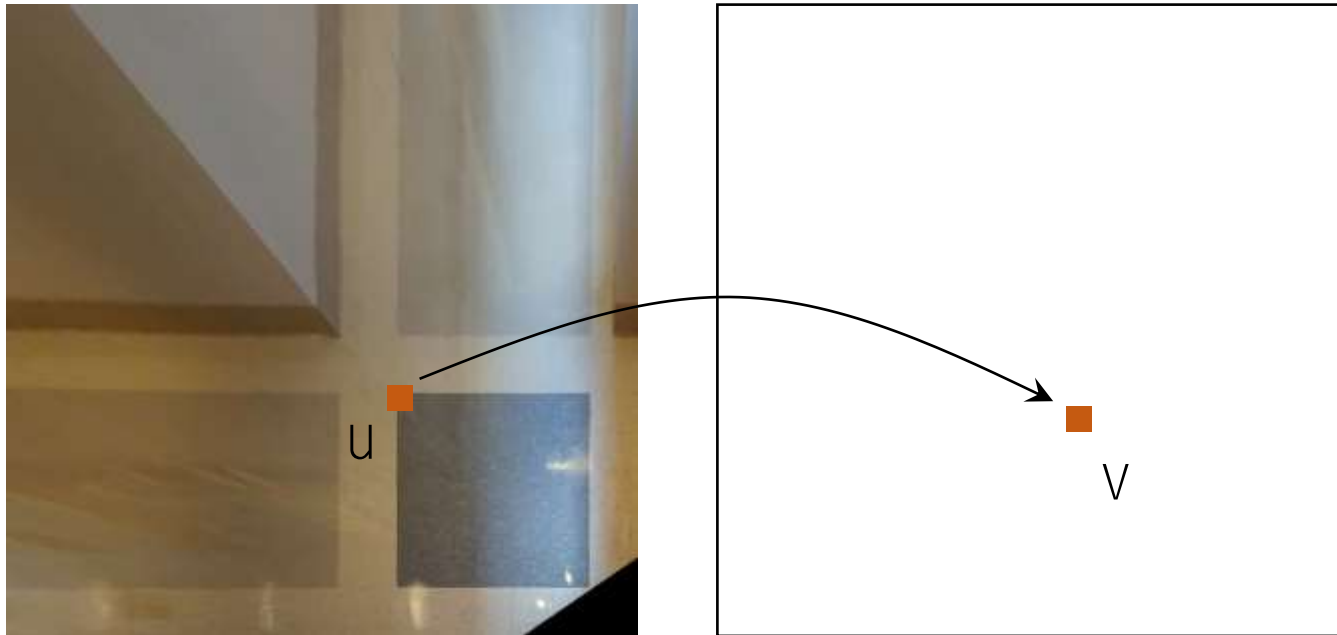
UndistortImageRadial.m

Euclidean Transform SE(3)

ImageWarpingEuclidean.m

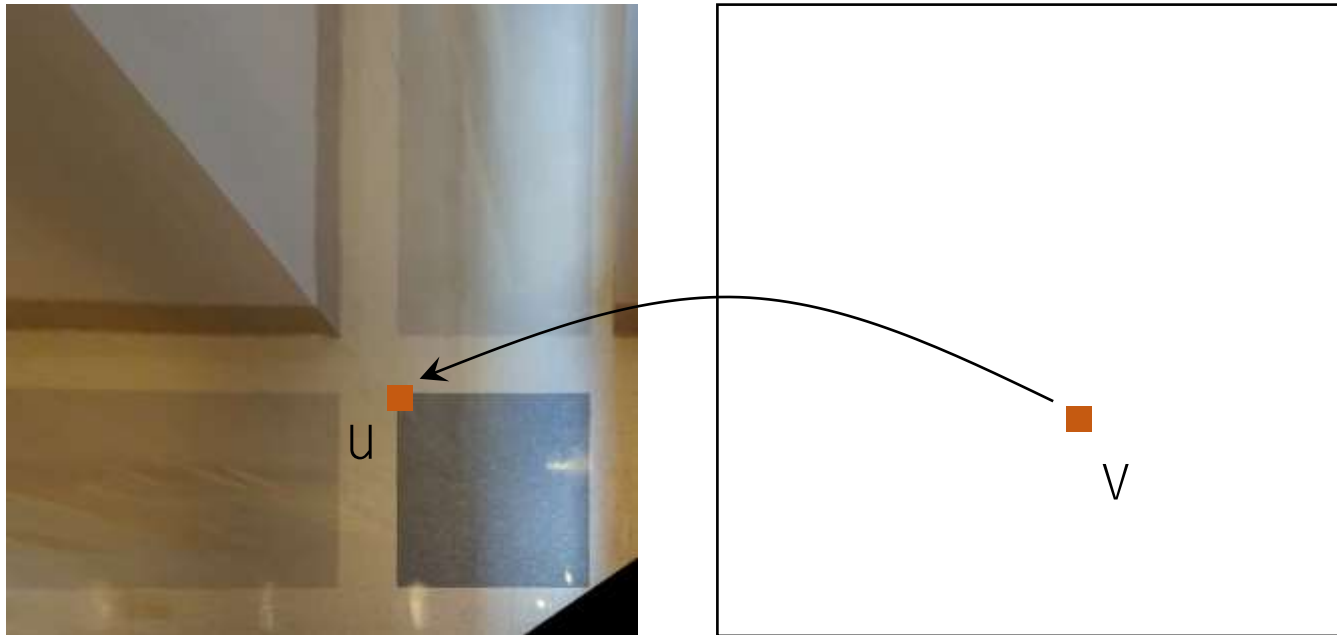
```
function im_warped = ImageWarpingEuclidean(im, H)
```

```
im = double(im);
```



$$\begin{bmatrix} v_x \\ v_y \\ 1 \end{bmatrix} = H \begin{bmatrix} u_x \\ u_y \\ 1 \end{bmatrix}$$

Euclidean Transform SE(3)



$$H^{-1} \begin{bmatrix} v_x \\ v_y \\ 1 \end{bmatrix} = \begin{bmatrix} u_x \\ u_y \\ 1 \end{bmatrix}$$

ImageWarpingEuclidean.m

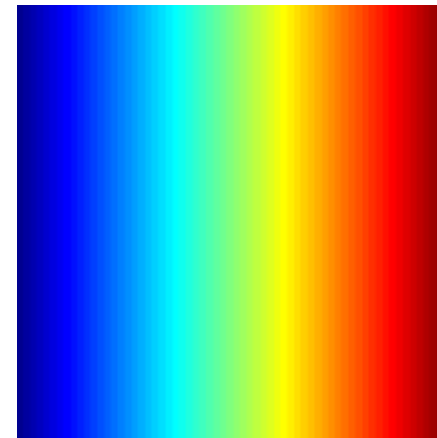
```
function im_warped = ImageWarpingEuclidean(im, H)
```

```
im = double(im);
```

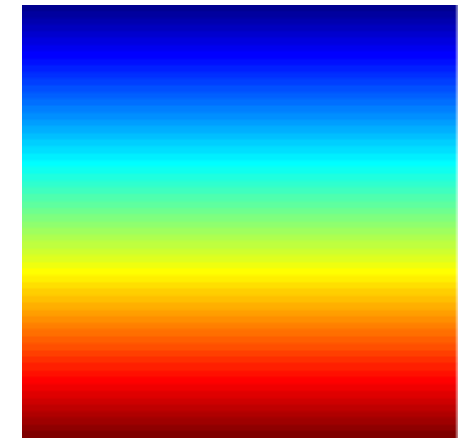
```
H = inv(H);
```

```
[v_x, v_y] = meshgrid(1:(size(im,2)), 1:(size(im,1)));
```

```
h = size(v_x, 1); w = size(v_x, 2);
```

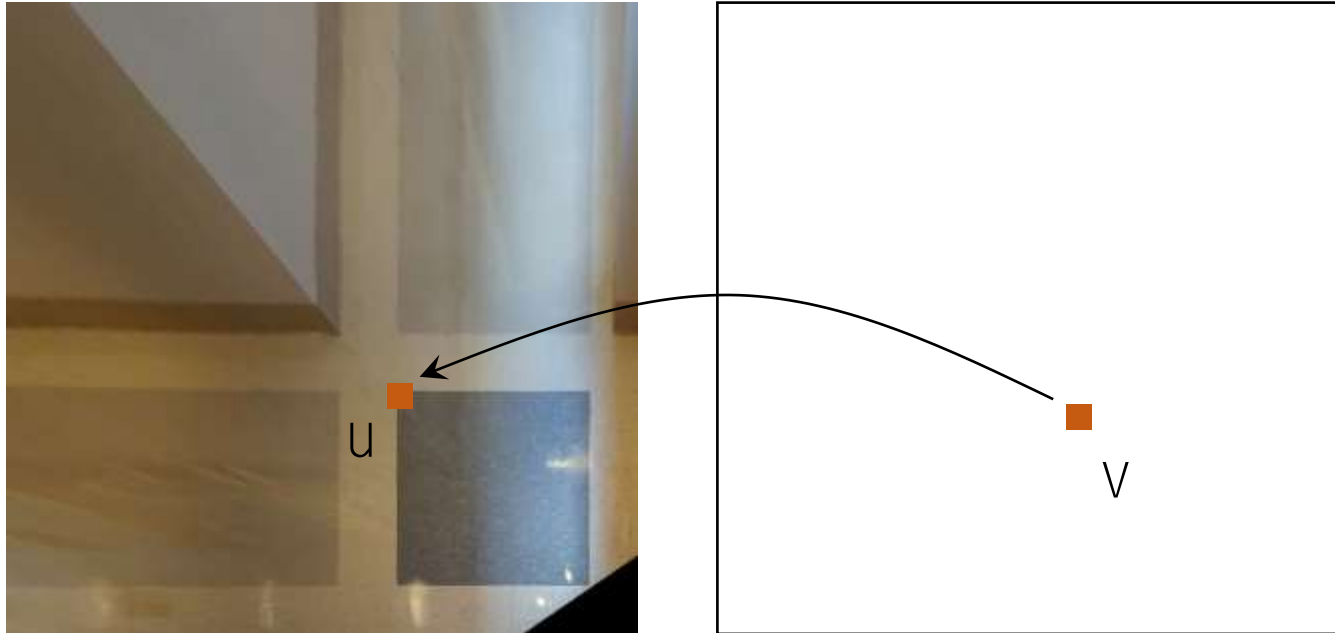


v_x



v_y

Euclidean Transform SE(3)



$$H^{-1} \begin{bmatrix} v_x \\ v_y \\ 1 \end{bmatrix} = \begin{bmatrix} u_x \\ u_y \\ 1 \end{bmatrix}$$

ImageWarpingEuclidean.m

```
function im_warped = ImageWarpingEuclidean(im, H)
```

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im = double(im);
```

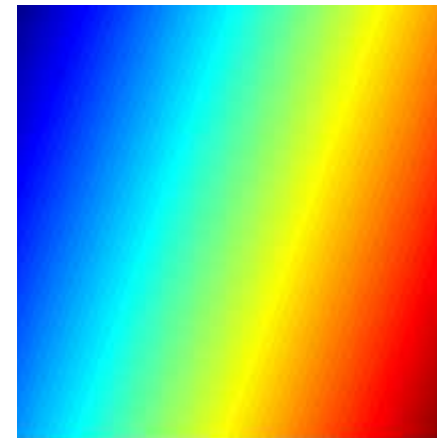
```
H = inv(H);
```

```
[v_x, v_y] = meshgrid(1:(size(im,2)), 1:(size(im,1)));
```

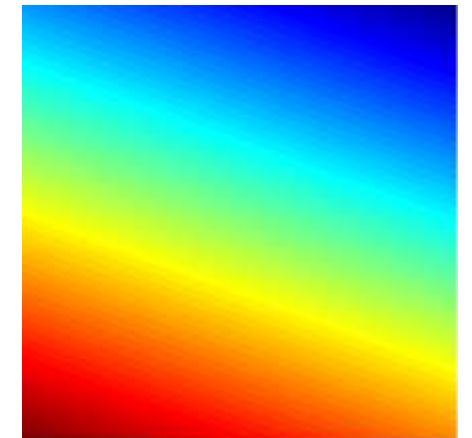
```
h = size(v_x, 1); w = size(v_x, 2);
```

```
u_x = H(1,1)*v_x + H(1,2)*v_y + H(1,3);
```

```
u_y = H(2,1)*v_x + H(2,2)*v_y + H(2,3);
```

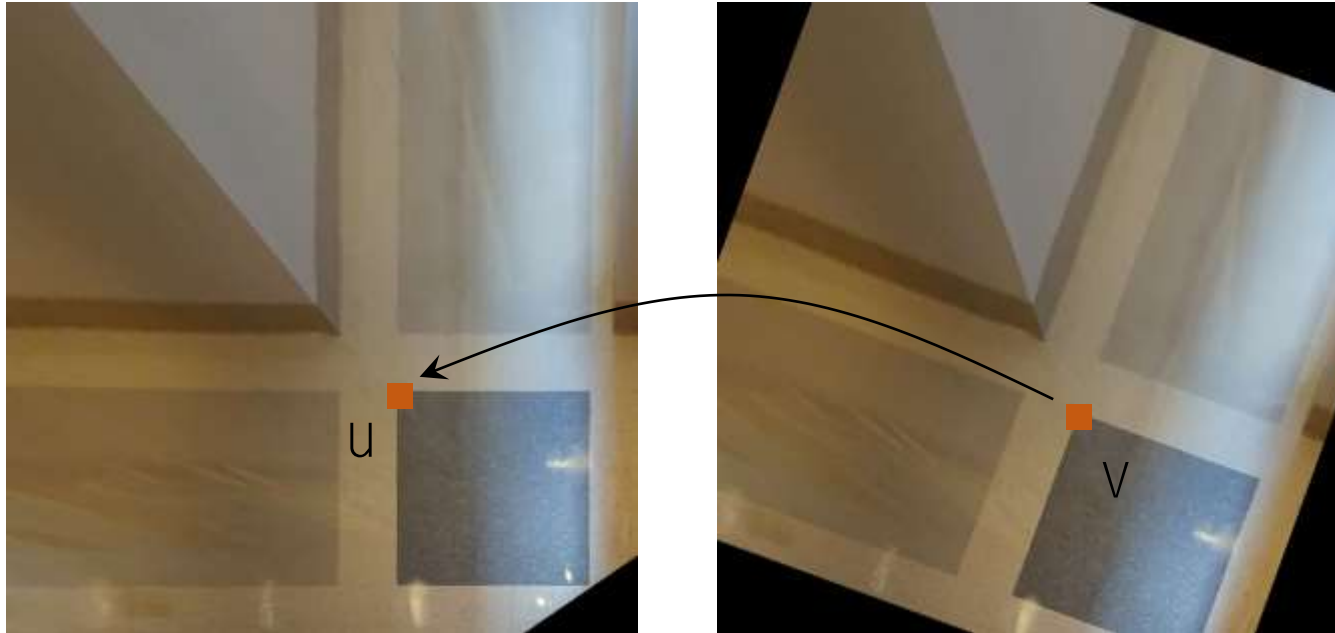


u_x



u_y

Euclidean Transform SE(3)



$$H^{-1} \begin{bmatrix} v_x \\ v_y \\ 1 \end{bmatrix} = \begin{bmatrix} u_x \\ u_y \\ 1 \end{bmatrix}$$

ImageWarpingEuclidean.m

```
function im_warped = ImageWarpingEuclidean(im, H)
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```
im = double(im);
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```
H = inv(H);
```

```
[v_x, v_y] = meshgrid(1:(size(im,2)), 1:(size(im,1)));
```

```
h = size(v_x, 1); w = size(v_x, 2);
```

```
u_x = H(1,1)*v_x + H(1,2)*v_y + H(1,3);
```

```
u_y = H(2,1)*v_x + H(2,2)*v_y + H(2,3);
```

```
im_warped(:, :, 1) = reshape(interp2(im(:, :, 1), u_x(:), u_y(:)), [h, w]);
```

```
im_warped(:, :, 2) = reshape(interp2(im(:, :, 2), u_x(:), u_y(:)), [h, w]);
```

```
im_warped(:, :, 3) = reshape(interp2(im(:, :, 3), u_x(:), u_y(:)), [h, w]);
```

```
im_warped = uint8(im_warped);
```