cse327hw7

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Notes:

1. The code performs better when points are chosen in order and near the center of the image
2. Output is in grayscale
3. The interp2() method of backward warping does not function well currently. It only gives the shape of the warped image, and I have not been able to fix it.

```
% Read images as src and dest
src = double(imread("img1.tif"));
dest = double(imread("img2.tif"));

% imshowpair(uint8(src), uint8(dest), "montage");
```

1. Homography matrix estimation

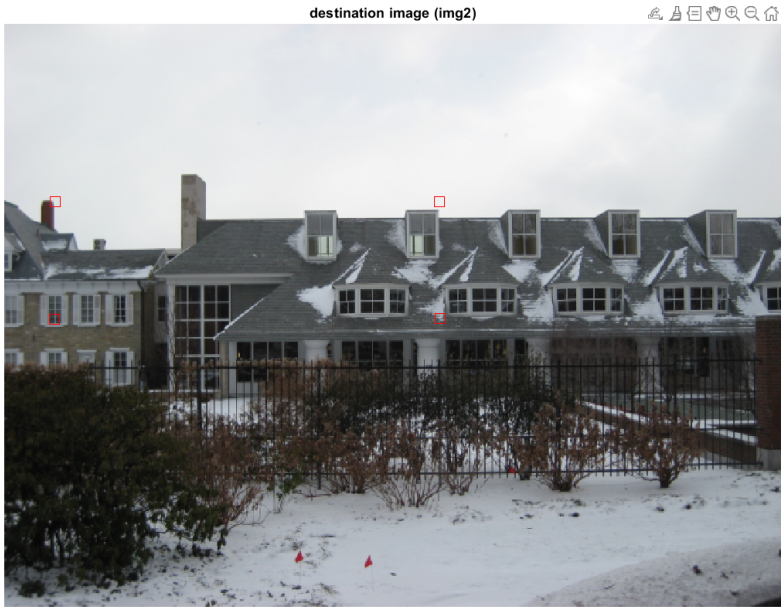
```
% Choose 4 points from src img
imshow(uint8(src));
title('source image (img1)');
[x,y] = ginput(4);

hold on;
plot(x, y, 'rsquare', 'MarkerSize',10);
hold off;
```

```
src_points = [x, y];

% Choose 4 points from dest img
imshow(uint8(dest));
title('destination image (img2)');
[x,y] = ginput(4);

hold on;
plot(x, y, 'rsquare', 'MarkerSize',10);
hold off;
```




```
dest_points = [x, y];

% Display src & dest points here
disp(src_points);
```

```
  200.2347  136.8727
  494.4655  136.8727
  495.0623  224.6048
  200.8316  224.0080
```

```
disp(dest_points);
```

```
   39.6910  137.4695
  336.3090  137.4695
  336.9058  227.5889
   39.0942  228.1857
```

```
% Testing points
% src_points =[295.1286,  114.7905; 387.0385,  141.0504; 387.0385,  178.6499;
293.9350,  174.4721];
```

```
% dest_points =[ 137.5690,  118.9682; 231.8660,  145.2281; 233.0597,  182.2308;
138.1658,  177.4562];
```

```
% Compute the homography matrix by setting ||h|| = 1
A = zeros(2*size(dest_points, 1), 9);     % A is 2N*9

for i = 1:4
    x = src_points(i, 1);
    y = src_points(i, 2);
    x_pr = dest_points(i, 1);
    y_pr = dest_points(i, 2);

    A(2*i-1, :) = [x, y, 1, 0, 0, 0, -x*x_pr, -y*x_pr, -x_pr];
    A(2*i, :) = [0, 0, 0, x, y, 1, -x*y_pr, -y*y_pr, -y_pr];
end

% Extract the homography matrix H from the last column of V using vsd
[U, S, V] = svd(A);
H = reshape(V(:, end), 3,3)';
H = H / H(3, 3);
disp(H);
```

```
    1.0264   -0.0157 -163.5691
    0.0063    1.0334   -4.8516
    0.0000   -0.0000    1.0000
```

```
[V, D] = eig(A' * A);
[~, minEigenvalueIndex] = min(diag(D));
minEigenVector = V(:, minEigenvalueIndex);
H = reshape(minEigenVector, 3, 3)';
H = H / H(3, 3);
disp(H);
```

```
    1.0264   -0.0157 -163.5691
    0.0063    1.0334   -4.8516
    0.0000   -0.0000    1.0000
```

2. implement forward and backward warping using H

```
% Forward warping using the nearest neighbor

[n_rows_src, n_cols_src] = size(rgb2gray(src));
[n_rows_dest, n_cols_dest] = size(rgb2gray(dest));

% Initialize warped img
warpedImgForward = zeros(n_rows_src, n_cols_src);

for x = 1:n_cols_src
    for y= 1:n_rows_src
```

```
            p = [x;y;1];
            p_prime = H * p;
            x_prime = p_prime(1)/p_prime(3);
            y_prime = p_prime(2)/p_prime(3);

            % Check if the new position is out of boundary, if so, continue
            if x_prime<1 || x_prime>n_cols_dest || y_prime<1 || y_prime>n_rows_dest
                continue;
            end
            % Insert src density to warpted img
            warpedImgForward(round(y_prime), round(x_prime)) = src(y, x);
    end
end

imshow(uint8(warpedImgForward));
```

```
% Backward img warping using nearest neighbor or bilinear interpolation

% Initialize warped img
warpedImgBackward = zeros(n_rows_src, n_cols_src);

for x_prime1 = 1: n_cols_dest
    for y_prime1 = 1:n_rows_dest

        p_prime1 = [x_prime1; y_prime1; 1];
        p = H\p_prime1;
```

```
        x1 = p(1)/p(3);
        y1 = p(2)/p(3);

        % Check if the new position is out of boundary, if so, continue
        if x1<1 || x1>n_cols_src || y1<1 || y1>n_rows_src
            continue;
        end

        % Insert src density to warpted img

        % 1. nearest neighbor
        % warpedImgBackward(round(y1), round(x1)) = dest(y_prime1, x_prime1);

        % 2. bilinear
        a = x_prime1 - floor(x_prime1);
        b = y_prime1 - floor(y_prime1);

        I1 = (1-a)*(1-b)*dest(floor(y_prime1), floor(x_prime1));
        I2 = a*(1-b)*dest(floor(y_prime1), ceil(x_prime1));
        I3 = (1-a)*b*dest(ceil(y_prime1), floor(x_prime1));
        I4 = a*b*dest(ceil(y_prime1), ceil(x_prime1));

        I = I1 + I2 + I3 + I4;
        warpedImgBackward(round(y1), round(x1)) = I;
    end
end
imshow(uint8(warpedImgBackward));
```

```
% Use interp2() for backward warping ??

[xi, yi] = meshgrid(1:n_cols_dest, 1:n_rows_dest);
src = rgb2gray(src);
dest = rgb2gray(dest);

H_inv = inv(H);
xx = (H_inv(1,1) * xi + H_inv(1,2) * yi + H_inv(1,3)) ./ (H_inv(3,1) * xi +
H_inv(3,2) * yi + H_inv(3,3));
yy = (H_inv(2,1) * xi + H_inv(2,2) * yi + H_inv(2,3)) ./ (H_inv(3,1) * xi +
H_inv(3,2) * yi + H_inv(3,3));

warped_image = interp2(src, xx, yy);
imshowpair(warped_image, uint8(warped_image), "montage");
```