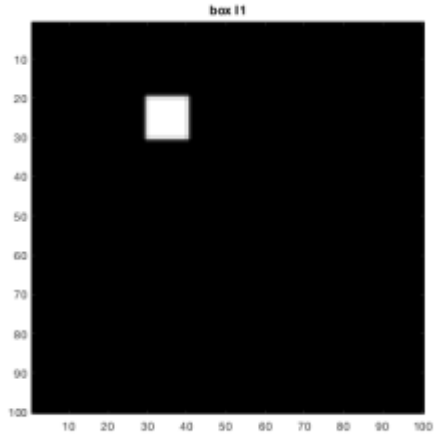
```
%================================ flowme ================================
%
%  script flowme
%
%  This is a script stub that will execute the optical flow solver to be
%  written for this homework.  The script code will not work as is, and
%  must be adjusted.  The dynamic range of the images definitely needs to
%  be adjusted, as may the smoothness of the image data.
%
%
%  Variables in the script:
%    source             - which image sequence source to use.
%    di                 - vector spacing for quiver.
%    scale              - what scale to use for plotting vector field.
%    alphasqHS          - the value of alpha squared for optical flow.
%    iterHS             - the number of iterations in the solver.
%
%================================ flowme ================================

%==(0) Setup variables and get images ready.
close all
load('optflowData.mat');
sources = {'box','bonanza','fish3','fish4'};
for i=1:length(sources)

  source = sources(i);
  source = source{1};
  switch source
  case 'box'
    I1 = imsmooth(box(:,:,1),0.5);
    I2 = imsmooth(box(:,:,3),0.5);
    scale = 1.5;
    alphasqHS = 0.02;
    iterHS = 4000;
    di = 1;
  case 'bonanza'
    I1 = imsmooth(bonanza(:,:,1),2);
    I2 = imsmooth(bonanza(:,:,4),2);
    scale = 2.5;
    alphasqHS = 10;
    iterHS = 100;
    di = 10;
  case 'fish3'
    I1 = imsmooth(fish03(:,:,1),3);
    I2 = imsmooth(fish03(:,:,20),3);
    scale = 2.5;
    alphasqHS = 10;
    iterHS = 100;
    di = 5;
  case 'fish4'
    I1 = imsmooth(fish04(:,:,1),3);
    I2 = imsmooth(fish04(:,:,12),3);
    scale = 2;
    alphasqHS = 10;
    iterHS = 100;
    di = 5;
  end
    %==(1) Actually compute the optical flow.
    [X.u, X.v] = optflowHS(I1, I2, alphasqHS, iterHS);
```

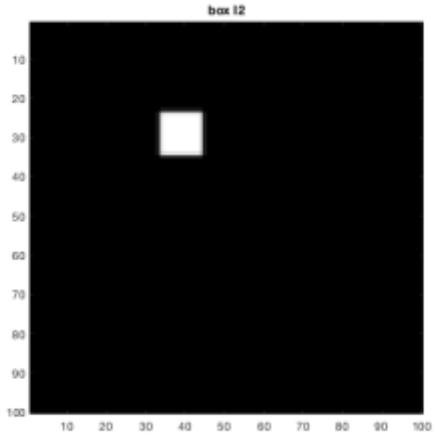
```
    lenX = abs(X.u + i*X.v);
    disp(['The max length optical vector is: ' num2str(max(lenX(:)))]);

    %==(2) Display output of the optical flow.
    j = 8 * (i - 1);
    figure(j + 1);
      imagesc(I1);
      colormap('gray');
      axis image;
      title(strcat(source, ' I1'));
    figure(j + 2);
      imagesc(I2);
      colormap('gray');
      axis image;
      title(strcat(source, ' I2'));
    figure(j + 3);
      imagesc(I2-I1);
      colormap('gray');
      colorbar;
      axis image;
      title(strcat(source, ' I2 - I1'));
    figure(j + 4);
      imagesc(X.u);
      colorbar;
      axis image;
      title(strcat(source, ' u'));
    figure(j + 5);
      imagesc(X.v);
      colorbar;
      axis image;
      title(strcat(source, ' v'));
    figure(j + 6);
      imagesc(I1);
      colormap('gray');
      axis image;
      [M, N] = size(I1);
      subx = [1:di:N];
      suby = [1:di:M];
      [gridx, gridy] = meshgrid(subx, suby);
      hold on;
      quiver(gridx, gridy, X.u(suby,subx),X.v(suby, subx),scale,'Color','r');
      hold off;
      title(strcat(source, ' I1 + Vector Field'));

    intI = optflow_check(I1, I2, X);

    figure(j + 7);
      imagesc(intI);
      colormap('gray');
      axis image;
      title(strcat(source, ' Warped I1'));

    figure(j + 8);
      imagesc(I2 - intI);
      colorbar;
      title(strcat(source, ' Error Between I1 + Velocity and I2'));
end

%============================== optflowHS ==============================
%
```

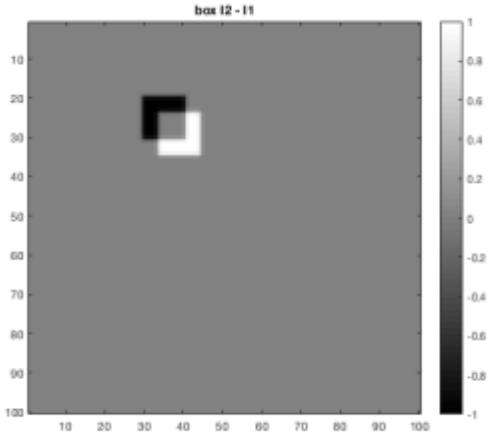
```
%  [Xu, Xv] = optflowHS(I1, I2, alphasq, iter)
%
%
%  Implements the Horn and Schunck optical flow algorithm for determination
%  of optical flow between two images.
%
%  Source:
%    Horn, BKP and Schunck, BG, â€œDetermining Optical Flow,â€?
%      Artificial Intelligence, vol. 17, pp. 185-204, 1981.
%
%  Inputs:
%    I1         -the first image in time.
%    I2         -the second image in time.
%    alphasq    -the parameter alpha^2.
%    iter       -number of Gauss-Siedel iterations.
%
%============================== optflowHS ==============================
function [Xu, Xv] = optflowHS(I1, I2, alphasq, iter)

Xu = zeros(size(I1));                  % This is the initial guess.
Xv = zeros(size(I2));

[Ix, Iy, It] = differentialsHS(I1, I2);

% Missing code here for the constant parts.
k = 1;
denom = (k * alphasq + Ix.^2 + Iy.^2);

for i=1:iter
  barXu = lapAverage(Xu);
  barXv = lapAverage(Xv);

  % Missing code here for iterative solver.
  gradConst = (Ix .* barXu + Iy .* barXv + It);
  Xu = barXu - (gradConst .* Ix)./ denom;
  Xv = barXv - (gradConst .* Iy)./ denom;
end

end

%------------------------- differentialsHS -------------------------
%
% [Ix, Iy, It] = differentialsHS
%
%------------------------- differentialsHS -------------------------
function [Ix, Iy, It] = differentialsHS(I1, I2)

% Missing code here.  Make sure to take care of boundary conditions.

Kt = (1.0/4.0)*[1,1;1,1];
Kx = (1.0/4.0)*[-1,1;-1,1];
Ky = (1.0/4.0)*[-1,-1;1,1];

It = imfilter(I2, Kt) - imfilter(I1, Kt);
Ix = imfilter(I1, Kx) + imfilter(I2, Kx);
Iy = imfilter(I1, Ky) + imfilter(I2, Ky);


end
%----------------------------- lapAverage -----------------------------
%
```

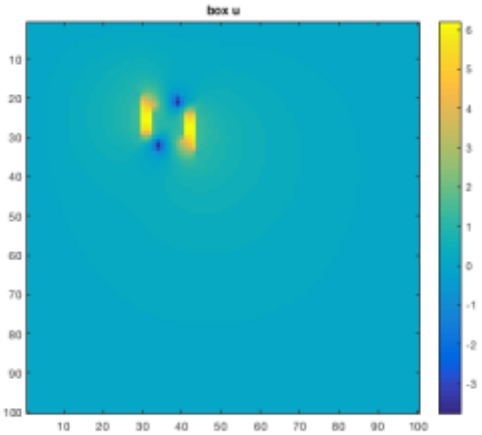
```
% [ubar] = lapAverage(u)
%
%------------------------------ lapAverage -----------------------------
function [ubar] = lapAverage(u)

% Missing code here.  Make sure to take care of boundary conditions.

k = 3;
A = (1/12.0)*[1,2,1;2,0,2;1,2,1];
%lapU = k * u + imfilter(u, k * A);
%ubar = mean(mean(lapU));
ubar = imfilter(u, A);
end
```

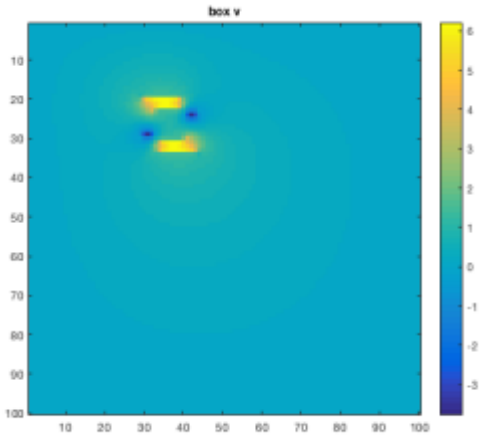
```
The max length optical vector is: 9.1339
The max length optical vector is: 35.5712
The max length optical vector is: 78.3867
The max length optical vector is: 125.093
```

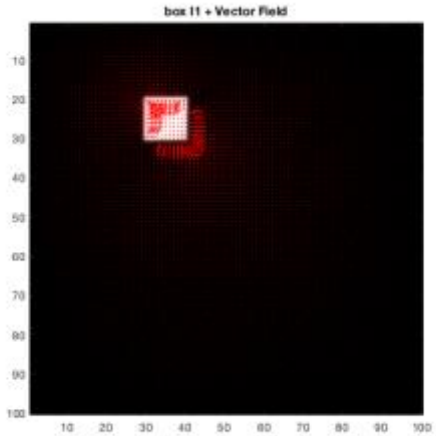

box I1

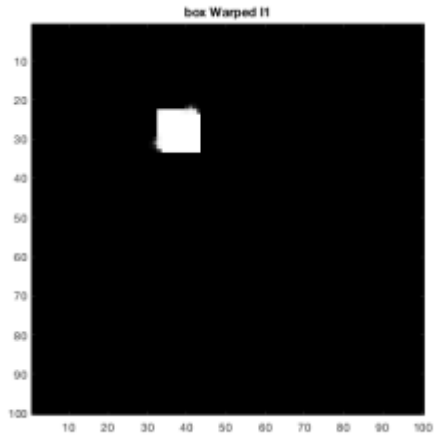

box I2

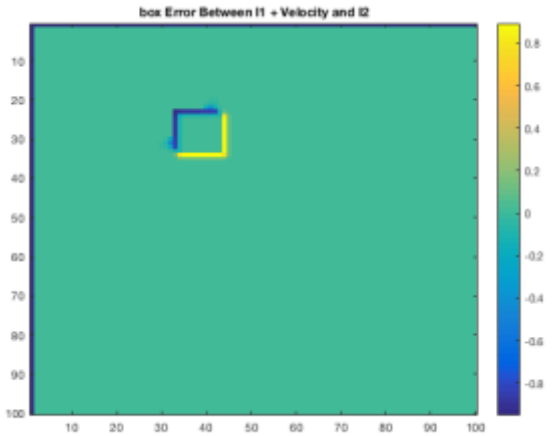

box I2 - I1

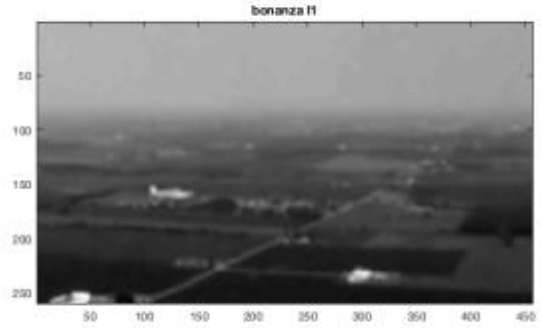

box u

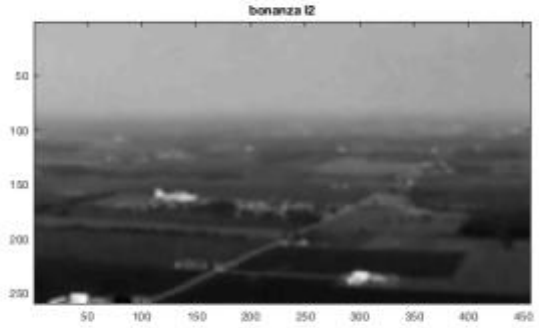

box v

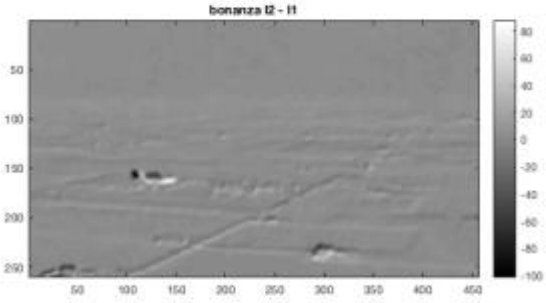

box I1 + Vector Field

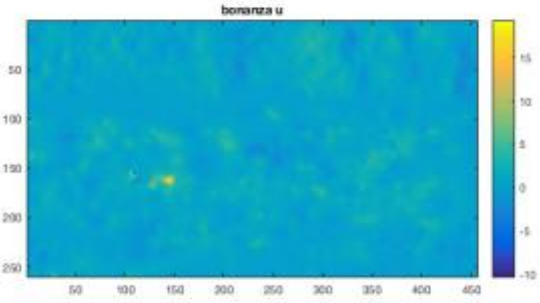

box Warped I1

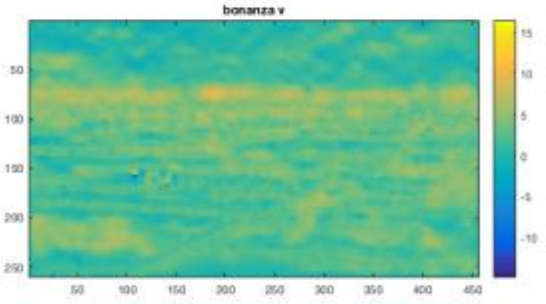

box Error Between I1 + Velocity and I2

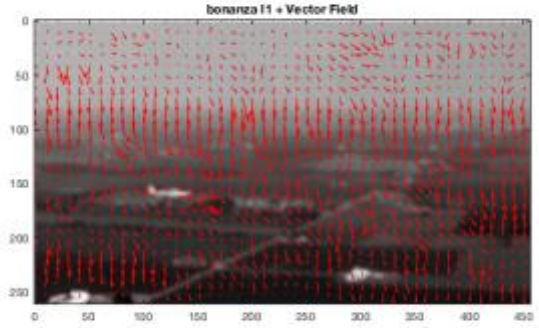

bonanza I1

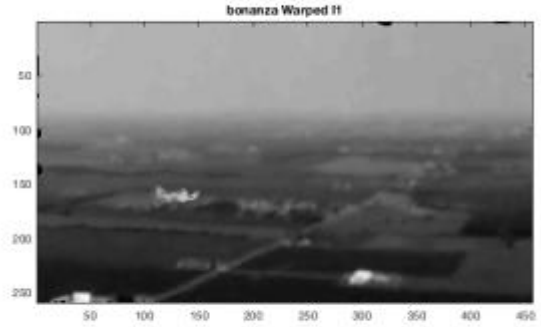

bonanza I2

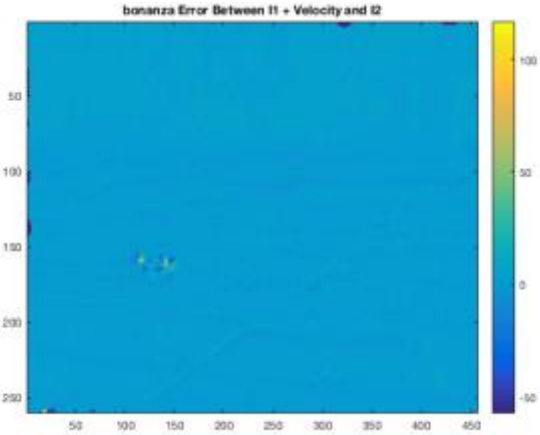

bonanza I2 - I1

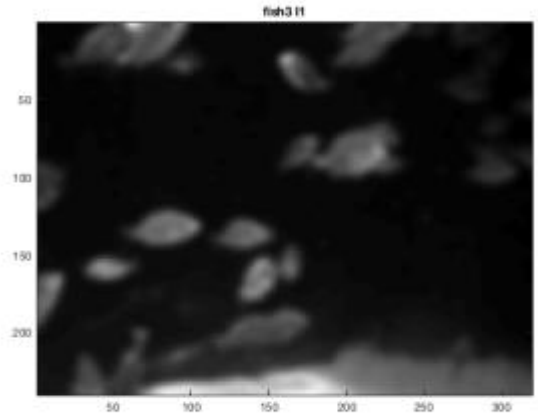

bonanza u

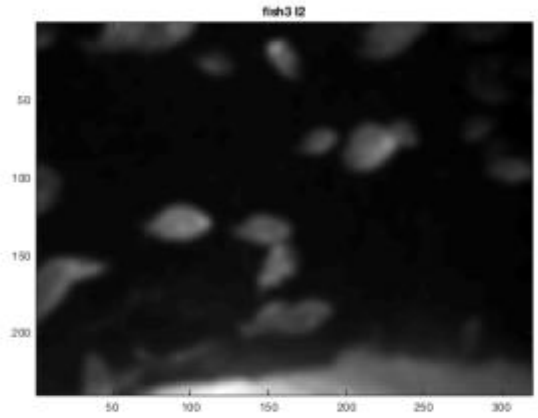

bonanza v

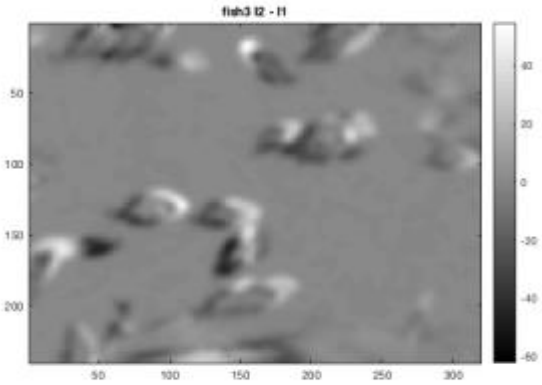

bonanza I1 + Vector Field

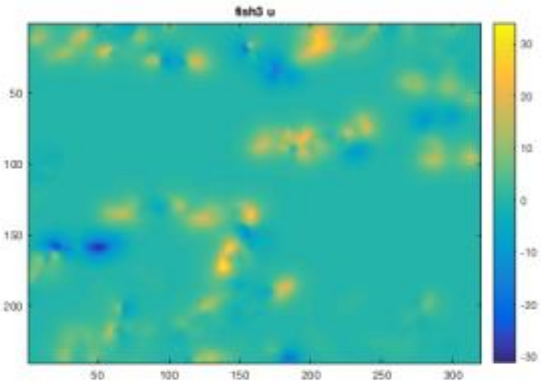

bonanza Warped I1

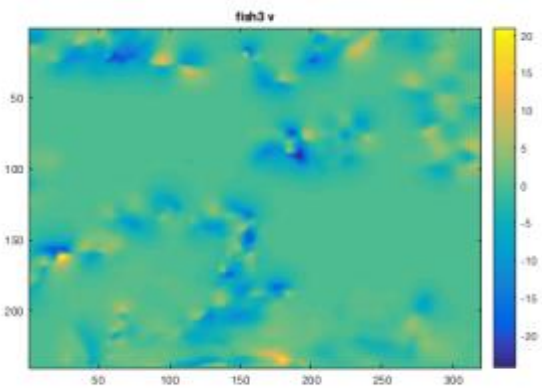

bonanza Error Between I1 + Velocity and I2

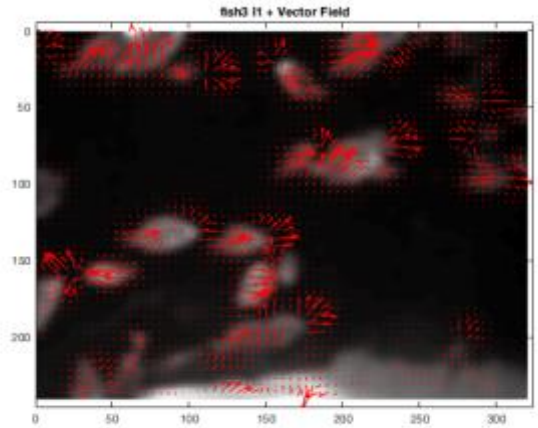

fish3 I1

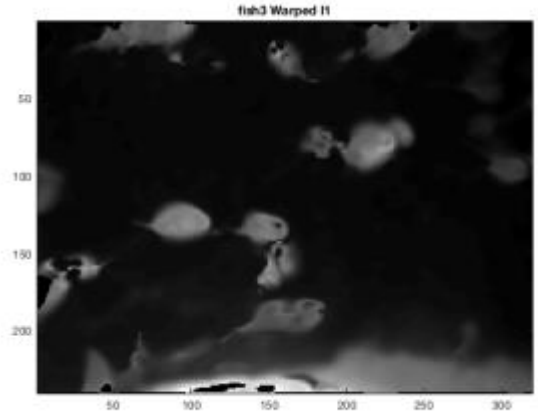

fish3 I2

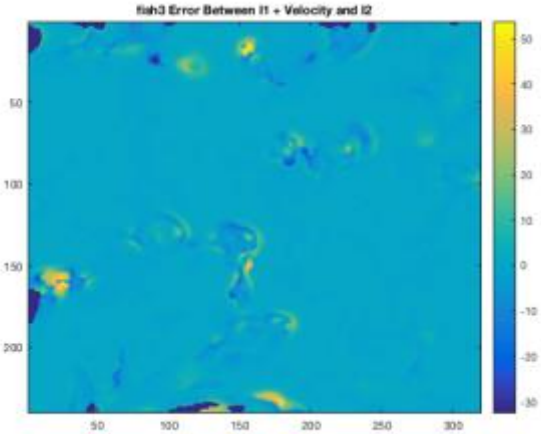

fish3 I2 - I1

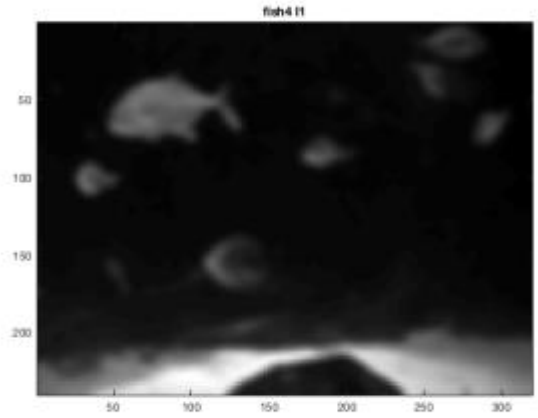

fish3 u

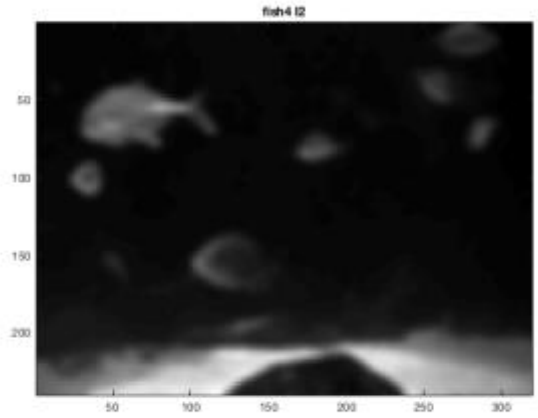

fish3 v

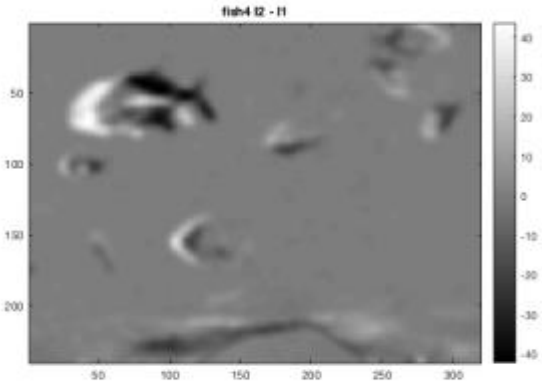

fish3 I1 + Vector Field

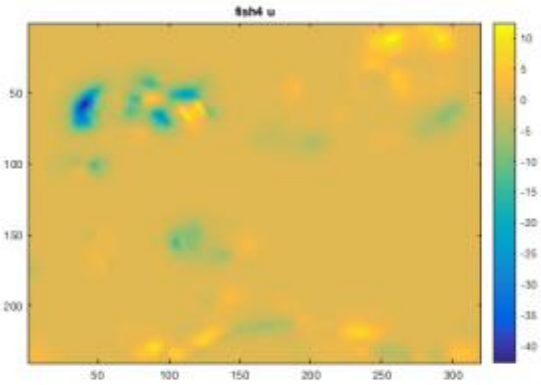

fish3 Warped I1

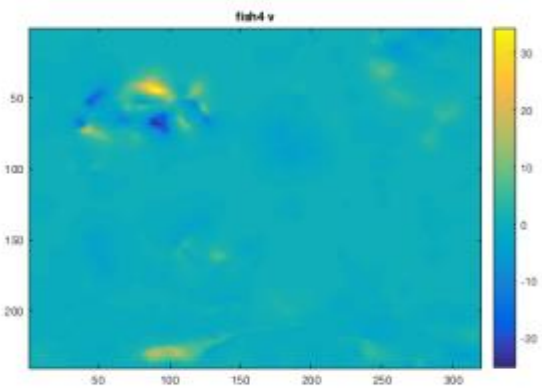

fish3 Error Between I1 + Velocity and I2

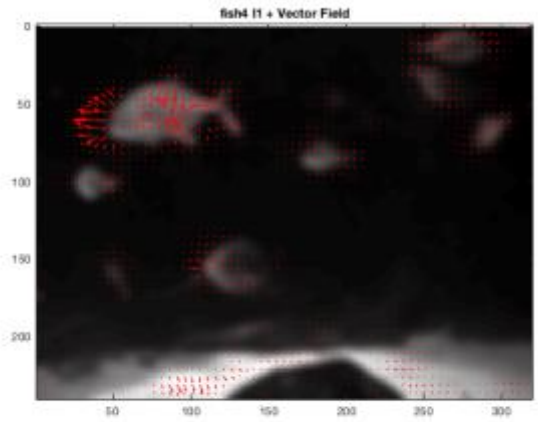

fish4 I1

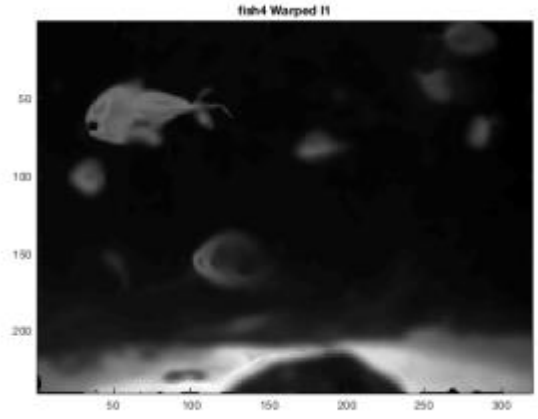

fish4 I2

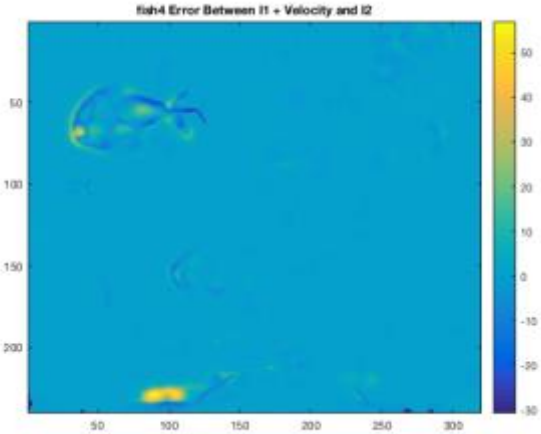

fish4 I2 - I1


fish4 u


fish4 v


fish4 I1 + Vector Field


fish4 Warped I1


fish4 Error Between I1 + Velocity and I2