Week 2

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K-Means Clustering

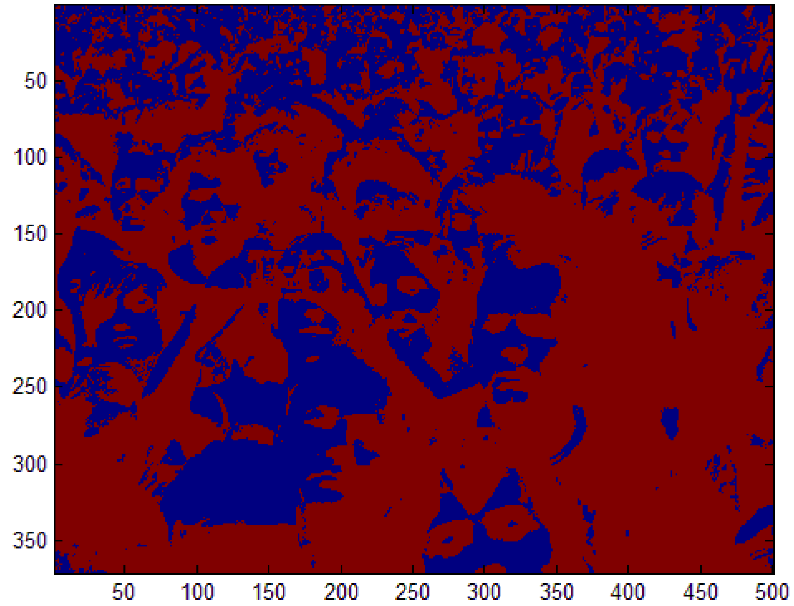
- An algorithm to partition *n* observations into *k* clusters in which each observation belongs to the cluster with the nearest mean.

The Experiment

- Original Image:

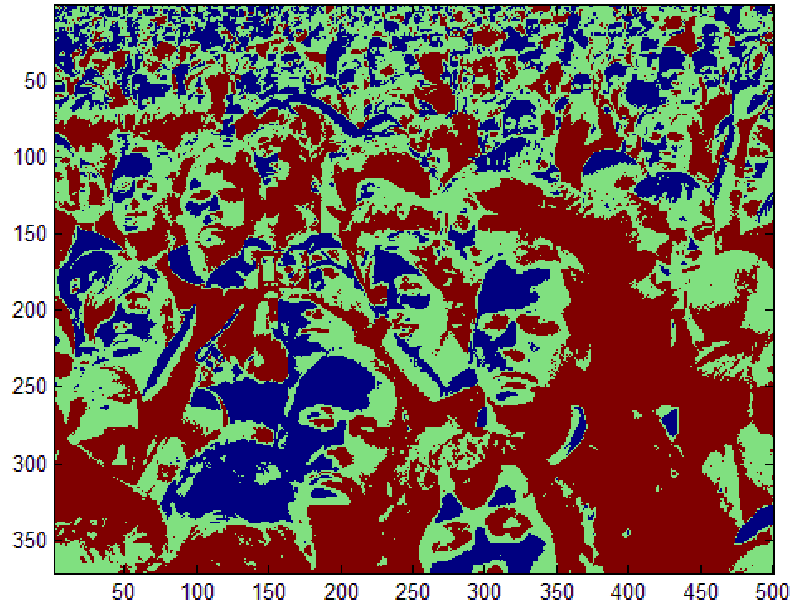
Results

- K = 2:



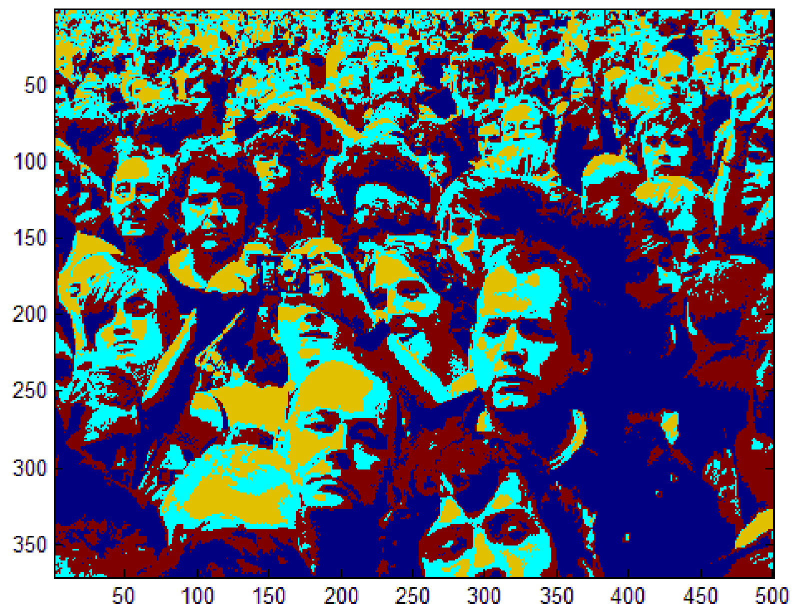
Results

- K = 3:



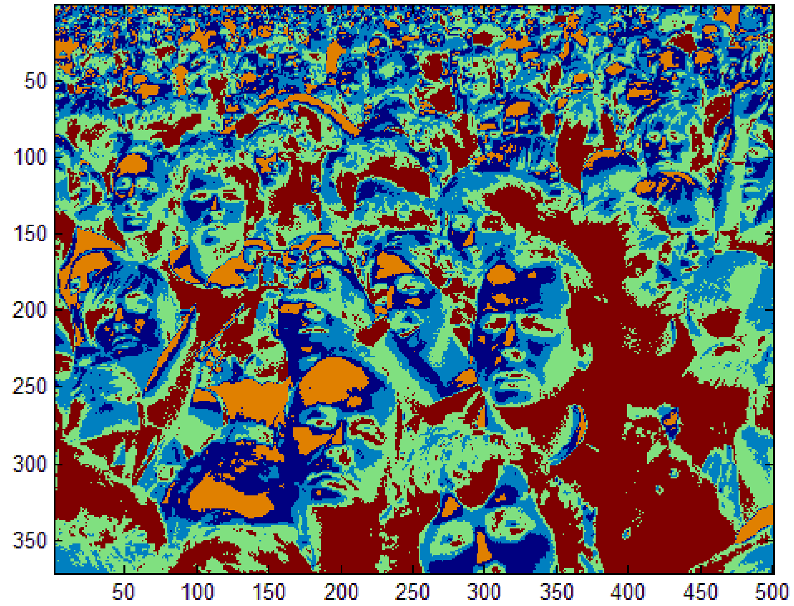
Results

- K = 4:

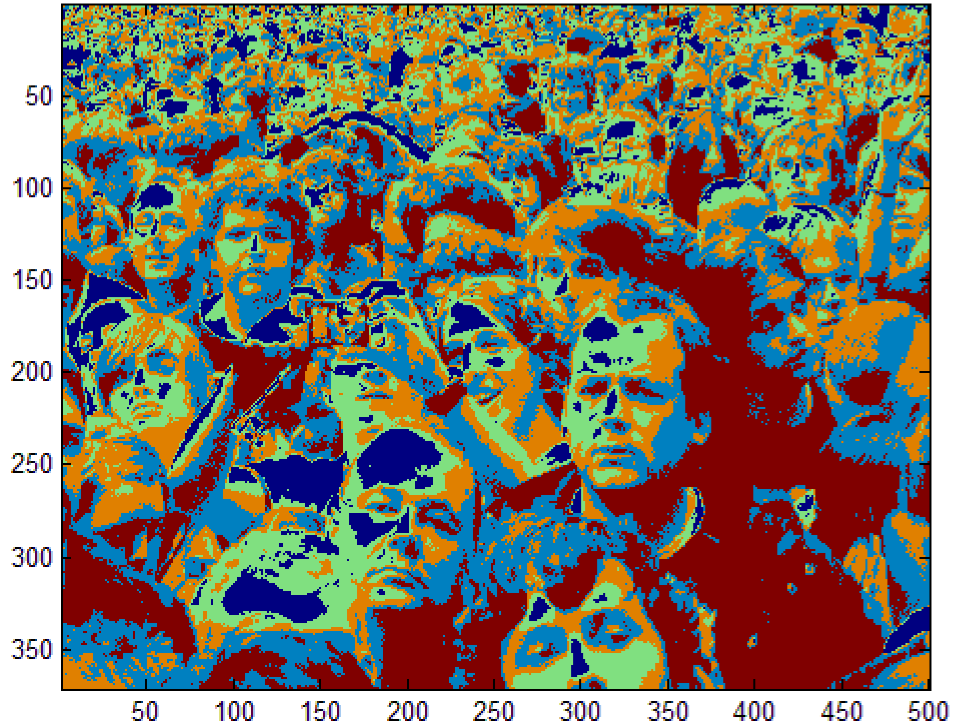


Results

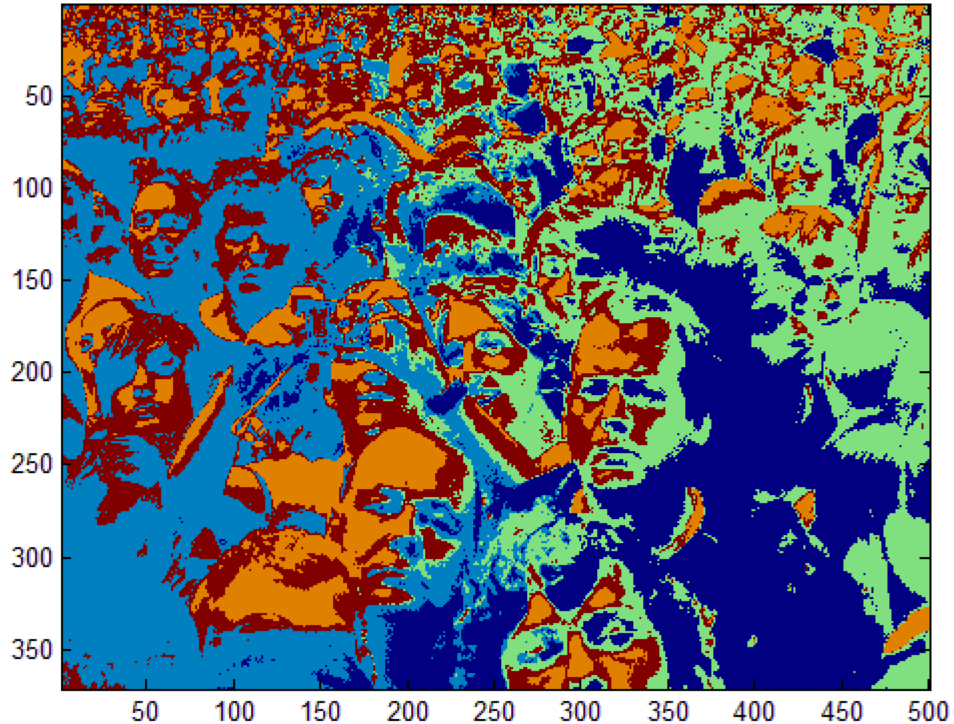
- K = 5:



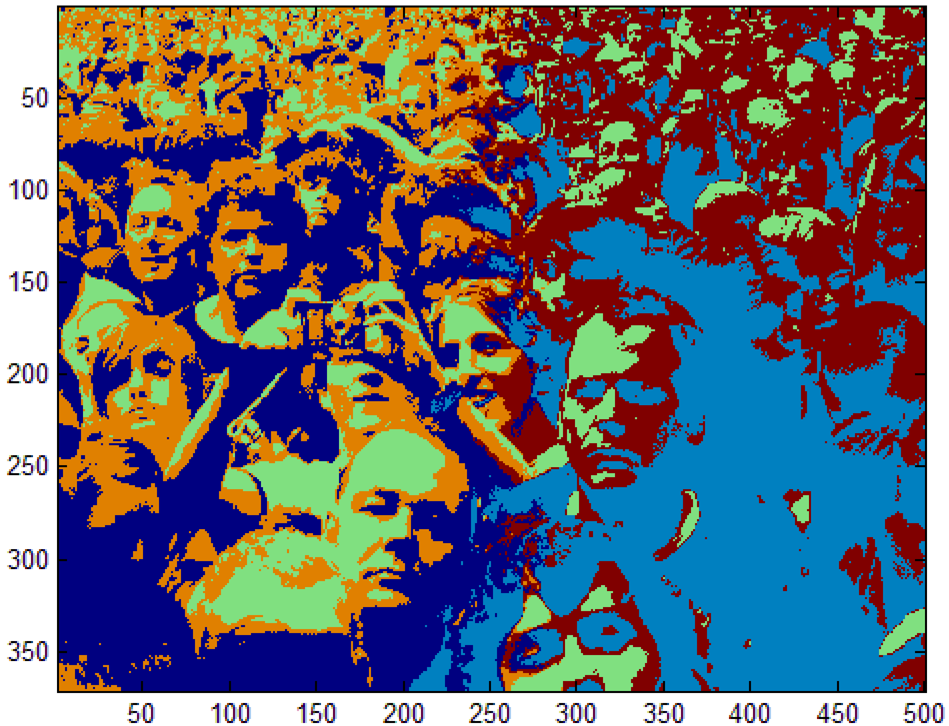
Results



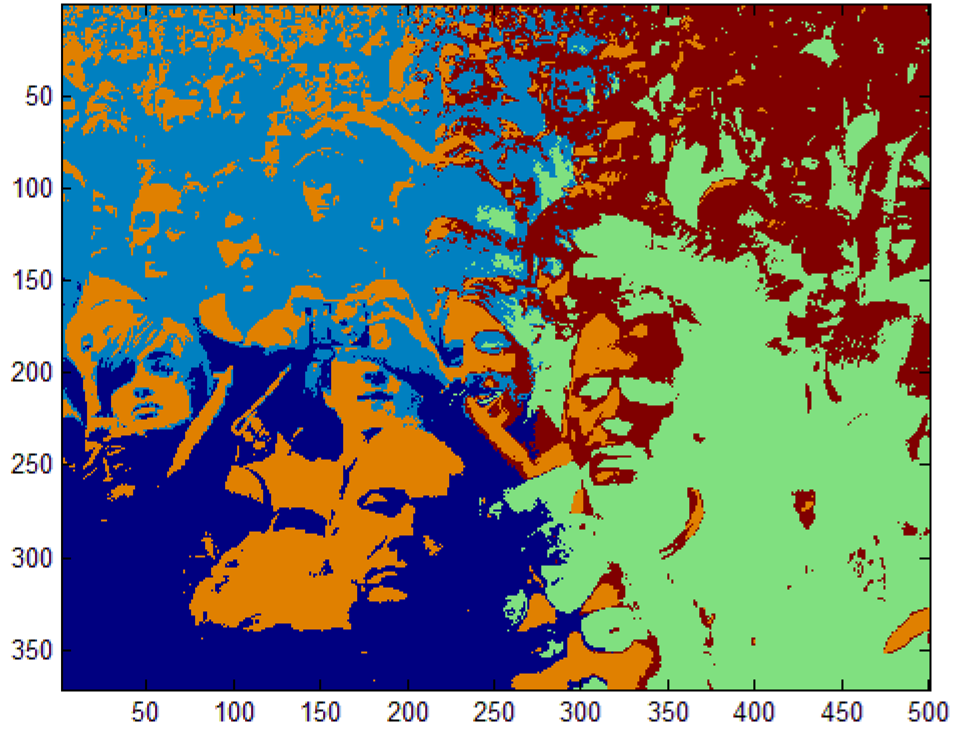
Results



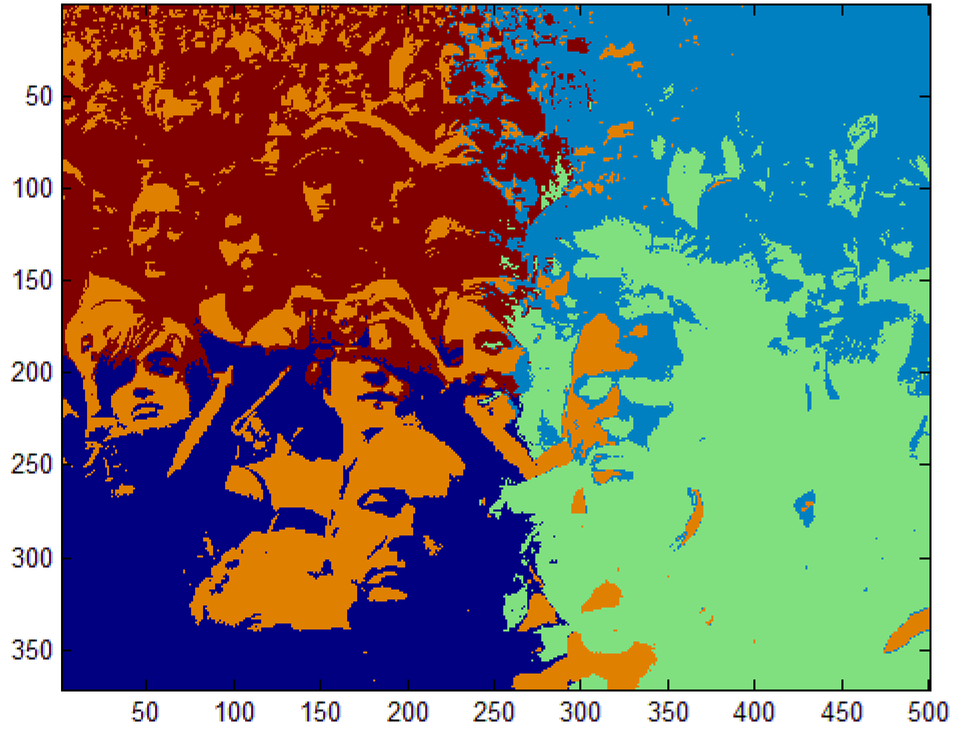
Results



Results



Results



Results

- Including a proximity term can subtly increase performance.
- Choosing a large weight for proximity in the "similarity" function can significantly decrease the quality of the output because the clusters begin to form "blobs."

Optical Flow with Lucas-Kanade

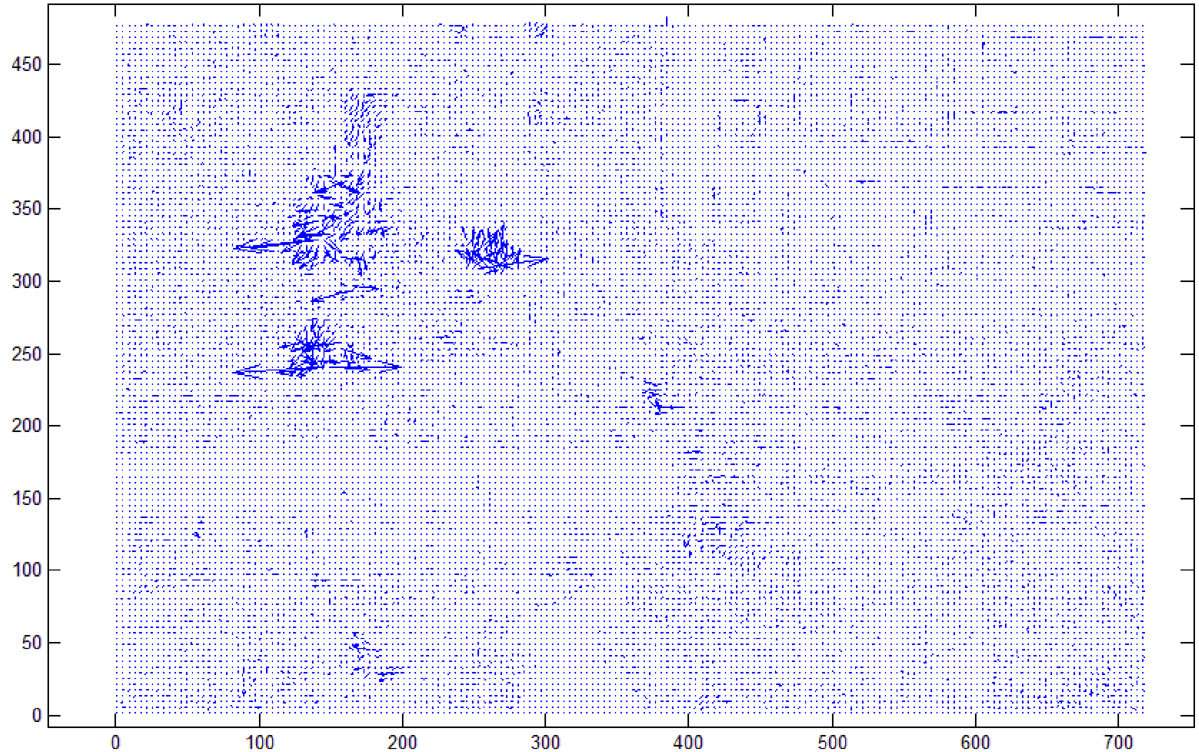
- The ***Lucas-Kanade method*** is a way to estimate optical flow from two successive frames. ***Optical flow*** is the apparent motion of objects between an observer and the scene.

The Experiment

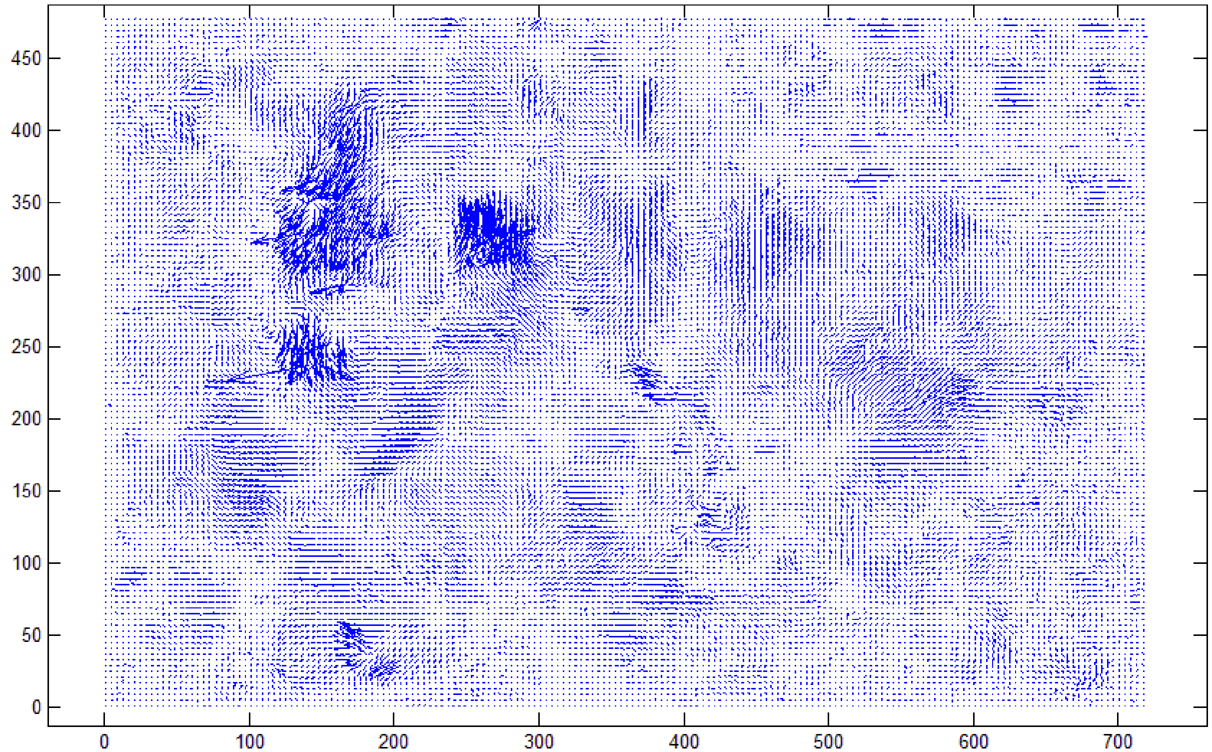
- First Image:

Second Image:

Results



Results



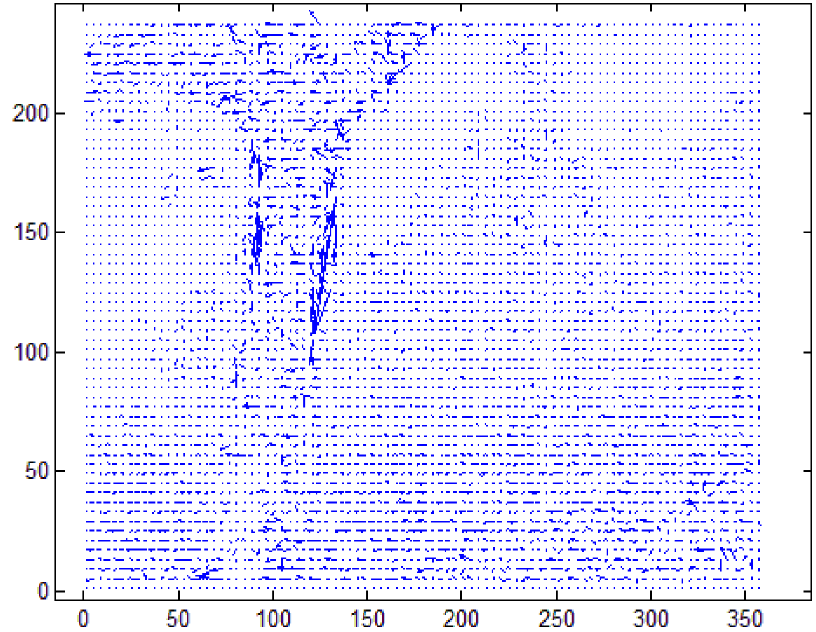
The Experiment

- First Image:

Second Image:

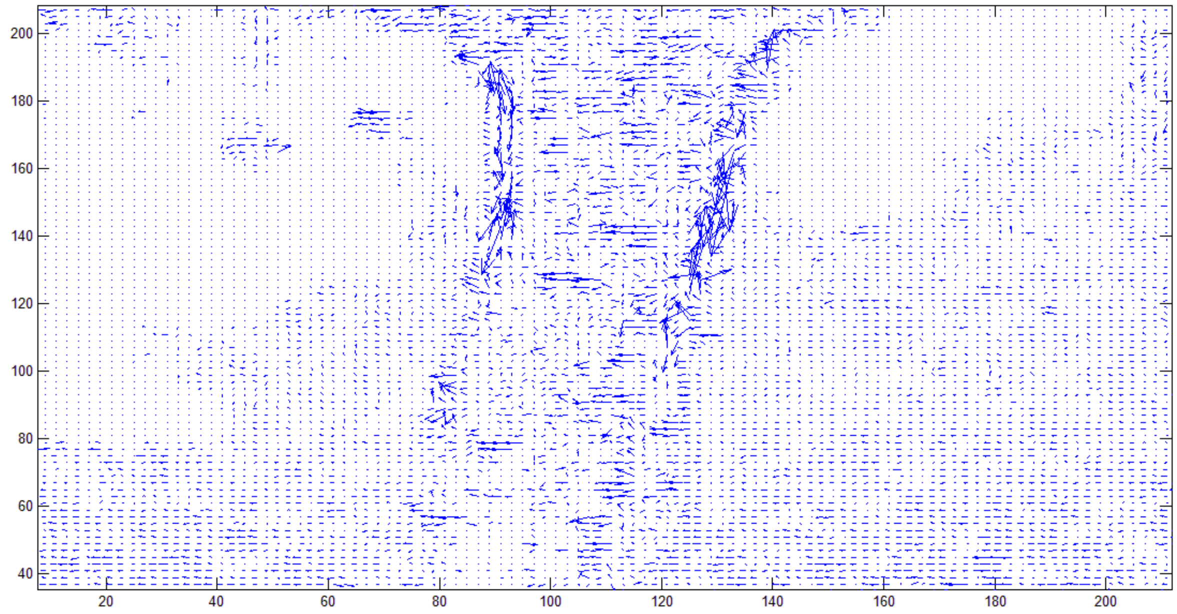
Results

- Without pyramidal refinement:



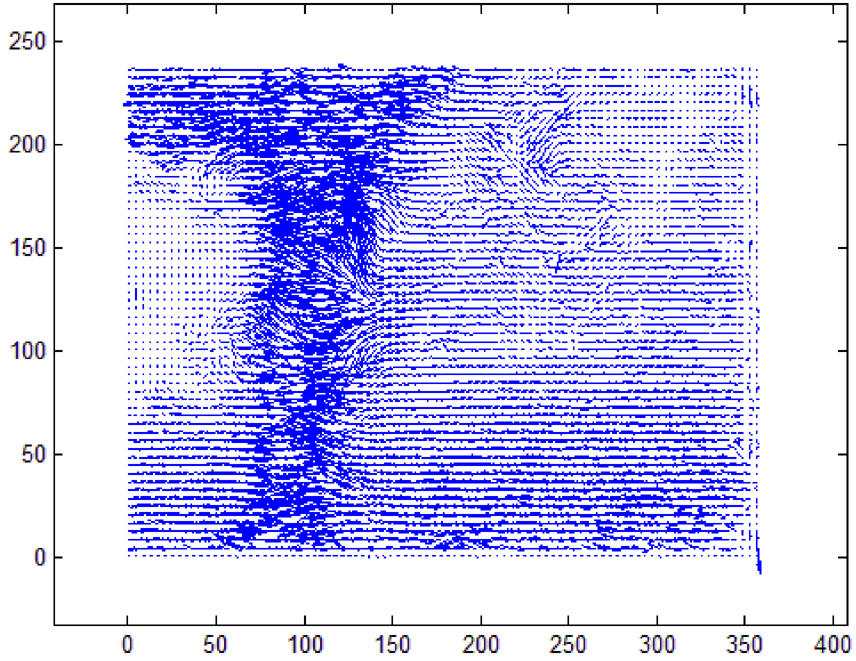
Results

- Without pyramidal refinement:



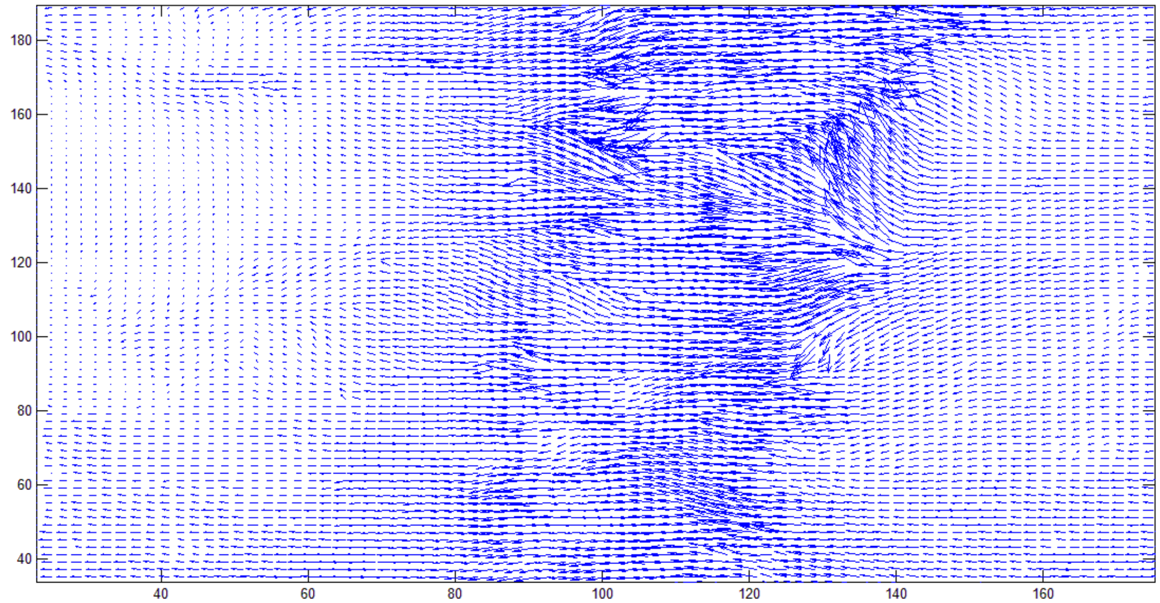
Results

- With pyramidal refinement:



Results

- With pyramidal refinement:



Results

- When a scene contains movement of more than a few pixels, pyramidal refinement dramatically increases accuracy.
- Pyramidal refinement took about 1.5 times longer due to generating the mipmaps of the pyramid and calculating the optical flow of each.

Background Subtraction

- Two methods were used:

1. Computing the background as the median of the intensities of each pixel and rejecting the pixels which were 0.05 away (where intensity ranges from 0 to 1).
2. Modeling the intensity of each pixel as a Gaussian distribution and rejecting the pixels which were not within 2.5 standard deviations of the mean.

Results for Method 1

Original Video

Result of Background Subtraction

Results for Method 2

Original Video

Result of Background Subtraction

Results

- Method 1 (background as median) worked better because the median ignores statistical outliers (i.e. moving foreground objects).
- Method 2 would have likely worked better if a mixture of Gaussians was allowed, rather than a single Gaussian to fit a possibly irregular distribution.
- Both methods used arbitrary thresholds, one in terms of brightness and one in terms of standard deviations. The thresholds were chosen to yield optimal results for both methods.

Research Ideas

- Augmented reality on Android phones.
- Medical image processing to detect tumors, fractures, etc.
- Image and video vectorization, interpolation, and compression.
- Detecting aggressive driving behavior with surveillance cameras.
- Optical character recognition, including mathematical typography.
- Texture recognition (bricks, wood, etc.).
- Aesthetic image scaling.
- High resolution photography from multiple low-resolution cameras.
- Shape/depth from shading and texture (i.e. not stereography).
- Estimating high dynamic range from LDR imagery.
- Remote sensing of river/stream/lake/ocean advection through optical flow methods.