

#ImageLibraries

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Compatibility:

This library package has been written for compatibility with the Mac OS distribution of the Unix OS. Limited compatibility with the linux (Ubuntu) operating system has been tested but is not guaranteed functional. For use with the linux operating please adjust the environment parameters at the top of the makefile to build against the opencv layout of your local system.

Dependencies:

This library requires use of a g++ (or aliased clang) compiler with compatibility with C++11 as well as local installation of opencv2. Opencv2 is used strictly for reading image files into raw pixel buffers and displaying images in windows. Please execute `./dependency.sh` for more information on installing opencv2 to your local system.

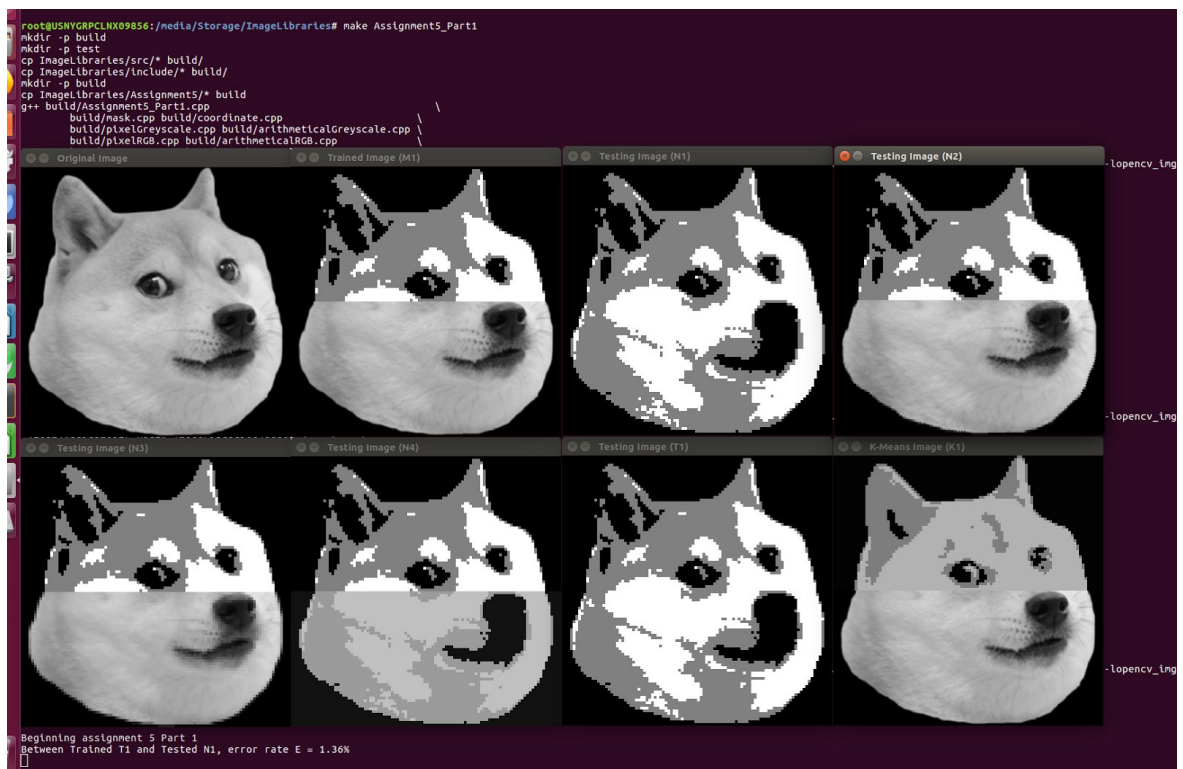
Algorithms & Methods:

Part1:

Algorithms for machine learning are contained within GreyscaleClassification.h, these algorithms will receive a sliced image and will perform training upon the upper half of the image as specified in the assignment specification. In the instance of the k-means algorithm distance is calculated from each candidate data component starting with a set of means = {0, 128, 255}. These will loop 10 times with new means and greyscale intensity levels being displayed upon each loop iteration.

NOTE: The error rate % difference between N1 & T1 will be output to the console during the program execution.

PART 1 Example Execution Images:



Part2:

Algorithms for motion vector estimation may be found within `motionVectorMap.hpp`, the algorithm will iterate over each pixel applying a structuring element to be used to search for candidate pixel matches. The structuring elements used is a circular radii of 7 pixels as this radii guarantees a signed 4-bit x-coordinate offset with a signed 4-bit y-coordinate offset, allowing for each pixel in frame at time T1 to be compressed to a single byte x+y coordinate offset to map from pixel in frame at T0. From here, the theory was to block 8x8 pixel groups for motion vectors, however a valuable heuristic for determining an effective block motion vector from individual pixel motion vectors could not be derived. Each of mean, median, and mode were attempted to group (x,y) offsets however results of each proved dissatisfactory.

At current an 8-bit geographic offset is stored for each pixel with a resultant motion compensated difference calculated and reversed for image quality verification. Motion compensated images appear to remove most information within the pixel motion vector algorithm.

NOTE: The motion vectors of each pixel will be output to the console during program execution with a block printed for each horizontal row of pixels printing their corresponding motion vectors. Given the poor performance of blocked motion vectors it proved impractical to render each motion vector within the image frame, thus they are demonstrated with (x, y) offsets within the terminal.

PART 2 Example Execution Images:

```
1 Image
File Edit View Search Terminal Help
root@GUYGRPCLN09856:/media/Storage/Inagelibraries# make Assignment5_Part2
mkdir -p build
mkdir -p test
cp Inagelibraries/src/* build/
cp Inagelibraries/include/* build/
mkdir -p build
cp Inagelibraries/Assignments/* build
g++ build/Assignment5_Part2.cpp
    build/mask.cpp build/coordinate.cpp
    build/pixelGreyscale.cpp build/arithmeticalGreyscale.cpp
    build/pixelRGB.cpp build/arithmeticalRGB.cpp
    build/pixelHSI.cpp build/arithmeticalHSI.cpp
    -Wall -Wfatal-errors -Werror -std=c++11 -O0 -I/usr/local/cellar/opencv\02/2.4.13.2_2/include/ -L/usr/local/cellar/opencv\02/2.4.13.2_2/lib -lopencv_highgui -lopencv_core -lopencv_imgproc -o
Assignment5_Part2
./test/Assignment5_Part2 Inagelibraries/assets/Pong1.bmp Inagelibraries/assets/Pong2.bmp
./test/Assignment5_Part2 Inagelibraries/assets/Tennis1.bmp Inagelibraries/assets/Tennis2.bmp

Beginning assignment 5 Part 2
InagelRow[0] = {
    (6,3) (5,3) (3,2) (2,1) (3,2) (0,3) (1,2) (5,0) (2,0) (0,0)
    (1,0) (-4,2) (-5,2) (-1,0) (-2,0) (-1,0) (-7,0) (0,0) (0,0) (5,3)
    (1,1) (0,0) (0,1) (-3,1) (2,0) (1,0) (-2,0) (0,4) (0,2)
    (5,2) (6,1) (-3,5) (-5,1) (-6,1) (1,1) (-3,2) (5,0) (-4,0) (6,0)
    (5,0) (4,0) (6,0) (-4,0) (1,0) (2,0) (0,0) (-1,1) (0,0) (2,3)
    (0,0) (-4,2) (0,2) (0,1) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0)
    (0,0) (0,1) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (-4,5) (3,0)
    (0,1) (0,1) (2,0) (1,0) (0,0) (0,0) (0,0) (0,0) (0,1) (7,0)
    (-1,5) (-1,0) (-2,0) (-2,1) (7,0) (5,0) (-3,0) (0,0) (4,0) (-5,0)
    (1,0) (0,0) (0,0) (-2,1) (0,0) (0,0) (0,0) (-1,1) (0,0) (0,0)
    (0,0) (-4,5) (-2,0) (5,0) (-2,5) (-1,0) (-2,0) (-4,0) (1,0) (4,2)
    (3,2) (-1,0) (1,0) (-6,0) (0,0) (-1,0) (0,0) (1,0) (0,4) (0,0)
    (0,2) (0,1) (2,0) (1,0) (0,0) (0,0) (0,0) (0,0) (0,0) (-1,0)
    (0,0) (-3,0) (-5,0) (0,0) (0,0) (0,0) (3,0) (6,1) (5,1) (0,0)
    (0,0) (1,0) (6,2) (5,3) (0,0) (7,0) (0,0) (-2,0) (3,0) (1,0)
    (5,1) (0,0) (-6,0) (0,0) (0,0) (0,0) (1,0) (-6,3) (0,0) (0,0)
    (0,0) (-1,1) (-5,2) (-5,1) (-7,0) (0,0) (1,0) (-1,1) (0,0) (-6,1)
    (-1,0) (1,0) (-1,5) (-2,5) (-3,1) (1,0) (-1,0) (-6,1) (-5,0) (-6,0)
    (2,4) (0,1) (1,2) (0,0) (0,0) (1,0) (6,2) (0,0) (1,0) (-2,6)
    (1,0) (4,1) (1,0) (0,0) (-3,0) (-4,0) (0,0) (0,0) (0,0) (0,0)
    (-3,0) (0,0) (0,0) (0,0) (3,1) (2,2) (1,2) (0,1) (-1,0) (-6,2)
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    (1,0) (-1,6) (-2,6) (-3,0) (1,1) (6,2) (6,0) (6,0) (0,5) (0,5)
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    (-4,4) (-1,1) (0,0) (1,0) (-1,1) (0,1) (-1,1) (-1,0) (1,1) (1,0)
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    (0,1) (0,0) (0,0) (0,0) (-1,0) (-2,1) (0,0) (0,0) (0,0) (-1,1)
    (-1,3) (-3,4) (-1,1) (-2,0) (-3,1) (-4,0) (3,0) (2,0) (1,0) (0,0)
}

InagelRow[1] = {
    (5,1) (4,0) (2,0) (4,1) (0,0) (1,2) (-1,2) (0,1) (3,-1) (-1,-1)
    (-5,-1) (-5,-1) (-7,0) (1,0) (-6,3) (-1,0) (0,-1) (-1,-1) (-1,-1) (6,1)
    (1,0) (1,0) (0,0) (-2,-1) (-4,-1) (-3,1) (-1,1) (-1,-1) (-1,-1) (0,4)
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    (-6,-1) (1,-1) (-6,0) (-7,0) (1,0) (1,0) (0,-1) (-2,-1) (-4,-1) (1,-1)
    (1,1) (-1,-1) (0,1) (0,0) (-1,1) (0,1) (-1,1) (-1,0) (1,1) (1,0)
    (0,0) (-1,0) (0,0) (0,0) (0,0) (2,0) (0,0) (0,0) (6,3) (3,-1)
    (1,0) (-2,-1) (0,0) (1,5) (0,5) (0,0) (0,0) (0,0) (6,-1) (5,1)
    (1,0) (-5,2) (-3,5) (5,0) (4,-1) (6,0) (6,3) (-1,2) (0,0) (1,0)
    (0,0) (0,0) (0,0) (0,0) (1,-1) (0,0) (4,3) (1,0) (0,0) (0,0)
    (0,0) (-1,-1) (0,0) (0,0) (3,0) (2,0) (-2,-1) (1,-1) (4,-1) (1,-1)
    (3,1) (-2,-1) (1,-1) (-5,-1) (0,0) (0,0) (-7,0) (1,3) (-2,1) (0,1)
}

Beginning assignment 5 Part 2
InagelRow[0] = {
    (0,0) (-1,0) (0,0) (0,0) (-2,0) (-3,0) (-2,0) (-3,0) (-6,0) (-7,0)
    (-7,0) (-5,0) (-6,0) (0,0) (-4,2) (1,2) (0,2) (1,0) (1,5) (-1,2)
    (1,5) (7,0) (3,0) (3,0) (2,2) (1,2) (6,0) (5,0) (5,3) (-2,0)
    (6,3) (0,0) (-1,0) (4,4) (3,4) (6,1) (1,1) (1,0) (-1,4) (3,0)
    (-4,1) (1,0) (-5,2) (-5,0) (-5,2) (-5,0) (4,1) (2,0) (2,1) (-6,0)
    (-6,0) (-3,4) (-1,0) (1,0) (1,0) (-3,1) (-2,4) (-5,0) (2,1) (2,1)
    (-4,2) (-5,0) (-6,2) (1,4) (4,0) (-2,5) (-4,4) (-3,2) (1,2) (0,1)
    (-1,0) (-1,1) (-2,1) (0,0) (1,0) (-3,0) (0,1) (0,0) (-2,0) (6,0)
    (3,1) (4,0) (-2,1) (-3,1) (0,0) (1,0) (1,1) (1,1) (-2,2) (7,0)
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    (-4,0) (1,0) (3,0) (3,0) (1,0) (0,0) (-5,0) (-2,3) (5,0) (7,0)
    (-7,0) (-7,0) (2,0) (2,0) (1,0) (0,0) (-1,0) (-2,0) (-3,4) (-4,3)
    (-5,4) (-6,3) (0,7) (-1,2) (-1,0) (1,2) (0,1) (0,3) (-1,1) (0,0)
    (-4,3) (-5,0) (7,0) (1,0) (0,4) (-1,4) (-1,2) (-1,0) (4,0) (4,4)
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    (-3,0) (6,2) (4,0) (5,0) (0,7) (-1,2) (2,3) (-4,1) (0,7) (-6,0)
    (-4,0) (-2,2) (-2,2) (-1,1) (-1,2) (-3,2) (3,6) (-4,0) (-5,0) (2,4)
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    (-4,0) (-2,2) (-2,0) (-2,0) (3,0) (4,0) (3,0) (-2,2) (-4,5) (-4,4)
    (-5,4) (-4,5) (-3,0) (1,2) (0,3) (-1,4) (-1,4) (0,5) (-1,4) (-4,3)
    (1,3) (1,1) (-2,1) (-2,1) (-4,0) (-2,0) (-3,0) (-1,1) (-2,1) (-1,5)
    (2,1) (-2,2) (-4,3) (-3,3) (-2,3) (-3,3) (-4,3) (5,4) (4,5) (-3,0)
    (-5,4) (-5,0) (-6,0) (-7,0) (-7,0) (-7,0) (-7,0) (-2,2) (7,0) (6,0)
    (-4,3) (-5,3) (-2,2) (4,3) (3,4) (1,3) (0,4) (0,4) (-1,4) (-7,0)
}

InagelRow[1] = {
    (0,0) (-1,-1) (0,0) (0,0) (-2,-1) (-3,-1) (0,0) (0,0) (-6,-1) (-6,-1)
    (-4,-1) (-5,-1) (7,0) (0,0) (-4,1) (1,1) (0,1) (1,5) (-7,0) (2,1)
    (1,4) (7,0) (4,-1) (3,-1) (2,0) (1,0) (6,-1) (6,3) (5,2) (-2,-1)
    (6,2) (6,2) (5,4) (4,3) (3,3) (3,-1) (6,-1) (-4,2) (3,5) (2,5)
    (5,0) (2,0) (-1) (-5,-1) (-5,-1) (-5,-1) (2,-1) (2,-1) (-5,-1) (-5,-1)
    (2,-1) (-7,0) (-1,-1) (1,-1) (-2,-1) (-3,0) (-2,3) (-5,-1) (3,0) (2,-1)
    (-4,1) (-5,4) (-6,1) (0,2) (0,0) (-2,4) (-3,4) (3,3) (1,3) (-5,1)
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    (6,1) (6,1) (5,1) (5,0) (4,0) (4,5) (3,5) (1,2) (6,-1) (1,2)
    (-1,1) (2,-1) (6,-1) (-5,-1) (2,1) (2,-1) (2,0) (5,-1) (-5,-1) (3,0)
    (-6,3) (6,-1) (-1,1) (6,3) (-4,-1) (-4,0) (3,0) (1,-1) (0,-1) (-1,5)
    (-2,1) (-4,-1) (0,1) (0,2) (-1,0) (-6,-1) (-1,3) (-6,2) (-5,-1) (-6,0)
}
```

```
1 Image
File Edit View Search Terminal Help
root@GUYGRPCLN09856:/media/Storage/Inagelibraries# make Assignment5_Part2
mkdir -p build
mkdir -p test
cp Inagelibraries/src/* build/
cp Inagelibraries/include/* build/
mkdir -p build
cp Inagelibraries/Assignments/* build
g++ build/Assignment5_Part2.cpp
    build/mask.cpp build/coordinate.cpp
    build/pixelGreyscale.cpp build/arithmeticalGreyscale.cpp
    build/pixelRGB.cpp build/arithmeticalRGB.cpp
    build/pixelHSI.cpp build/arithmeticalHSI.cpp
    -Wall -Wfatal-errors -Werror -std=c++11 -O0 -I/usr/local/cellar/opencv\02/2.4.13.2_2/include/ -L/usr/local/cellar/opencv\02/2.4.13.2_2/lib -lopencv_highgui -lopencv_core -lopencv_imgproc -o
Assignment5_Part2
./test/Assignment5_Part2 Inagelibraries/assets/Pong1.bmp Inagelibraries/assets/Pong2.bmp

Beginning assignment 5 Part 2
InagelRow[0] = {
    (0,0) (-1,0) (0,0) (0,0) (-2,0) (-3,0) (-2,0) (-3,0) (-6,0) (-7,0)
    (-7,0) (-5,0) (-6,0) (0,0) (-4,2) (1,2) (0,2) (1,0) (1,5) (-1,2)
    (1,5) (7,0) (3,0) (3,0) (2,2) (1,2) (6,0) (5,0) (5,3) (-2,0)
    (6,3) (0,0) (-1,0) (4,4) (3,4) (6,1) (1,1) (1,0) (-1,4) (3,0)
    (-4,1) (1,0) (-5,2) (-5,0) (-5,2) (-5,0) (4,1) (2,0) (2,1) (-6,0)
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    (-4,2) (-5,0) (-6,2) (1,4) (4,0) (-2,5) (-4,4) (-3,2) (1,2) (0,1)
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    (3,1) (4,0) (-2,1) (-3,1) (0,0) (1,0) (1,1) (1,1) (-2,2) (7,0)
    (-3,1) (7,0) (6,0) (4,2) (4,1) (3,3) (2,2) (7,0) (2,3) (1,2)
    (0,1) (2,0) (-5,0) (-6,1) (5,3) (2,0) (-4,0) (-4,0) (-7,0) (-5,0)
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    (-6,1) (1,1) (-1,3) (-1,3) (-2,3) (-7,0) (-7,0) (-3,0) (-4,2) (-4,3)
    (-1,0) (-2,3) (1,0) (-5,0) (-6,0) (-4,1) (-6,1) (0,0) (-1,0) (-3,5)
    (6,0) (-7,0) (6,0) (1,0) (0,0) (1,3) (-3,0) (-5,1) (0,0) (-3,1)
    (-4,0) (1,0) (3,0) (3,0) (1,0) (0,0) (-5,0) (-2,3) (5,0) (7,0)
    (-7,0) (-7,0) (2,0) (2,0) (1,0) (0,0) (-1,0) (-2,0) (-3,4) (-4,3)
    (-5,4) (-6,3) (0,7) (-1,2) (-1,0) (1,2) (0,1) (0,3) (-1,1) (0,0)
    (-4,3) (-5,0) (7,0) (1,0) (0,4) (-1,4) (-1,2) (-1,0) (4,0) (4,4)
    (0,7) (0,0) (5,4) (1,5) (-1,5) (3,0) (-1,4) (-2,5) (1,6) (3,6)
    (-3,0) (6,2) (4,0) (5,0) (0,7) (-1,2) (2,3) (-4,1) (0,7) (-6,0)
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    (1,4) (0,4) (0,4) (-1,0) (-1,3) (-2,3) (1,1) (-1,1) (-1,2) (-2,2)
    (-3,2) (-4,2) (-5,2) (-6,2) (-6,2) (6,2) (6,2) (1,1) (6,2) (5,2)
    (3,2) (0,2) (1,2) (1,0) (-2,2) (0,7) (0,7) (-3,2) (-3,2) (-5,2)
    (-4,0) (-2,2) (-2,0) (-2,0) (3,0) (4,0) (3,0) (-2,2) (-4,5) (-4,4)
    (-5,4) (-4,5) (-3,0) (1,2) (0,3) (-1,4) (-1,4) (0,5) (-1,4) (-4,3)
    (1,3) (1,1) (-2,1) (-2,1) (-4,0) (-2,0) (-3,0) (-1,1) (-2,1) (-1,5)
    (2,1) (-2,2) (-4,3) (-3,3) (-2,3) (-3,3) (-4,3) (5,4) (4,5) (-3,0)
    (-5,4) (-5,0) (-6,0) (-7,0) (-7,0) (-7,0) (-7,0) (-2,2) (7,0) (6,0)
    (-4,3) (-5,3) (-2,2) (4,3) (3,4) (1,3) (0,4) (0,4) (-1,4) (-7,0)
}

InagelRow[1] = {
    (0,0) (-1,-1) (0,0) (0,0) (-2,-1) (-3,-1) (0,0) (0,0) (-6,-1) (-6,-1)
    (-4,-1) (-5,-1) (7,0) (0,0) (-4,1) (1,1) (0,1) (1,5) (-7,0) (2,1)
    (1,4) (7,0) (4,-1) (3,-1) (2,0) (1,0) (6,-1) (6,3) (5,2) (-2,-1)
    (6,2) (6,2) (5,4) (4,3) (3,3) (3,-1) (6,-1) (-4,2) (3,5) (2,5)
    (5,0) (2,0) (-1) (-5,-1) (-5,-1) (-5,-1) (2,-1) (2,-1) (-5,-1) (-5,-1)
    (2,-1) (-7,0) (-1,-1) (1,-1) (-2,-1) (-3,0) (-2,3) (-5,-1) (3,0) (2,-1)
    (-4,1) (-5,4) (-6,1) (0,2) (0,0) (-2,4) (-3,4) (3,3) (1,3) (-5,1)
    (1,1) (0,1) (-5,0) (0,1) (-3,-1) (-3,-1) (-5,0) (-4,0) (-2,1) (2,-1)
    (1,-1) (2,0) (-2,0) (1,-1) (-1,0) (0,0) (0,1) (0,0) (3,4) (7,0)
    (6,1) (6,1) (5,1) (5,0) (4,0) (4,5) (3,5) (1,2) (6,-1) (1,2)
    (-1,1) (2,-1) (6,-1) (-5,-1) (2,1) (2,-1) (2,0) (5,-1) (-5,-1) (3,0)
    (-6,3) (6,-1) (-1,1) (6,3) (-4,-1) (-4,0) (3,0) (1,-1) (0,-1) (-1,5)
    (-2,1) (-4,-1) (0,1) (0,2) (-1,0) (-6,-1) (-1,3) (-6,2) (-5,-1) (-6,0)
}
```

Results & Easy Assignment 5 Execution:

To launch assignment 5 please execute "make Assignment5" after resolving any outstanding local dependencies on opencv. Upon executing makefile, programs will be built and launched. Different steps of assignment may be proceeded to by pressing escape key.

Multiple image demonstrations will be presented in simultaneously for each required image step. These will present the resultant processed images with their respective labels placed into the Window label of the OpenCV window. These labels will explain the feature the window implements with respect to the assignment.

The Region of Interest algorithm was not yet fully implemented. As of submission, the program will beginning the preprocessing steps of refining the edges of the HSI model using masking and the sobel operator. The image will be thresholded based upon its histogram data before being converted to binary. The binary image is then used to restore the original image with all edges thoroughly defined. The key steps of this algorithm following preprocessing were not yet implemented.

Execution Screenshots:

Please see the screenshots folder for images demonstrating execution output.

Advanced Assignment 5 Execution:

Please see contents of makefile

Bug Report & Missing features:

Compression of pixel motion vectors by grouping can be substantially improved to yield better than the slightly less than 3:1 compression ratio than the algorithm as presented in part 2 of the assignment.