**Experiments: Results**

Student: Luke Agius

Student Number: 080358084

Table of Contents .

**1.** [**Experiment 1**](#_1._Experiment_1)**4**

**1.0** [**Aim**](#_1.0_Aim)**4**

**1.1** [**Data Set Description**](#_Data_set)**4**

**1.2** [**Experiment timeline**](#_1.2_Project_Planning)**4**

**1.2.1** [General Deadline](#_1.2.1_General_Deadline)**4**

**1.2.2** Pre-Experiment Tasks & Deadline**X**

**1.2.3** [Configuration Tasks & Deadline](#_1.2.2__Stage)**4**

**1.2.4** [Training Tasks & Deadline](#_1.2.3_Stage_2)**5**

**1.2.5** [Testing Tasks & Deadline](#_1.2.4_Stage_3)**5**

**1.2.6** [Post-Experiment Tasks & Deadline](#_1.2.5_Post_Experiment)**5**

**1.3** [**Results**](#_1.3_Results)**5**

**1.3.1** [Batch 1](#_1.3.1_Batch_1)**5**

**1.3.2** [Batch 2](#_1.3.1_Batch_2)**5**

**1.4** [**Conclusion**](#_1.4_Conclusion)**6**

**1.5** [**Going Forward**](#_1.5_Going_Forward)**6**

**2.** [**Experiment 2**](#_1._Experiment_1)**7**

**2.0** [**Aim**](#_Data_set)**7**

**2.1** [**Data Set Description**](#_Data_set)**7**

**2.2** [**Experiment timeline**](#_1.2_Project_Planning)**7**

**2.2.1** [General Deadline](#_2.2.1_General_Deadline)**7**

**2.2.2** [Pre-Experiment Tasks & Deadline](#_2.2.2_Pre-Experiment_Stage)**7**

**2.2.3** [Configuration Tasks & Deadline](#_2.2.3_Stage_1)**7**

**2.2.4** [Training Tasks & Deadline](#_2.2.4_Stage_2)**8**

**2.2.5** [Testing Tasks & Deadline](#_2.2.5_Stage_3)**8**

**2.2.6** [Post-Experiment Tasks & Deadline](#_2.2.6_Post_Experiment)**8**

**2.3** [**Results**](#_2.3_Results)**8**

**2.3.1** [Batch 1](#_2.3.1_Batch_1)**8**

**2.3.2** [Batch 2](#_2.3.2_Batch_2)**9**

**2.3.3** [Batch 3](#_2.3.3_Batch_3)**9**

**2.3.4** [Batch 1](#_1.3.1_Batch_2) with alpha 0.05**9**

**2.3.5** [Batch 1](#_1.3.1_Batch_2) with alpha 0.1**9**

**2.3.6** [Batch 1](#_1.3.1_Batch_2) with alpha 0.2**9**

**2.3.7** [Batch 1](#_1.3.1_Batch_2) with alpha 0.3**10**

**2.4** [**Conclusion**](#_2.4_Conclusion)**10**

**2.5** [**Going Forward**](#_2.5_Going_Forward)**10**

**3.** [**Experiment 3**](#_3._Experiment_3)**12**

**3.1** [Aim](#_3.0_Aim)**12**

**3.1** [**Data Set Description**](#_3.1_Data_set)**12**

**3.2** [**Experiment timeline**](#_3.2_Project_Planning)**12**

**3.2.1** [General Deadline](#_3.2.1_General_Deadline)**12**

**3.2.2** [Pre-Experiment Tasks & Deadline](#_3.2.2_Pre-Experiment_Stage)**12**

**3.2.3** [Configuration Tasks & Deadline](#_3.2.3_Stage_1)**12**

**3.2.4** [Training Tasks & Deadline](#_3.2.4_Stage_2)**13**

**3.2.5** [Testing Tasks & Deadline](#_3.2.5_Stage_3)**13**

**3.2.6** [Post-Experiment Tasks & Deadline](#_3.2.6_Post_Experiment)**13**

**3.3** [**Results**](#_3.3_Results)**13**

**3.3.1** [Batch 1](#_3.3.1_Batch_1)**13**

**3.4** [**Conclusion**](#_3.4_Conclusion)**13**

**3.5** [**Going Forward**](#_3.5_Going_Forward)**14**

**4.** [**Experiment 4**](#_4._Experiment_4)**16**

**4.1** [Aim](#_4.0_Aim)**16**

**4.1** [**Data Set Description**](#_4.1_Data_set)**16**

**4.2** [**Experiment timeline**](#_4.2_Project_Planning)**16**

**4.2.1** [General Deadline](#_4.2.1_General_Deadline)**16**

**4.2.2** [Pre-Experiment Tasks & Deadline](#_4.2.2_Pre-Experiment_Stage)**17**

**4.2.3** [Configuration Tasks & Deadline](#_4.2.3_Stage_1)**17**

**4.2.4** [Training Tasks & Deadline](#_4.2.4_Stage_2)**17**

**4.2.5** [Testing Tasks & Deadline](#_4.2.5_Stage_3)**17**

**4.2.6** [Post-Experiment Tasks & Deadline](#_4.2.6_Post_Experiment)**17**

**4.3** [**Results**](#_4.3_Results)**17**

**4.3.1** [Batch 1](#_4.3.1_Batch_1)**17**

**4.3.2** [Batch 2](#_4.3.2_Batch_2)**18**

**4.3.3** [Batch 3](#_4.3.3_Batch_3)**18**

**4.3.4** [Batch 4](#_4.3.1_Batch_4)**18**

**4.4** [**Conclusion**](#_4.4_Conclusion)**18**

**4.5** [**Going Forward**](#_4.5_Going_Forward)**18**

**5.** [**Experiment 5**](#_5._Experiment_5)**12**

**5.1** [Aim](#_5.0_Aim)**12**

**5.1** [**Data Set Description**](#_5.1_Data_set)**12**

**5.2** [**Experiment timeline**](#_5.2_Project_Planning)**12**

**5.2.1** [General Deadline](#_5.2.1_General_Deadline)**12**

**5.2.2** [Pre-Experiment Tasks & Deadline](#_5.2.2_Pre-Experiment_Stage)**12**

**5.2.3** [Configuration Tasks & Deadline](#_5.2.3_Stage_1)**12**

**5.2.4** [Training Tasks & Deadline](#_5.2.4_Stage_2)**13**

**5.2.5** [Testing Tasks & Deadline](#_5.2.5_Stage_3)**13**

**5.2.6** [Post-Experiment Tasks & Deadline](#_5.2.6_Post_Experiment)**13**

**5.3** [**Results**](#_5.3_Results)**13**

**5.3.1** [sketches25f-level1](#_4.3.1_Batch_1)**13**

**5.3.2** [sketches25f-level2](#_4.3.2_Batch_2)**13**

**5.3.3** [sketches25f-level3](#_4.3.3_Batch_3)**13**

**5.3.4** [sketches25-level1](#_4.3.1_Batch_4)**13**

**5.3.5** [sketches25-level2](#_5.3.5_Batch_5)**13**

**5.3.6** [sketches25-level3](#_5.3.6_Batch_6)**13**

**5.3.7** sketches50f-level1**13**

**5.3.8** sketches50f-level2**13**

**5.3.9** sketches50f-level3**13**

**5.3.10** sketches50-level1**13**

**5.3.11** sketches50-level2**13**

**5.3.12** sketches50-level3**13**

**5.3.13** sketches100f-level1**13**

**5.3.14** sketches100f-level2**13**

**5.3.15** sketches100f-level3**13**

**5.4** [**Conclusion**](#_4.4_Conclusion)**13**

**5.5** [**Going Forward**](#_4.5_Going_Forward)**14**

**6. Experiment 612**

**6.1** [Aim](#_5.0_Aim)**12**

**6.1** [**Data Set Description**](#_5.1_Data_set)**12**

**6.2** [**Experiment timeline**](#_5.2_Project_Planning)**12**

**6.2.1** [General Deadline](#_5.2.1_General_Deadline)**12**

**6.2.2** [Pre-Experiment Tasks & Deadline](#_5.2.2_Pre-Experiment_Stage)**12**

**6.2.3** [Configuration Tasks & Deadline](#_5.2.3_Stage_1)**12**

**6.2.4** [Training Tasks & Deadline](#_5.2.4_Stage_2)**13**

**6.2.5** [Testing Tasks & Deadline](#_5.2.5_Stage_3)**13**

**6.2.6** [Post-Experiment Tasks & Deadline](#_5.2.6_Post_Experiment)**13**

**6.3** [**Results**](#_5.3_Results)**13**

**6.3.1** sketches100-level1**13**

**6.3.2** sketches100-level2**13**

**6.3.3** sketches100-level3**13**

**6.3.4** sketches150f-level1**13**

**6.3.5** sketches150f-level2**13**

**6.3.6** sketches150f-level3**13**

**6.3.7** sketches150-level1**13**

**6.3.8** sketches150-level2**13**

**6.3.9** sketches150-level3**13**

**6.4** [**Conclusion**](#_4.4_Conclusion)**13**

**6.5** [**Going Forward**](#_4.5_Going_Forward)**14**

# 1. Experiment 1

## 1.0 Aim

The aim of experiment 1 is to ensure that the developed code around the COSFIRE filter is functioning and yielding the correct results depending on the datasets and the parameters given.

## 1.1 Data set

|  |  |
| --- | --- |
| Name : | Final Test > Recognition Dataset |
| Link : | <http://mathieu.delalandre.free.fr/projects/sesyd/symbols/isrc2011.html> |

This data set is a final test data set for the 2011 International Symbol Recognition Contest. It is made up of 4 different datasets named Set A, Set B, Set C and finally Set D. Each data set has a different number of model symbols and test symbols in it. Each test data set has also a different level of degradation applied to it. The following are the figures describing the data sets.

|  |  |  |  |
| --- | --- | --- | --- |
| Data Set | No. Of Models | Symbols / Model | Symbol |
| Set A | 50 | 50 | 2500 |
| Set B | 100 | 50 | 5000 |
| Set C | 150 | 50 | 7500 |
| Set D | 36 | 50 | 1800 |

## 1.2 Project Planning Timeline.

|  |
| --- |
| 1.2.1 General Deadline |
| **12/11/2012** |

|  |
| --- |
| 1.2.2 Stage 1 : Configuration Stage Deadline |
| **5/11/2012** |
| **Task Breakdown** |
| * **Task 1** : Configure one COSFIRE filter for each symbol model.   + **Step 1** : Find a way to choose the centre of the symbol image as the point of interest.   + **Step 2** : Increase the number of concentric circles to cover in a way the whole symbol model. This is to be done in the parameters file.   + **Step 3** : After setting the centre of the image as the point of interest and increasing the number of concentric circles, find a way to store the tuples that are outputted from the COSFIRE filter for each image. * **Task 1 Result :** This should result in 50 COSFIRE operators**.** |

|  |
| --- |
| 1.2.3 Stage 2 : Training Stage Deadline |
| **8/11/2012** |
| **Task Breakdown** |
| * **Task 1**: For each symbol model image apply the 50 COSFIRE filters one by one.   + **Step 1**:  Taking the 50 COSFIRE operators which were saved in task 1, find a way to apply them all one by one to each symbol image.   + **Step 2:** Out of the 50 responses for each model image, choose the maximum value for each one. * **Task 1 Result:** In the end every symbol model image is described by a vector of 50 values. |
| 1.2.4 Stage 3 : Testing Stage Deadline |
| **10/11/2012** |
| **Task Breakdown** |
| * **Task 1**: For each testing symbol, we have to apply the 50 COSFIRE filters one by one.   + **Step 1**: For each testing symbol, find a way to apply the 50 COSFIRE filters one by one. This should result in a vector of 50 values as well.   + **Step 2**: By means of K-Nearest Neighbour (KNN) algorithm you then compute the Euclidean distance to every training vector. The symbol name of the testing vector is then the symbol name of the training vector for which the Euclidean distance is minimum. * **Task 2:**   + **Step 1**: Count the number of true positives and false positives. |

|  |
| --- |
| 1.2.5 Post Experiment Deadline |
| **12/11/2012** |
| **Task Breakdown** |
| * **Tasks related to Stage 1**   + **Task 1:** Save operators to file in 2 different files, each corresponding to a specific list of Rho. * **Tasks related to  Stage 2**   + **Task 1:** Save operators output to file in 2 different files, each corresponding to a specific list of Rho.   + **Task 2:** Transpose final result so that we use a row vector (rather than column vector) to represent the responses achieved by 50 COSFIRE operators for each symbol. * **Misc Tasks**   + **Task 1:** Section code into separate Scripts.   + **Task 2 :** Use tic toc commands to measure times of execution |

## 1.3 Results

### 1.3.1 Batch 1

|  |  |
| --- | --- |
| Rho List | [0 4 9 15 22 30 39 49 60 72 85 99 114 130 147 165]; |
| Alpha | 0.1 |
| Data set | Final Test > Recognition Dataset |
| Results | |
| True positives : 25  False positives : 16 | |
| Elapsed Time | 831.622468 seconds. |

### 1.3.1 Batch 2

|  |  |
| --- | --- |
| Rho List | [0:5:165]; |
| Alpha | 0.1 |
| Data set | Final Test > Recognition Dataset |
| Results | |
| True positives : 26  False positives : 15 | |
| Elapsed Time | 1620.702225 seconds. |

## 1.4 Conclusion

Due to time constraints and a lack of computational power on my workstation this first experiment was very selective. In order to ensure that proper classification was achieved only testing images of the same type as the first symbol model image have been run through the configuration, Training and testing phases. The test images were handpicked manually, each with a different type of degradation.

The changes in this experiment were done on RhoList, which is the collection of radiuses for the concentric circles used in the COSFIRE filter. In the first batch the circles have been increased. This did not yield very good results at first. Therefore as a second try, Rho List was once again increased to more. This however did not yield any greater results, which the number of true positives and false positives varying only by one. Also, a significant change to be noticed is that it took twice as much time to compute.

Therefore the result out of this experiment is that beyond a certain amount of concentric circles or in other words more entries in Rho List will result in redundant calculations thus making the computation heavier and longer.

## 1.5 Going Forward

The conclusions / results achieved with these experiments were not satisfactory. A lot of redundant calculations were done with no improvements at all. The next experiment should focus on having less number of concentric circles. Also after a discussion with the tutor it was suggested that the Gaussian blobs in the COSFIRE operator should be reduced so as to reduce further more calculations. This is represented by the alpha parameter in the COSFIRE parameter file. In the next experiment a different data set will be used. A data set with less degradation but more deformation of symbols.

# 2. Experiment 2

## 2.0 Aim

The aim of this experiment was to start altering the parameters of the COSFIRE filter in order to analyse their corresponding output. This experiment is the first in a string which should yield the parameters which are most adequate for the solution we are trying to find for our specific case of classification problem

## Data set

|  |  |
| --- | --- |
| Name : | Sketched Symbols (25) > sketches25f-level 1  Sketched Symbols (25) > sketches25f-level 2  Sketched Symbols (25) > sketches25f-level 3 |
| Link : | <http://mathieu.delalandre.free.fr/projects/sesyd/symbols/sketches.html> |

The dataset is a sub set of a bigger data set found in the link specified above. The ones to be used in this experiment are numbers 01, 02 and 03. Each sub data set contains the model symbols and the test symbols. The model symbols collection contains 17 images while the testing symbols collection contains 1000 images. The test images do not have any degradations applied, instead they are deformed. This deformation increases as the level furthers. Each image also has a corresponding XML file. This file holds the target classification to be achieved. This should be used to determine whether the classification was success full or not. An important thing to note is that these three data sets only contain symbols made up of straight lines and no arcs or circles were introduced since this is a very early database from the whole set.

## 2.2 Project Planning Timeline.

|  |
| --- |
| 2.2.1 General Deadline |
| **18/11/2012** |

|  |
| --- |
| 2.2.2 Pre-Experiment Stage Deadline |
| 16/11/2012 |
| **Task Breakdown** |
| * **Pre-Experiment**(**Deadline :** 16/11/2012)   + **Task 1:** Set deadlines for Experiment 2   + **Task 2:** Download sketched symbols data sets from websites.   + **Task 3:** Optimize Code.     - **Step 1 :**  Optimize Code     - **Step 2 :** Document changes in ever note |

|  |
| --- |
| 2.2.3 Stage 1 :Configuration Stage Deadline |
| 17/11/2012 |
| **Task Breakdown** |
| * **Task 1 :** Use code from experiment 1 to run configuration with less circles   + **Step 1:** Lessen the number of concentric circles Rho List   + **Step 2:** Resize configuration images by.5 to match testing images in the testing stage.   + **Step 3:** Check output operator images so that the collection of Gaussian blobs are covering the entire object |

|  |
| --- |
| 2.2.4 Stage 2 : Training Stage Deadline |
| 17/11/2012 |
| **Task Breakdown** |
| * **Task 1 :** Run Training   + **Step 1 :** Run training stage, same as experiment 1 |

|  |
| --- |
| 2.2.5 Stage 3 : Testing Stage Deadline |
| 18/11/2012 |
| **Task Breakdown** |
| * **Task 1 :** Run testing for sketches25f-level1   + **Step 1 :**Run testing  stage, same as experiment 1 * **Task 2 :** Run testing for sketches25f-level2   + **Step 1 :**Run testing  stage, same as experiment 1 * **Task 3 :** Run testing for sketches25f-level3   + **Step 1 :**Run testing  stage, same as experiment 1 |

|  |
| --- |
| 2.2.6 Post Experiment Deadline |
| 18/11/2012 |
| **Task Breakdown** |
| * **Task 1 :** Results   + **Step 1 :** Copy testing images XML files, and read it from Mat lab to determine number of positives and negatives.   + **Step 2 :** Compile results into a report so that they are sent to George.   + **Step 3 :** Imagesc on matrix to make sure that the diagonal line are the largest values * **Task 2 :** Different parameters   + Re-run dataset 1 with different versions of alpha (0.05,0.1,0.2,0.3) |

## 2.3 Results

### 2.3.1 Batch 1

|  |  |
| --- | --- |
| Rho List | [0 4 15 30 49 72 99 130 165]; |
| Alpha | 0.4 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : **884**  False positives : **116** | |
| Elapsed Time | 11826.102556 seconds. |

### 2.3.2 Batch 2

|  |  |
| --- | --- |
| Rho List | [0 4 15 30 49 72 99 130 165]; |
| Alpha | 0.4 |
| Dataset | sketches25f-level2 |
| Results | |
| True positives : **882**  False positives : **118** | |
| Elapsed Time | 10712.213686 seconds. |

### 2.3.3 Batch 3

|  |  |  |
| --- | --- | --- |
| Rho List | [0 4 15 30 49 72 99 130 165]; | |
| Alpha | 0.4 | |
| Dataset | sketches25f-level3 | |
| Results | | |
| True positives : **875**  False positives : **125** | | |
| Elapsed Time | | 10785.434068 seconds. |

### 2.3.4 Batch 1 with alpha 0.05

|  |  |
| --- | --- |
| Rho List | [0 4 15 30 49 72 99 130 165]; |
| Alpha | 0.05 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : **1000**  False positives : **0** | |
| Elapsed Time | 5754.524771 seconds |

### 2.3.5 Batch 1 with alpha 0.1

|  |  |
| --- | --- |
| Rho List | [0 4 15 30 49 72 99 130 165]; |
| Alpha | 0.1 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : **1000**  False positives : **0** | |
| Time | 6525.518401 seconds |

### 2.3.6 Batch 1 with alpha 0.2

|  |  |
| --- | --- |
| Rho List | [0 4 15 30 49 72 99 130 165]; |
| Alpha | 0.2 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : **947**  False positives :**53** | |
| Time | 8555.841877 |

### 2.3.7 Batch 1 with alpha 0.3

|  |  |
| --- | --- |
| Rho List | [0 4 15 30 49 72 99 130 165]; |
| Alpha | 0.3 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : **951**  False positives : **49** | |
| Time | 9827.567556 seconds. |

## 2.4 Conclusion

This experiment was initiated by first setting the alpha parameter for the COSFIRE filter to 0.4. Also the Rho List was reduced to fewer circles to avoid redundant calculations as specified in the previous experiment. The following diagram shows the COSFIRE operator output for the first symbol model image.

C:\Users\Luke\Documents\My Dropbox\1. Documents Repository\Education\University\5th year\Thesis\Data sets\Symbols Datasets\Sketched Symbols\sketches25f-models\symbol007.tiff C:\Users\Luke\Documents\My Dropbox\1. Documents Repository\Education\University\5th year\Thesis\Code base\Experiment 2\Final Results\Batch1-(Alpha 0.4)\Operators\symbol007.tiff

With these new values for alpha and Rho, the classification was run on the first data set (Batch 1), namely sketches25f-level1. This test run yielded an 88.4% recognition rate. The data sets sketches25f-level2 (Batch 2) and sketches25f-level3 (Batch 3) were also run under the same values for parameters alpha and rho list. They yielded 88.2% and 87.5% recognition rate respectively.

Having seen recognition rates which did not even touch early values of 90s, I have decided to alter the alpha parameter. The choice was done due to the fact that the alpha parameter controls how big the blobs (A Gaussian function) are on the COSFIRE operator. Therefore, in order to do this, the first dataset was re-run again for 3 different parameters of alpha. These values were 0.05, 0.1, 0.2 and 0.3. The following are the COSFIRE operators for each of these new alpha values.

C:\Users\Luke\Documents\My Dropbox\1. Documents Repository\Education\University\5th year\Thesis\Code base\Experiment 2\Final Results\Batch1-(Alpha 0.05)\Operators\symbol007.tiff C:\Users\Luke\Documents\My Dropbox\1. Documents Repository\Education\University\5th year\Thesis\Code base\Experiment 2\Final Results\Batch1-(Alpha 0.1)\Operators\symbol007.tiff C:\Users\Luke\Documents\My Dropbox\1. Documents Repository\Education\University\5th year\Thesis\Code base\Experiment 2\Final Results\Batch1-(Alpha 0.2)\Operators\symbol007.tiff C:\Users\Luke\Documents\My Dropbox\1. Documents Repository\Education\University\5th year\Thesis\Code base\Experiment 2\Final Results\Batch1-(Alpha 0.3)\Operators\symbol007.tiff

Alpha = 0.05 Alpha = 0.1 Alpha = 0.2 Alpha = 0.3

As one can see, the blobs get larger the more the alpha values increase. This time the results were more promising. The following is a roundup of the recognition rates achieved on the first data set with the different values of alpha.

|  |  |
| --- | --- |
| Alpha Value | Recognition Rate |
| 0.05 | 100% |
| 0.1 | 100% |
| 0.2 | 94.7% |
| 0.3 | 95.1% |
| 0.4 | 88.4% |

As one can see from this table is that for this data set Alpha value of 0.05 and 0.1 were the most adequate. The more the alpha values were increased, therefore increasing the Gaussian blob, the higher the fail rate.

## 2.5 Going Forward

Since lowering the number of concentric circles (Rho List) and the value of alpha has yielded such good results with less elapsed time, the next experiment should test (as a safe measure) how the filter would react if the parameters for the Gaussian function would be set to 0. Therefore making the filter more rigid and therefore not letting a lot of tolerance when detecting lines.

Besides this suggested experiment, another experiment should also take place, this time testing the filter with even less concentric circles (Rho List) but all the while clamping the alpha value to either 0.05 or 0.1. 0.05 would be most ideal since it reduces the number of calculations even more.

# 3. Experiment 3

## 3.0 Aim

The aim of this experiment is to play around with the filter rigidity or in other words tolerance in the it’s Gaussian function. The parameters for the Gaussian blobs, namely alpha and sigma0 will be set to 0. This represents a tolerance of 0 in the filter and thus, it will try to find something which resembles the prototype very much.

## 3.1 Data set

|  |  |
| --- | --- |
| Name : | Sketched Symbols (25) > sketches25f-level 1 |
| Link : | <http://mathieu.delalandre.free.fr/projects/sesyd/symbols/sketches.html> |

The dataset is a sub set of a bigger data set found in the link specified above. The ones to be used in this experiment are numbers 01, 02 and 03. Each sub data set contains the model symbols and the test symbols. The model symbols collection contains 17 images while the testing symbols collection contains 1000 images. The test images do not have any degradations applied, instead they are deformed. This deformation increases as the level furthers. Each image also has a corresponding XML file. This file holds the target classification to be achieved. This should be used to determine whether the classification was success full or not. An important thing to note is that these three data sets only contain symbols made up of straight lines and no arcs or circles were introduced since this is a very early database from the whole set.

## 3.2 Project Planning Timeline.

|  |
| --- |
| 3.2.1 General Deadline |
| **22/11/2012** |

|  |
| --- |
| 3.2.2 Pre-Experiment Stage Deadline |
| **22/11/2012** |
| **Task Breakdown** |
| * **Pre-Experiment**   + **Task 1 :** Setting parameters for rigidity     - **Step 1 :** Set alpha to 0     - **Step 2 :** Set Sigma0 to 0 |

|  |
| --- |
| 3.2.3 Stage 1 :Configuration Stage Deadline |
| **22/11/2012** |
| **Task Breakdown** |
| * **Stage 1 :**Configuration   + **Task 1 :** Run configuration |

|  |
| --- |
| 3.2.4 Stage 2 : Training Stage Deadline |
| **22/11/2012** |
| **Task Breakdown** |
| * **Stage 2 :** Training   + **Task 1 :** Run Training |

|  |
| --- |
| 3.2.5 Stage 3 : Testing Stage Deadline |
| **22/11/2012** |
| **Task Breakdown** |
| * **Stage 3 :** Testing   + **Task 1 :** Run testing |

|  |
| --- |
| 3.2.6 Post Experiment Deadline |
| **22/11/2012** |
| **Task Breakdown** |
| * **Post Experiment Tasks**   + **Task 1 :** Report results     - **Step 1 :** Include Results, Conclusions etc in the Results report |

## 3.3 Results

### 3.3.1 Batch 1

|  |  |
| --- | --- |
| Rho List | [0 4 15 30 49 72 99 130 165]; |
| Alpha | 0 |
| Sigma0 | 0 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : 807  False positives : 193 | |
| Time | 4298.750194 seconds. |

## 3.4 Conclusion

With this experiment I have tested the filter’s parameters for rigidity. The Gaussian blobs in the operators were too small to allow variances from the prototype. The following are two operator outputs which show the “No Tolerance“fact we have just mentioned. In other words, no blob is equal to no tolerance in the image recognition. In fact the number of false positives is higher. Due to the fact that the dataset used has little variance from the model images, this has resulted in some tests being passed but the majority failed.

C:\Users\Luke\Documents\My Dropbox\1. Documents Repository\Education\University\5th year\Thesis\Code base\Experiment 3\Intermediate Results\Batch 1\COSFIRE Operators\symbol007.tiff C:\Users\Luke\Documents\My Dropbox\1. Documents Repository\Education\University\5th year\Thesis\Code base\Experiment 3\Intermediate Results\Batch 1\COSFIRE Operators\symbol008.tiff

Symbol007.tiff Symbol008.tiff

## 3.5 Going Forward

In this experiment two properties, namely alpha and sigma0, of the filter have been tested. This will give a general idea of how those two parameters work, and will prove useful in the following experiments. In the next experiment the number of concentric circles is going to be reduced. This will be done to cross check the results yielded from reducing Rho list against the results in experiment 2, where we have yielded 100% recognition rate with alpha values 0.05 and 0.1

# 4. Experiment 4

## 4.0 Aim

The aim for this experiment was to find, more or less, the most optimal Rho List. That is the number of concentric circles in the configuration stage. By shortening this list, the number of calculations is reduced resulting in a speedier process. Various combinations will be tried. The selection of the rho list in this experiment follows no particular set of rules. The circles were evenly spaced out so that the whole symbol can be covered with the filter.

## 4.1 Data set

|  |  |
| --- | --- |
| Name : | Sketched Symbols (25) > sketches25f-level 1 |
| Link : | <http://mathieu.delalandre.free.fr/projects/sesyd/symbols/sketches.html> |

The dataset is a sub set of a bigger data set found in the link specified above. The ones to be used in this experiment are numbers 01, 02 and 03. Each sub data set contains the model symbols and the test symbols. The model symbols collection contains 17 images while the testing symbols collection contains 1000 images. The test images do not have any degradations applied, instead they are deformed. This deformation increases as the level furthers. Each image also has a corresponding XML file. This file holds the target classification to be achieved. This should be used to determine whether the classification was success full or not. An important thing to note is that these three data sets only contain symbols made up of straight lines and no arcs or circles were introduced since this is a very early database from the whole set.

## 4.2 Project Planning Timeline.

|  |
| --- |
| 4.2.1 General Deadline |
| **23/11/2012** |

|  |
| --- |
| 4.2.2 Pre-Experiment Stage Deadline |
| 23/11/2012 |
| **Task Breakdown** |
| * **Pre-Experiment**   + **Task 1 :** Setting Rho List to have fewer concentric circles     - **Step 1 :**Omit radius from the list     - **Step 2 :** Re-set alpha to previous value     - **Step 3:** Re-set sigma0 to previous value |

|  |
| --- |
| 4.2.3 Stage 1 :Configuration Stage Deadline |
| 23/11/2012 |
| **Task Breakdown** |
| * **Stage 1 :**Configuration   + **Task 1 :** Run Configuration |

|  |
| --- |
| 4.2.4 Stage 2 : Training Stage Deadline |
| 23/11/2012 |
| **Task Breakdown** |
| * **Stage 2 :** Training   + **Task 1 :** Run Training |

|  |
| --- |
| 4.2.5 Stage 3 : Testing Stage Deadline |
| 23/11/2012 |
| **Task Breakdown** |
| * **Stage 3 :** Testing (**Deadline :** 23/11/2012)   + **Task 1 :** Run Testing |

|  |
| --- |
| 4.2.6 Post Experiment Deadline |
| 23/11/2012 |
| **Task Breakdown** |
| * **Post Experiment Tasks**(**Deadline :** 23/11/2012)   + **Task 1 :** Report results     - **Step 1 :** Include Results, Conclusions etc in the Results report   + **Task 2 :** Report any changes     - **Step 1 :** Include code changes etc to the specifications report |

## 4.3 Results

### 4.3.1 Batch 1

|  |  |
| --- | --- |
| Rho List | [0 15 49 99 165] |
| Alpha | 0.05 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : 1000  False positives : 0 | |
| Time | 4342.535324 seconds. |

### 

### 4.3.2 Batch 2

|  |  |
| --- | --- |
| Rho List | [15 49 99 165] |
| Alpha | 0.05 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : 1000  False positives : 0 | |
| Time | 4367.247536 seconds. |

### 4.3.3 Batch 3

|  |  |
| --- | --- |
| Rho List | [0 15 99 165]; |
| Alpha | 0.05 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : 960  False positives : 40 | |
| Time | 3892.137795 seconds. |

### 4.3.1 Batch 4

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : 1000  False positives : 0 | |
| Time | 3620.767969 seconds. |

## 4.4 Conclusion

By trimming down rho list, the time in which the classification is done has been dramatically decreased. Starting with 11826 seconds from experiment 2, where a first full data set was tested with all three stages included, to 3620 seconds. In other words, a threefold increase in speed.

## 4.5 Going Forward

When trying out rho list with just few elements or a certain collections of radii, the filter was giving out errors. These errors should be investigated in order to be ironed out and maybe increase the filter’s speed even more. This should be done in the pre-experiment stage of the next experiment, experiment5. Furthermore, the next experiment should also run the other datasets through the classification process with this new set of parameters. The results should be very good like in the last few experiments and obviously faster.

# 5. Experiment 5

## 5.0 Aim

The aim for this experiment is to process all the datasets available with the results achieved in experiment 4. This will be done with the new values for alpha, the size of the Gaussian blurs, and Rho list, the number of concentric circles in the configuration stage. This will also determine if the new found rholist is optimal for all the datasets.

## 5.1 Data set

|  |  |
| --- | --- |
| Name : | Sketched Symbols (25) > sketches25f-level 1  Sketched Symbols (25) > sketches25f-level 2  Sketched Symbols (25) > sketches25f-level 3  Sketched Symbols (25) > sketches25-level 1  Sketched Symbols (25) > sketches25-level 2  Sketched Symbols (25) > sketches25-level 3  Sketched Symbols(50) > sketches50f-level1  Sketched Symbols(50) > sketches50f-level2  Sketched Symbols(50) > sketches50f-level3  Sketched Symbols(50) > sketches50-level1  Sketched Symbols(50) > sketches50-level2  Sketched Symbols(50) > sketches50-level3  Sketched Symbols(50) > sketches100f-level1  Sketched Symbols(50) > sketches100f-level2  Sketched Symbols(50) > sketches100f-level3  ~~Sketched Symbols(50) > sketches100-level1~~  ~~Sketched Symbols(50) > sketches100-level2~~  ~~Sketched Symbols(50) > sketches100-level3~~ |
| Link : | <http://mathieu.delalandre.free.fr/projects/sesyd/symbols/sketches.html> |

The dataset is a sub set of a bigger data set found in the link specified above. The ones to be used in this experiment are numbers 01, 02 and 03. Each sub data set contains the model symbols and the test symbols. The model symbols collection contains 17 images while the testing symbols collection contains 1000 images. The test images do not have any degradations applied, instead they are deformed. This deformation increases as the level furthers. Each image also has a corresponding XML file. This file holds the target classification to be achieved. This should be used to determine whether the classification was success full or not. An important thing to note is that these three data sets only contain symbols made up of straight lines and no arcs or circles were introduced since this is a very early database from the whole set.

## 5.2 Project Planning Timeline.

|  |
| --- |
| 5.2.1 General Deadline |
| **01/12/2012** |

|  |
| --- |
| 5.2.2 Pre-Experiment Stage Deadline |
| 23/11/2012 |
| **Task Breakdown** |
| * **Pre-Experiment**   + **Task 0:** Investigate errors when giving out different sets of rho lists.   + **Task1:** Set parameters according to best combinations from the previous experiments   + **Task 2:** Tend to new code changes like exporting of Jpegs.   + **Task 3:** Saving result to text file.   + **Task 4:**  Port rhoList viewer to MATLAB.   + **Task 5:**  Modify script as to run multiple datasets in one run. |

|  |
| --- |
| 5.2.3 Stage 1 :Configuration Stage Deadline |
| 24/11/2012 |
| **Task Breakdown** |
| * **Stage 1 :**Configuration   + **Task 1:** Run Configuration, all datasets |

|  |
| --- |
| 5.2.4 Stage 2 : Training Stage Deadline |
| 24/11/2012 |
| **Task Breakdown** |
| * **Stage 2 :** Training   + **Task 1:** Run Training. all datasets |

|  |
| --- |
| 5.2.5 Stage 3: Testing Stage Deadline |
| 01/12/2012 |
| **Task Breakdown** |
| * **Stage 3 :** Testing (**Deadline :** 26/11/2012)   + **Task 1 :** Run Testing, all datasets |

|  |
| --- |
| 5.2.6 Post Experiment Deadline |
| 01/12/2012 |
| **Task Breakdown** |
| * **Post Experiment Tasks**   + **Task 1 :** Report results     - **Step 1 :** Include Results, Conclusions etc in the Results report   + **Task 2 :** Report any changes     - **Step 1 :** Include code changes etc to the specifications report |

## 5.3 Results

### 5.3.1 Batch 1

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches25f-level1 |
| Results | |
| True positives : **1000**  False positives : **0** | |
| Time | 01:00:15 |

### 5.3.2 Batch 2

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches25f-level2 |
| Results | |
| True positives : **999**  False positives : **1** | |
| Time | 00:59:54 |

### 5.3.3 Batch 3

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches25f-level3 |
| Results | |
| True positives : **995**  False positives : **5** | |
| Time | 01:00:09 |

### 5.3.4 Batch 4

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches25-level1 |
| Results | |
| True positives : **1000**  False positives : **0** | |
| Time | 01:50:18 |

### 5.3.5 Batch 5

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches25-level2 |
| Results | |
| True positives : **1000**  False positives : **0** | |
| Time | 01:50:25 |

### 

### 5.3.6 Batch 6

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches25-level3 |
| Results | |
| True positives : **997**  False positives : **3** | |
| Time | 01:50:38 |

### 5.3.7 Batch 7

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | Sketches50f-level1 |
| Results | |
| True positives : 1000  False positives : 0 | |
| Time | 01:44:00 |

### 5.3.8 Batch 8

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | Sketches50f-level2 |
| Results | |
| True positives : 997  False positives : 3 | |
| Time | 01:44:46 |

### 5.3.9 Batch 9

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | Sketches50f-level3 |
| Results | |
| True positives : 989  False positives : 11 | |
| Time | 01:45:26 |

### 5.3.10 Batch 10

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches50-level1 |
| Results | |
| True positives : 1000  False positives : 0 | |
| Time | 04:14:39 |

### 5.3.11 Batch 11

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches50-level2 |
| Results | |
| True positives : 999  False positives : 1 | |
| Time | 04:23:18 |

### 5.3.12 Batch 12

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches50-level3 |
| Results | |
| True positives : 992  False positives : 8 | |
| Time | 04:21:04 |

### 5.3.13 Batch 13

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches100f-level1 |
| Results | |
| True positives : 1000  False positives : 0 | |
| Time | 04:01:40 |

### 5.3.14 Batch 14

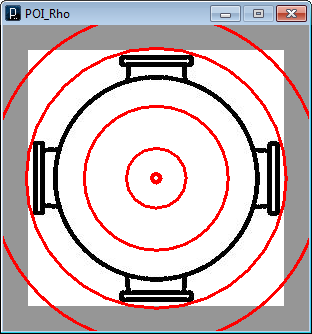
|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches100f-level2 |
| Results | |
| True positives : 996  False positives : 4 | |
| Time | 04:25:37 |

### 5.3.15 Batch 15

|  |  |
| --- | --- |
| Rho List | [4 30 72 130 165]; |
| Alpha | 0.05 |
| Data set | sketches100f-level3 |
| Results | |
| True positives : 991  False positives : 9 | |
| Time | 04:03:17 |

## 5.4 Conclusion

The recognition rates achieved are quite satisfactory. None go below the 98.9% mark. The 0.05 alpha along with the new list of concentric circles did help over all. However, it is possible to achieve a 100% in each just by careful placement of the concentric circles. The processing of all datasets has stopped during the dataset sketches100-level1 due to the concentric circles not hitting the edges of the model symbol correctly. The following is an example of the model image which halted the testing process.



As one can see the concentric circles did not hit the symbol model image correctly, thus resulting in no tuples for this model and therefore no operator for it to be compared with the test images. This shows that the chosen list of rho circles is not optimal for all the images in this dataset.

## 5.5 Going Forward

A plan of action is to be devised in order to get a good overall list of concentric circles to maximize the recognition rates in those tests. An application should be written that checks all these symbol model images against a certain list of concentric circles to ensure that at least each symbol model image has 4 tuples in the operator.

# 6. Experiment 6

## 6.0 Aim

The aim for this experiment is to process all the datasets available with the results achieved in experiment 4 and with indications for enhancements in experiment 5. This will be done with the new values for alpha, the size of the Gaussian blurs, and Rho list, the number of concentric circles in the configuration stage. This will also determine if the new found rholist is optimal for all the datasets.

## 6.1 Data set

|  |  |
| --- | --- |
| Name : | Sketched Symbols(100) > sketches100-level1  Sketched Symbols(100) > sketches100-level2  Sketched Symbols(100) > sketches100-level3  Sketched Symbols(150) > sketches150f-level1  Sketched Symbols(150) > sketches150f-level2  Sketched Symbols(150) > sketches150f-level3  Sketched Symbols(150) > sketches150-level1  Sketched Symbols(150) > sketches150-level2  Sketched Symbols(150) > sketches150-level3 |
| Link : | <http://mathieu.delalandre.free.fr/projects/sesyd/symbols/sketches.html> |

The dataset is a sub set of a bigger data set found in the link specified above. The ones to be used in this experiment are numbers 01, 02 and 03. Each sub data set contains the model symbols and the test symbols. The model symbols collection contains 17 images while the testing symbols collection contains 1000 images. The test images do not have any degradations applied, instead they are deformed. This deformation increases as the level furthers. Each image also has a corresponding XML file. This file holds the target classification to be achieved. This should be used to determine whether the classification was success full or not. An important thing to note is that these three data sets only contain symbols made up of straight lines and no arcs or circles were introduced since this is a very early database from the whole set.

## 6.2 Project Planning Timeline.

|  |
| --- |
| 6.2.1 General Deadline |
| **12/12/2012** |

|  |
| --- |
| 6.2.2 Pre-Experiment Stage Deadline |
| 06/12/2012 |
| **Task Breakdown** |
| * **Task 1 :** Make note of the changes done with George to lighten the process of configuration, (removing redundant tuples). * **Task 2:** Write program which checks the rho list against each model image. Making sure that each model image has at least 4 tuples in it's operators. Mention this as pre-processing.   + Note : Include it in the configuration stage, once a configuration has no more than a pre-defined number of tuples break experiment. * **Task 3:** Email Delalandre regarding the datasets. |

|  |
| --- |
| 6.2.3 Stage 1 : Configuration Stage Deadline |
| **07/12/2012** |
| **Task Breakdown** |
| * **Task 1:** Run the configuration |

|  |
| --- |
| 6.2.4 Stage 2 : Training Stage Deadline |
| **07/12/2012** |
| **Task Breakdown** |
| * **Task 1 :** Run Training. all datasets |
| 6.2.5 Stage 3 : Testing Stage Deadline |
| **12/12/2012** |
| **Task Breakdown** |
| * **Task 1 :** Run Testing, all datasets |

|  |
| --- |
| 6.2.6 Post Experiment Deadline |
| 13/12/2012 |
| **Task Breakdown** |
| * **Task 1 :** Report results   + **Step 1 :**Include Results, Conclusions etc in the Results report * **Task 2 :** Report any changes   + **Step 1 :** Include code changes etc to the specifications report |

## 6.3 Results

### 6.3.1 Batch 1

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches100-level1 |
| Results | |
| True positives : 1000  False positives : 0 | |
| Elapsed Time | - |

### 6.3.2 Batch 2

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches100-level2 |
| Results | |
| True positives : 999  False positives : 1 | |
| Elapsed Time | - |

### 6.3.3 Batch 3

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches100-level3 |
| Results | |
| True positives : 992  False positives : 8 | |
| Elapsed Time | - |

### 6.3.4 Batch 4

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches150f-level1 |
| Results | |
| True positives : 985  False positives : 15 | |
| Elapsed Time | - |

### 6.3.5 Batch 5

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches150f-level2 |
| Results | |
| True positives : 986  False positives : 14 | |
| Elapsed Time | - |

### 6.3.6 Batch 6

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches150f-level3 |
| Results | |
| True positives :  False positives : | |
| Elapsed Time | - |

### 6.3.7 Batch 7

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches150-level1 |
| Results | |
| True positives : 997  False positives : 3 | |
| Elapsed Time | - |

### 6.3.8 Batch 8

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches150-level2 |
| Results | |
| True positives : 994  False positives : 6 | |
| Elapsed Time | - |

### 6.3.9 Batch 9

|  |  |
| --- | --- |
| Rho List | [4 30 72 120 165] |
| Alpha | 0.05 |
| Data set | sketches150-level3 |
| Results | |
| True positives : 983  False positives : 17 | |
| Elapsed Time | - |

## 6.4 Conclusion

The rhoList in this experiment has been slightly changed due to the problem which was introduced the previous experiment (experiment 5). A matlab script was created which cross checks the selected rho list against all the model images. This way we have a way of knowing whether any operators are to be yielded from a specific model image. Upon doing so and ensuring that this test is passed, all the data sets were configured, trained and tested. The classification suffered the lowest results so far with the lowest result being that of 98.5%. However with this said, a better rho list can be found which would optimise the recognition.

## 6.5 Going Forward

So far all the data sets have been run. The next experiment should focus on achieving better results on the already run data sets by taking a different approach in acquiring the features for every symbol model image. This will be done by setting two points of interest within the symbol model image in order to extract more features and therefore tuples.