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Automatic detection of white areas in dermoscopy images

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Department:

AUTOMATIC DETECTION OF WHITE AREAS IN DERMOSCOPY IMAGES

By

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ABSTRACT

This thesis presents an algorithm for automatically segmenting the white areas in dermoscopy images. The algorithm includes preprocessing of images, plotting the histogram (RGB) and calculating the average and standard deviation values (RGB) of the lesion. A threshold value for each color plane is determined using these parameters and white areas are automatically segmented. Various image features such as decile percentages and globule features are extracted and given to a neural network. The proposed algorithm has produced a maximum diagnostic accuracy of 94.67% and, when the lesions which touch the image border are removed from the set, the diagnostic accuracy is 96.17% using Receiver Operating Characteristic curve analysis. The code is implemented in MATLAB® 7.4.0.287 (R2007a).

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1. INTRODUCTION

Malignant melanoma is the most serious type of skin cancer. It begins in skin cells called melanocytes. Melanocytes are the cells that make melanin, which gives skin its color. Melanin also protects the deeper layers of the skin from the sun's harmful ultraviolet (UV) rays. When people spend time in the sunlight, the melanocytes make more melanin and cause the skin to tan. This also happens when skin is exposed to other forms of ultraviolet light. If the skin receives too much ultraviolet light, the melanocytes may begin to grow abnormally and become cancerous. This condition is called malignant melanoma [1].

According to the American Cancer Society, in 2008 the number of new cases of melanoma in USA was 62,480; of these, 34,950 were men and 27,350 were women. It resulted in 8,420 deaths; 5,400 in men and 3,020 in women [2]. It is more common in Caucasian populations living in sunny climates than in other groups [3].

Despite many years of intensive laboratory and clinical research, the sole effective cure is surgical resection of the primary tumor before it achieves a thickness of greater than 1 mm. The treatment includes surgical removal of the tumor; adjuvant treatment; chemo- and immunotherapy, or radiation therapy [3].

Dermoscopy or epiluminescence microscopy or dermatoscopy is a method of imaging skin lesions using low angle-of-incidence lighting and either liquid immersion or polarized lighting that allows deeper skin structures to be visible. When practiced by skilled observers, dermoscopy offers higher diagnostic accuracy for malignant melanoma than observation without magnification [4-6]. Dermoscopy images employ magnification

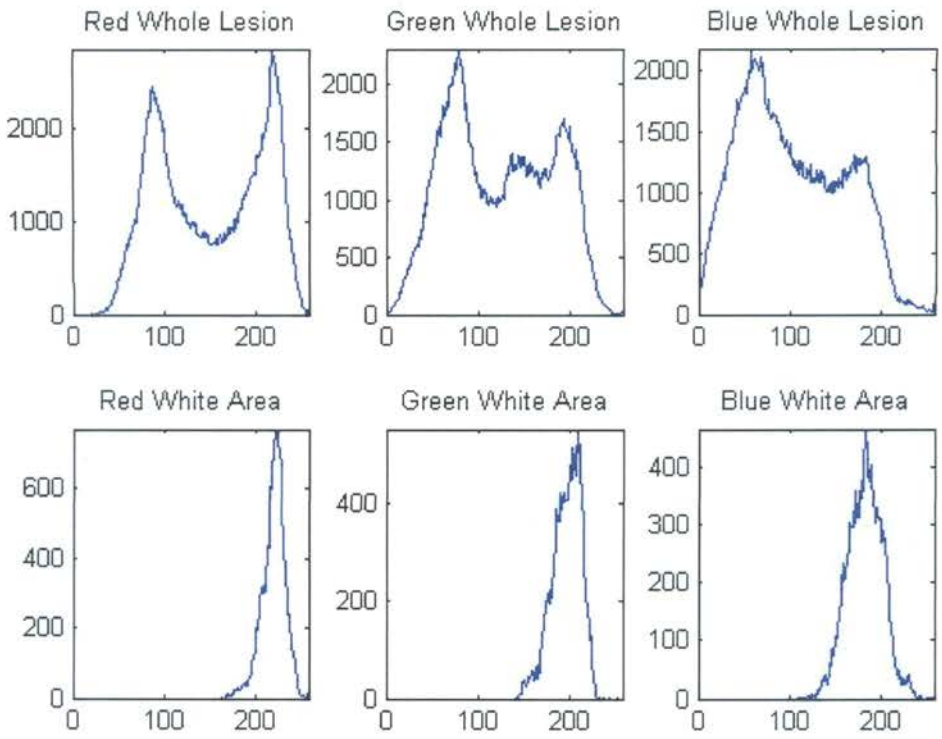


Figure 2.4. Histograms for the Whole Lesion and Marked White Areas

2.3. USING UPPER 20% OF HISTOGRAM

In this step, the gray level value corresponding to the upper 20% of the brightest pixels in the histogram of marked white areas is determined. First the total number of pixels which are marked as white areas is found. Then a counter is started in the histogram of the marked white areas from the lowest gray level value. This counter is stopped when the count is equal to 80% of the total pixels of the marked white areas. The gray level value at which counting stops is the gray level value corresponding to the 20% brightest pixels. The process is repeated for each of the three color planes.

Figure 1.1. Example of White Areas
(a) Original Melanoma Lesion (b) Lesion with Manually Marked White Areas

The entire set of images is randomly divided into two subsets, the training set and the test set. The training set consists of 75 images of which 25 are melanoma and 50 are benign. The test set consists of 245 images of which 177 are benign and 68 are melanoma.

Section 2 describes the algorithm for automatically segmenting white areas. Experimental results are described in Section 3 followed by conclusions in the next section.

2. DETECTION OF WHITE AREAS

2.1. PREPROCESSING OF IMAGES

The input set of images is pre-processed using the following steps –

- Creation of the lesion masks
- Creation of the white-area masks
- Multiplying lesion image with the lesion mask and the white-area mask

2.1.1. Creation of the Lesion Masks. The lesion masks are binary images containing only gray levels 0 and 255. The lesion area is assigned a gray level of 255 while the surrounding region is assigned a gray level of 0. These lesion masks are created using the Winshow software. These masks are manually marked and then verified by a dermatologist. Figure 2.1 displays an original image and its lesion mask.

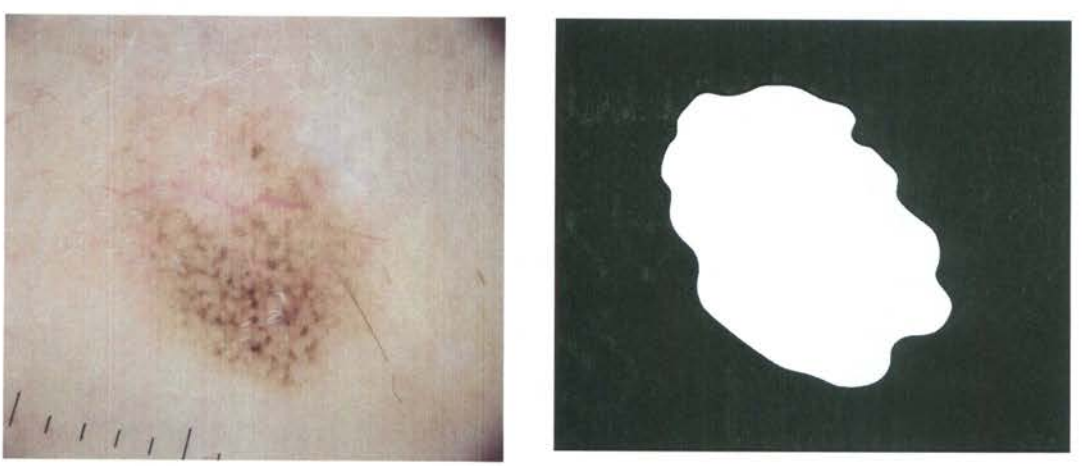


Figure 2.1. Original Lesion and Lesion Mask

2.1.2. Creation of the White-Area Masks. The white-area masks are similar to lesion masks. In this case, the white areas in a given lesion are assigned a gray level value of 255 whereas the rest of the image has a gray level value of 0. The white areas are manually marked and verified by a dermatologist. Winshow software is again used to create the masks. Figure 2.2 shows a lesion and its white area mask.

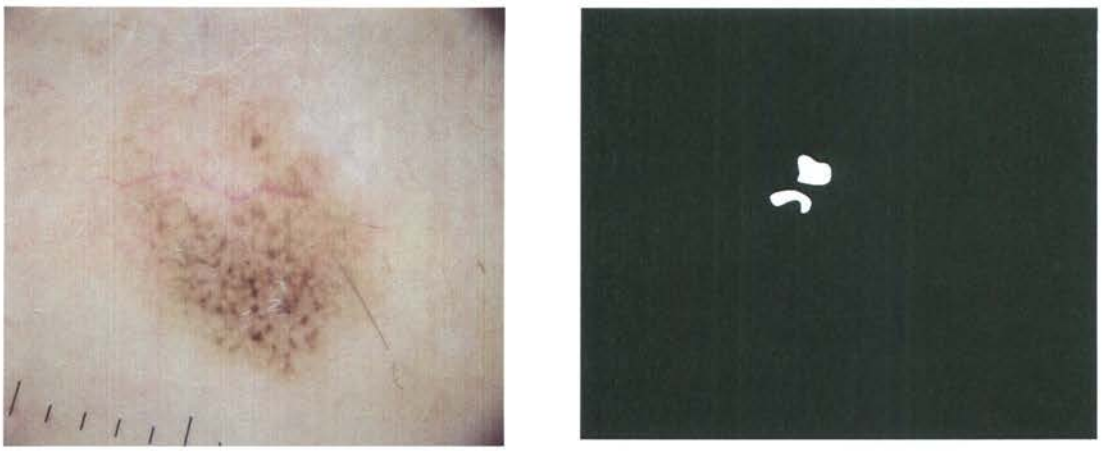
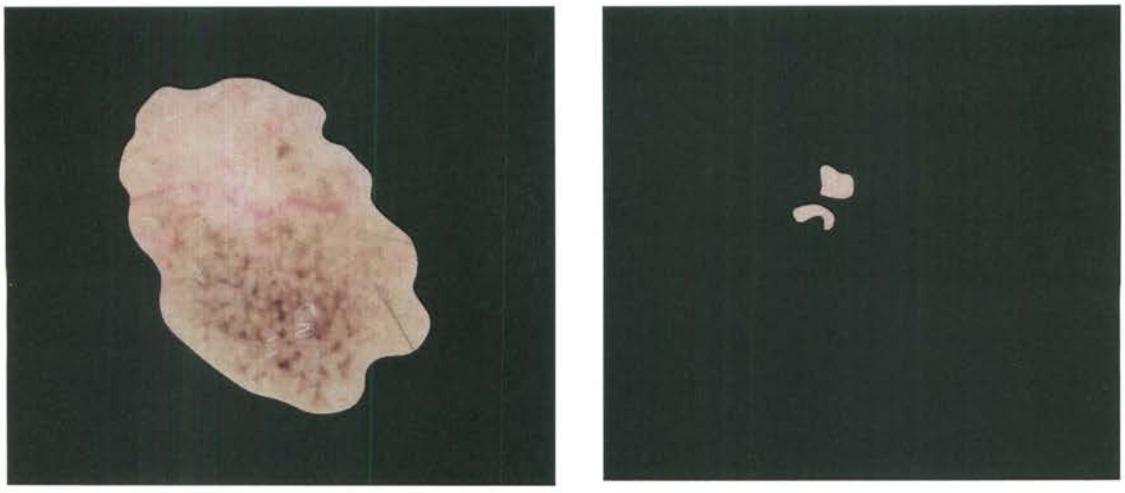


Figure 2.2. Original Lesion and White-Area Mask

2.1.3. Multiplying Lesion with Lesion Mask and White Area Mask. The lesion is then multiplied pixel-by-pixel with its corresponding lesion mask and white area mask. Since the lesion is a three-color image (Red, Green and Blue) and the mask is a binary image, the images are multiplied one plane at a time. Figure 2.3(a) shows the result of the multiplication of the lesion image with the lesion mask whereas Figure 2.3(b) shows the result of the multiplication of the lesion image with the white area mask.



(a) (b)

Figure 2.3. Multiplication Results
(a) Multiplication of Lesion with Lesion Mask
(b) Multiplication of Lesion with White Area Mask

2.2. COMPUTING HISTOGRAM FOR EACH COLOR PLANE

A histogram gives us the distribution of colors in a given image, derived by counting the number of pixels. The histogram is plotted independently for each of the color planes – Red, Green and Blue. The horizontal axis consists of a range of gray level values going from 0 to 255 and the vertical axis represents the number of pixels in that particular level. Separate histograms are plotted for the lesion and for the marked white areas. Figure 2.4 shows the histograms of all the color planes for the whole lesion and for the manually marked white areas.

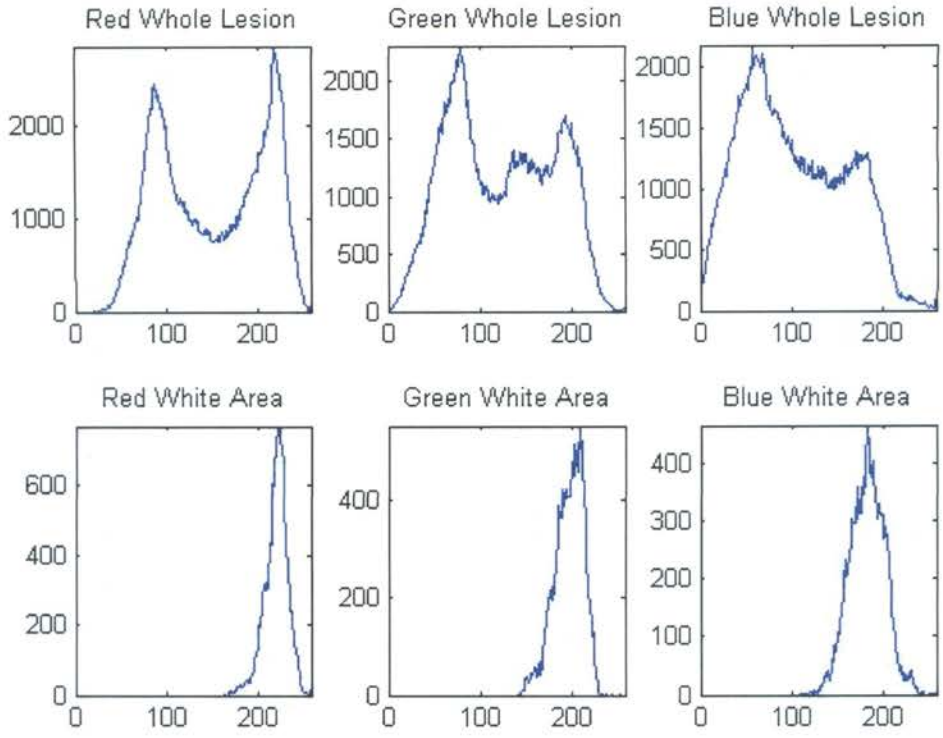


Figure 2.4. Histograms for the Whole Lesion and Marked White Areas

2.3. USING UPPER 20% OF HISTOGRAM

In this step, the gray level value corresponding to the upper 20% of the brightest pixels in the histogram of marked white areas is determined. First the total number of pixels which are marked as white areas is found. Then a counter is started in the histogram of the marked white areas from the lowest gray level value. This counter is stopped when the count is equal to 80% of the total pixels of the marked white areas. The gray level value at which counting stops is the gray level value corresponding to the 20% brightest pixels. The process is repeated for each of the three color planes.

2.4. AVERAGE AND STANDARD DEVIATION

The average Red, Green and Blue plane values are calculated for the whole lesion. For example, the average Red plane value of a lesion is –

Average Red value = Sum of Red plane values of all lesion pixels/Total number of pixels

The same process is repeated for the Green and Blue color planes.

For calculating the standard deviation, an array is formed which consists of all the color plane values of a given lesion. The array is a column vector with the number of rows equal to the number of pixels in the lesion. The standard deviation is then computed using the inbuilt Matlab® function *std*.

2.5. COMPUTING THRESHOLD VALUES

The threshold value is determined based on the histogram and the average color plane value. For example, let the value corresponding to the top 20% brightest pixels be *A*. Let the average value of a given lesion be *B* and the standard deviation value of the lesion be *C*. Then,

Diff = A – B

Ratio = Diff/C

All the *Ratio* values are stored in an Excel file. Then, the average value and the standard deviation of the different *Ratio* values are determined for the training set of lesions. The initial threshold value selected is the average value plus the standard deviation value of *Ratio* for the given color plane. The threshold values are then manually adjusted to increase the accuracy. The procedure is done independently on all three color planes and thus, three different threshold values are observed.

The threshold values selected are –

Red plane = 0.5; Green plane = 1.1; Blue plane = 1.2

2.6. APPLYING THE THRESHOLD VALUES

The threshold values computed above are used for automatically segmenting white areas. For any pixel to be marked as white, it has to satisfy three conditions

a) The red plane value of the pixel should be greater than the sum of the average red value of the lesion and the red threshold times the red standard deviation of the lesion.

b) The green plane value of the pixel should be greater than the sum of the average green value of the lesion and the green threshold times the green standard deviation of the lesion.

c) The blue plane value of the pixel should be greater than the sum of the average blue value of the lesion and the blue threshold times the blue standard deviation of the lesion.

All the pixels in a given lesion are examined and if the pixel satisfies the above three conditions, then the pixel is marked as a white area.

2.7. IMAGE FEATURES

Image features are used to determine the accuracy of detection of white areas using the neural network.

2.7.1. Decile Percentages. The lesion with marked white areas is converted into a black-and-white image with the marked white areas having a gray scale value of 255 and the rest of the lesion having a gray scale value of zero. The black-and-white lesion is then divided into 10 equal areas concentrically. A ratio of the number of white areas marked in a particular decile to the area of that decile is then computed. For eample,

R1 = number of pixels marked as white in 1^{st} decile / Total number of pixels in 1^{st} decile
R2 = number of pixels marked as white in 2^{nd} decile / Total number of pixels in 2^{nd} decile

As we have ten deciles, for each lesion we will have ten such ratios, i.e. R1, R2,..., R10. Now, again a ratio of all the above mentioned ratios is taken. For example,

c1 = R1/R2

c2 = R1/R3

The ratio of each decile to all the other nine deciles is found. Thus, various combinations of the ten deciles give us 90 such ratios. These 90 ratios are known as decile percentages.

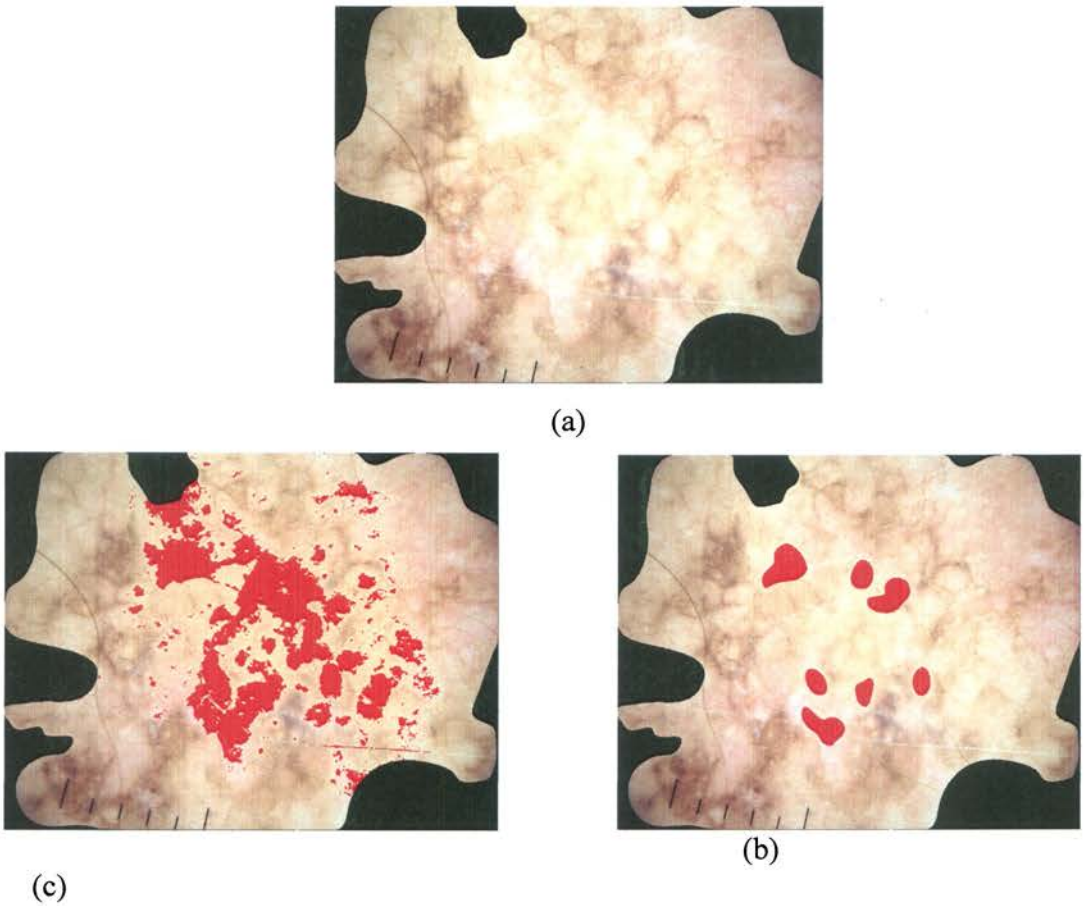
2.7.2. Globule Features. Various globule features of the lesion are also computed. The globule feature code requires a binary feature mask, lesion centroid co-ordinates and lesion area as the inputs. For the binary feature mask, the lesion with automatically marked white areas is converted into a binary image where the pixels marked as white areas are assigned a gray level of one whereas all the other pixels are assigned a gray level of zero. The code gives nine globule features as its output. They are

a) Average Eccentricity feature
b) Relative size of all white areas compared to lesion area
c) Relative size of largest white area compared to lesion area
d) Absolute size of the largest white area
e) Number of marked white areas per unit lesion area
f) Average border irregularities of all white areas
g) White Area dispersement index1 – Average distance of the white areas from the centroid of the lesion scaled by square root of lesion area
h) White Area dispersement index2 – Average distance of the white areas from the white area centroid scaled by square root of lesion area
i) Ratio of largest white area in the lesion to the ratio of largest white area present in the outermost decile

3. RESULTS

3.1. AUTOMATICALLY MARKED WHITE AREAS

The white areas are automatically marked using the algorithm as described in section 2.6. Figure 3.1 shows a melanoma lesion, automatically marked white areas and manually marked white areas.



(a)

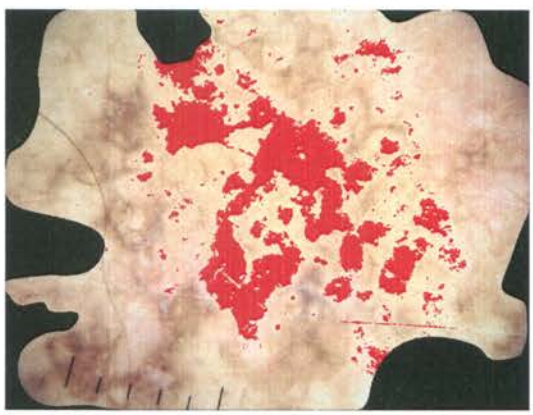
(b)

(c)

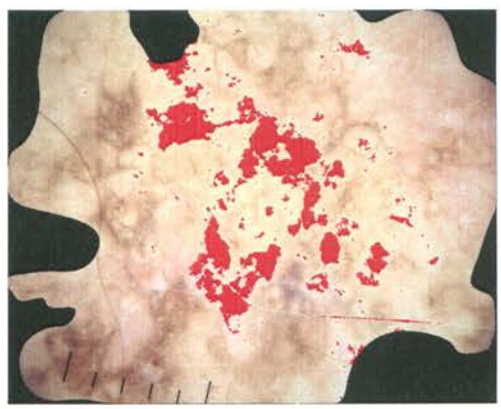
Figure 3.1 Automatic Marking of White Areas
(a) Original Melanoma Lesion (b) Automatically Marked White Areas
(c) Manually Marked White Areas

In Figure 3.1 (b) all the pixels considered as white areas by the algorithm are assigned a red plane value of 255. Figure 3.1 (c) shows the white areas as marked by a dermatologist. As can be seen from the figure, the algorithm identifies all the marked white areas in addition to some false positives.

If the threshold for the Red color plane is removed and only the Blue and Green color planes' thresholds are considered, the number of false positives is reduced. The threshold values of the Blue plane and Green plane in two-color-plane thresholding are different from the threshold values used for the same colors in three-color-plane thresholding. The results for three-color-plane thresholding and two-color-plane thresholding for the lesion in Figure 3.1(a) are as shown in the Figure 3.2



(a)



(b)

Figure 3.2 Comparison of Two-Plane and Three-Plane Thresholding
(a) Marked White Areas for Three-Plane Thresholding
(b) Marked White Areas for Two-Plane Thresholding

For two benign lesions, the output of the algorithm for two-color-plane thresholding (Green and Blue) is as shown in Figure 3.3 below.

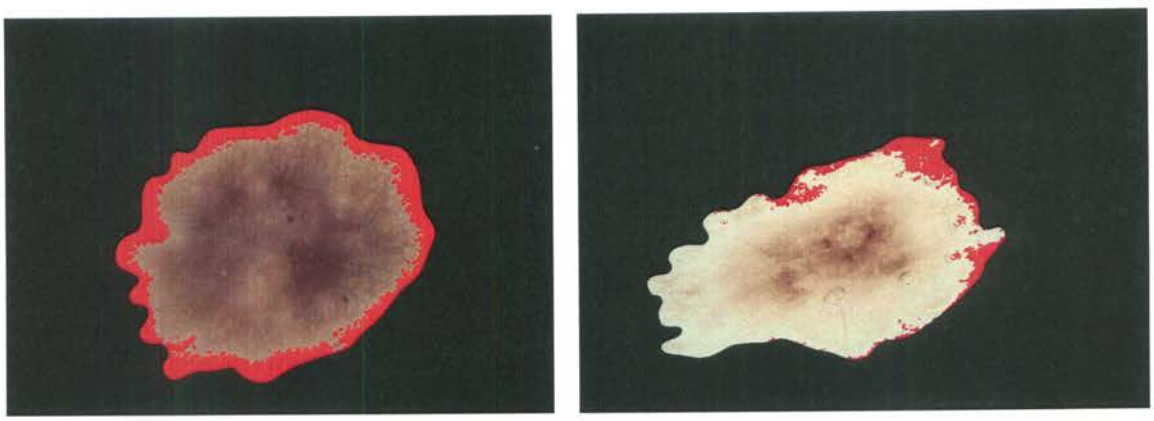


Figure 3.3. Benign Lesions

The algorithm marks some pixels as white areas in benign lesions as well. But most of the marked white areas are close to the lesion boundary as shown in the example above (Figure 3.3).

3.2. SELECTION OF FEATURES

The various image features described in section 2.7 were determined after automatically segmenting the white areas on the training set of images. The training set consists of a total of 75 lesions of which 50 are benign and 25 are melanoma. These

image features are then analyzed using the Statistical Analysis Software, SAS[9]. The input given to SAS is an excel file which contains a list of all the decile features and globule features.

The primary objective of the SAS algorithm is to obtain a list of variables which will be the best inputs to the neural network classifier to discriminate between melanoma and benign lesions. The various steps performed are as follows –

(i) Variable selection using stepwise logistic regression: Proc logistic is used to perform logistic regression. The selection parameter is specified as 'stepwise' in the proc logistic procedure to facilitate selection of variables. The best True vs. False classification of TP = 0.90 and TN = 0.80 is observed when the following variables are selected – c14, c34, c35, c39, c44, c59, c60, c82, c84, c89, c95 and c97

(ii) Linear discriminant analysis using proc discrim: This step is used to produce a classification table (confusion matrix). The initial inputs to the discrim procedure are the variables obtained from the stepwise selection procedure. The four variables which failed the stepwise selection procedure are also added. If at any step the TP and TN numbers fell below the previous step the current variable was removed from the list. The final set of variables is chosen to be the one that provided the highest true positive/true negative classification rates in the classification table. The highest true v/s false classification of TP = 0.96 and TN = 0.86 is obtained when the following

variables are selected - c14, c34, c35, c39, c44, c59, c60, c82, c84, c89, c95 and c97

The selected features are –

a) c14: ratio of decile percentages of 2nd decile to 6th decile

b) c34: ratio of decile percentage of 4th decile to 8th decile

c) c35: ratio of decile percentage of 4th decile to 9th decile

d) c39: ratio of decile percentage of 5th decile to 3rd decile

e) c44: ratio of decile percentage of 5th decile to 9th decile

f) c59: ratio of decile percentage of 7th decile to 5th decile

g) c60: ratio of decile percentage of 7th decile to 6th decile

h) c82: ratio of decile percentage of 10th decile to 1st decile

i) c84: ratio of decile percentage of 10th decile to 3rd decile

j) c89: ratio of decile percentage of 10th decile to 8th decile

k) c95: Number of marked white area per unit lesion area

l) c97: Average distance of the white areas from the white area centroid scaled by square root of lesion area

Here 1^{st} decile is the innermost decile and 10^{th} decile is the outermost decile.

3.3. NEURAL NETWORK RESULTS

The neural network was run on the test set of images with the twelve features selected by SAS. The neural network is implemented in Matlab®. The neural network used is a back-propagation neural network. It has two hidden layers with six nodes in the

first hidden layer and four nodes in the second. The neural network generates one output. The activation function is the log sigmoid function and a linear transfer function is used for the output. The stopping criterion is the root mean square (RMS) error value of 0.1 and maximum training is for fifteen epochs.

The test set consists of 245 lesions of which 177 are benign and 68 are melanoma. The neural network is run on two separate cases – the two-color-plane criteria before and after removing the lesions not touching the image border.

3.3.1. Two Color Planes. In this case, only the threshold criteria for the blue and green color plane are considered for marking out the white areas. The result of the neural network is as shown in Table 3.1 below.

Table 3.1. Neural Network Result for Two-Color-Plane Criteria

Feature Combination	Area Under ROC Curve
c14	87.28
c14,c34	88.96
c14,c34,c35	90.83
c14,c34,c35,c39	94.37
c14,c34,c35,c39,c44	94.14
c14,c34,c35,c39,c44,c59	89.23
c14,c34,c35,c39,c44,c59,c60	93.39
c14,c34,c35,c39,c44,c59,c60,c82	92.26
c14,c34,c35,c39,c44,c59,c60,c82,c84	91.61
c14,c34,c35,c39,c44,c59,c60,c82,c84,c89	92.12
c14,c34,c35,c39,c44,c59,c60,c82,c84,c89,c95	94.67
c14,c34,c35,c39,c44,c59,c60,c82,c84,c89,c95,c97	92.95

The area under the ROC curve represents the diagnostic accuracy of the algorithm. Observing the table, the best result for the area under the ROC curve is 94.67% and is given by the combination of the variables c14, c34, c35, c39, c44, c59, c60, c82, c84, c89 and c95.

Figure 3.4 displays the ROC curve for the training set of images for the Eleven-feature combination. The area under the curve is 94.67%.

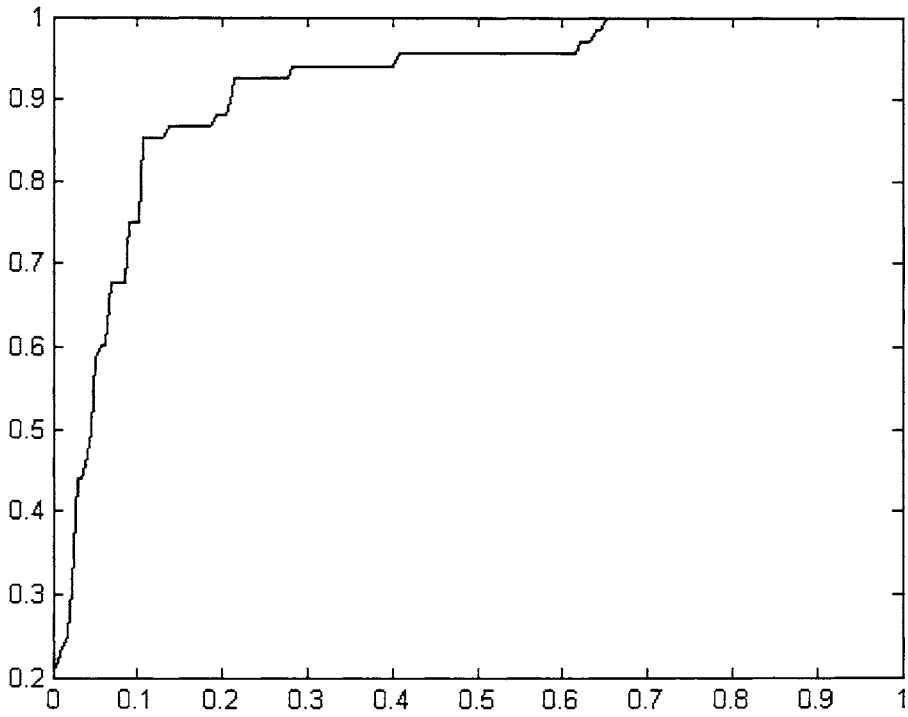


Figure 3.4. ROC Curve for Eleven-Feature Combination

3.3.2. Lesions not Touching the Image Border. In some images, the entire lesion area is not captured in the image, i.e., the lesion border extends past the image boundary. For these cases some of the image features are distorted. For example, a portion of what would normally be the outer deciles of the lesion is cut off. Thus, the lesions whose lesion borders go all the way to the image border are removed from the set and the neural network is run again. The test set consists of 169 lesions of which 137 are benign and 32 are melanoma. The result is as shown in Table 3.2.

Table 3.2 Neural Network Result

Feature Combination	Area Under ROC Curve
c14	89.79
c14,c34	90.43
c14,c34,c35	94.68
c14,c34,c35,c39	93.03
c14,c34,c35,c39,c44	96.17
c14,c34,c35,c39,c44,c59	94.15
c14,c34,c35,c39,c44,c59,c60	92.12
c14,c34,c35,c39,c44,c59,c60,c82	95.28
c14,c34,c35,c39,c44,c59,c60,c82,c84	93.16
c14,c34,c35,c39,c44,c59,c60,c82,c84,c89	92.69
c14,c34,c35,c39,c44,c59,c60,c82,c84,c89,c95	96.03
c14,c34,c35,c39,c44,c59,c60,c82,c84,c89,c95,c97	94.15

The best result for the area under the ROC curve is 96.17% and is given by the feature combination of c18, c37, c35, c39 and c44.

Figure 3.4 displays the ROC curve for the training set of images for the five-feature combination. The area under the curve is 96.17%.

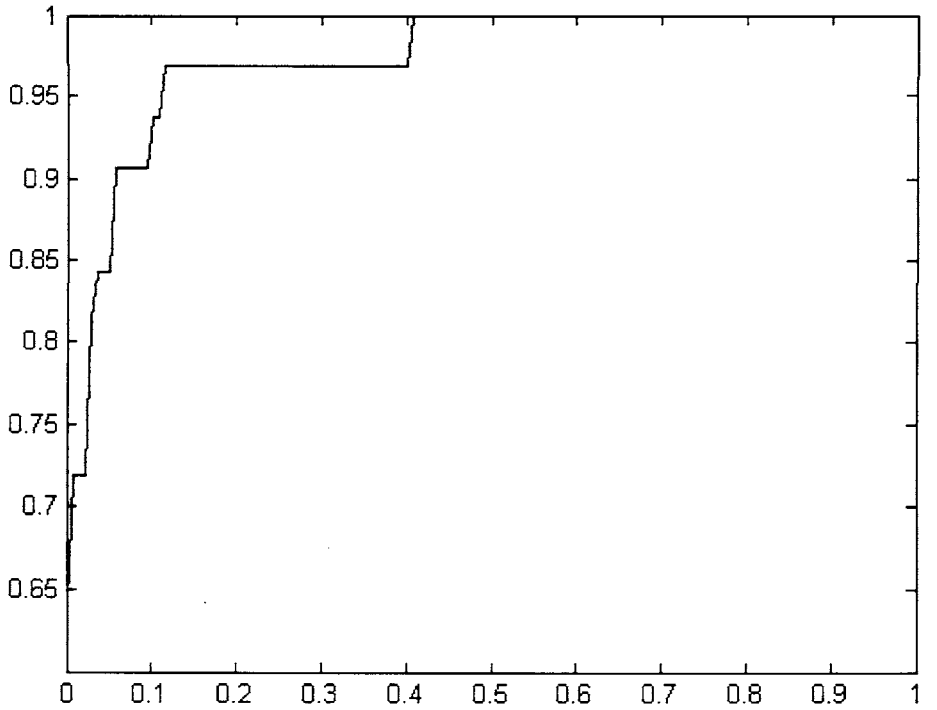


Figure 3.5. ROC Curve for Five-Feature Combination

4. CONCLUSION

The results show that the algorithm used for the detection of white areas gives a highest diagnostic accuracy of 94.67% from the ROC curve when two-color-plane thresholding is used. If the lesions whose borders touch the image border are removed, the diagnostic accuracy of detection improves to 96.17% from the ROC curve.

This method can be used to classify the lesions into melanoma or benign lesions and automatically mark the white areas in melanomas.

The principal growth in numbers of melanomas has been in early melanomas, particularly melanomas in situ. White areas, representing areas of scarlike regression, are often present in these early lesions. Detection of white areas helps significantly in early detection of malignant melanoma and thus contributes to saving lives from skin cancer.

APPENDIX A

IMAGE FEATURES

Table A.1. Feature description

Feature	Description
c1	Ratio of 1st decile to 2nd decile
c2	Ratio of 1st decile to 3rd decile
c3	Ratio of 1st decile to 4th decile
c4	Ratio of 1st decile to 5th decile
c5	Ratio of 1st decile to 6th decile
c6	Ratio of 1st decile to 7th decile
c7	Ratio of 1st decile to 8th decile
c8	Ratio of 1st decile to 9th decile
c9	Ratio of 1st decile to 10th decile
c10	Ratio of 2nd decile to 1st decile
c11	Ratio of 2nd decile to 3rd decile
c12	Ratio of 2nd decile to 4th decile
c13	Ratio of 2nd decile to 5th decile
c14	Ratio of 2nd decile to 6th decile
c15	Ratio of 2nd decile to 7th decile
c16	Ratio of 2nd decile to 8th decile
c17	Ratio of 2nd decile to 9th decile
c18	Ratio of 2nd decile to 10th decile
c19	Ratio of 3rd decile to 1st decile
c20	Ratio of 3rd decile to 2nd decile
c21	Ratio of 3rd decile to 4th decile
c22	Ratio of 3rd decile to 5th decile
c23	Ratio of 3rd decile to 6th decile
c24	Ratio of 3rd decile to 7th decile
c25	Ratio of 3rd decile to 8th decile
c26	Ratio of 3rd decile to 9th decile
c27	Ratio of 3rd decile to 10th decile
c28	Ratio of 4th decile to 1st decile
c29	Ratio of 4th decile to 2nd decile
c30	Ratio of 4th decile to 3rd decile
c31	Ratio of 4th decile to 5th decile
c32	Ratio of 4th decile to 6th decile
c33	Ratio of 4th decile to 7th decile
c34	Ratio of 4th decile to 8th decile
c35	Ratio of 4th decile to 9th decile
c36	Ratio of 4th decile to 10th decile
c37	Ratio of 5th decile to 1st decile
c38	Ratio of 5th decile to 2nd decile
c39	Ratio of 5th decile to 3rd decile
c40	Ratio of 5th decile to 4th decile
c41	Ratio of 5th decile to 6th decile
c42	Ratio of 5th decile to 7th decile

Table A.1. (continued)

c43	Ratio of 5th decile to 8th decile
c44	Ratio of 5th decile to 9th decile
c45	Ratio of 5th decile to 10th decile
c46	Ratio of 6th decile to 1st decile
c47	Ratio of 6th decile to 2nd decile
c48	Ratio of 6th decile to 3rd decile
c49	Ratio of 6th decile to 4th decile
c50	Ratio of 6th decile to 5th decile
c51	Ratio of 6th decile to 7th decile
c52	Ratio of 6th decile to 8th decile
c53	Ratio of 6th decile to 9th decile
c54	Ratio of 6th decile to 10th decile
c55	Ratio of 7th decile to 1st decile
c56	Ratio of 7th decile to 2nd decile
c57	Ratio of 7th decile to 3rd decile
c58	Ratio of 7th decile to 4th decile
c59	Ratio of 7th decile to 5th decile
c60	Ratio of 7th decile to 6th decile
c61	Ratio of 7th decile to 8th decile
c62	Ratio of 7th decile to 9th decile
c63	Ratio of 7th decile to 10th decile
c64	Ratio of 8th decile to 1st decile
c65	Ratio of 8th decile to 2nd decile
c66	Ratio of 8th decile to 3rd decile
c67	Ratio of 8th decile to 4th decile
c68	Ratio of 8th decile to 5th decile
c69	Ratio of 8th decile to 6th decile
c70	Ratio of 8th decile to 7th decile
c71	Ratio of 8th decile to 9th decile
c72	Ratio of 8th decile to 10th decile
c73	Ratio of 9th decile to 1st decile
c74	Ratio of 9th decile to 2nd decile
c75	Ratio of 9th decile to 3rd decile
c76	Ratio of 9th decile to 4th decile
c77	Ratio of 9th decile to 5th decile
c78	Ratio of 9th decile to 6th decile
c79	Ratio of 9th decile to 7th decile
c80	Ratio of 9th decile to 8th decile
c81	Ratio of 9th decile to 10th decile
c82	Ratio of 10th decile to 1st decile
c83	Ratio of 10th decile to 2nd decile

Table A.1. (continued)

c84	Ratio of 10th decile to 3rd decile
c85	Ratio of 10th decile to 4th decile
c86	Ratio of 10th decile to 5th decile
c87	Ratio of 10th decile to 6th decile
c88	Ratio of 10th decile to 7th decile
c89	Ratio of 10th decile to 8th decile
c90	Ratio of 10th decile to 9th decile
c91	Average Eccentricity feature
c92	Relative size of all white areas compared to lesion area
c93	Relative size of largest white area compared to lesion area
c94	Absolute size of largest white area
c95	Number of marked white areas per unit lesion area
c96	Average border irregularities of all white areas
c97	Average distance of the white areas from the centroid of the lesion scaled by square root of lesion area
c98	Average distance of the white areas from the white area centroid scaled by square root of lesion area
c99	Ratio of largest white area in the lesion to the ratio of largest white area present in the outermost decile

APPENDIX B

EXCEL SHEET FOR NEURAL NETWORK – TWO-PLANE-THRESHOLDING

Table B.1. Two-Plane-Thresholding

File name	Features											
	c14	c34	c35	c39	c44	c59	c60	c82	c84	c89	c95	c97
BA070907.tif	0.013684	0.2297007	0.3938563	0.5387715	0.0012006	0.0141592	0.3529512	2.833543	8.1166293	0.920983	0.0001601	0.3638154
CT110907.tif	0.00049	0.00239	0.0802267	0.3291136	0.047344	0.0030192	0.0239846	41.78619	31.642223	1.7448213	0.0001884	0.4377109
DT111507per45.tif	0.001509	0.044012	0.0157129	0.1061539	0.0011556	0.0104142	0.0056726	177.6795	81.732974	3.0066529	0.0004025	0.446026
DT111507per46.tif	0.001128	6.14E-05	0.0135329	0.0542715	0.000536	0.0104701	0.0051152	197.0582	12.952221	1.9813587	0.0001233	0.4364314
EH112607.tif	0.440423	0.1852897	0.0521003	0.3577581	0.0910605	0.4247815	0.0238748	41.95427	13.037599	1.6644698	0.0006842	0.3799
EQ071607.tif	2.649926	6.9039593	2.6181451	2.4380749	3.3826152	2.73047	0.4819429	2.075224	2.3292459	2.1859093	0.0006609	0.4359667
HC102607per34.tif	7.152495	7.4353308	1.0937441	2.835976	26.616778	7.1619764	0.4020041	2.488312	6.628313	1.5176304	0.001046	0.3254089
HC102607per35.tif	0.549034	0.995239	0.8237443	0.883152	0.0269488	0.5423588	0.4264242	2.345332	5.4195539	3.6555092	0.0006272	0.408372
JG071807per11.tif	3.81036	0.1854453	0.0324792	0.1883037	0.6117812	3.8875235	0.0143037	70.14332	3.6656622	3.0538332	0.0005485	0.393597
JG071807per12.tif	5.91E-05	0.1918821	0.1722449	0.3408865	0.0001967	0.0005787	0.1048158	9.54442	7.3041338	2.8651332	0.0009142	0.4998543
KB060807.tif	0.191183	0.5834581	0.5563751	0.7133444	0.119846	0.1959568	0.4425796	2.25968	0.2223631	0.8240546	0.0008187	0.3644158
LB110907per41.tif	0.032078	0.0784967	0.1457887	0.369406	0.0010987	0.0331515	0.0794076	12.6014	4.0563036	0.4540087	0.000867	0.4826219
LB110907per42.tif	0.01829	0.0108535	0.0237661	0.087228	0.0019769	0.0218309	0.0112811	88.98526	1.0737588	2.6823436	0.0006068	0.4592039
MG100507.tif	0.001117	0.0048315	0.0087781	0.0264731	0.0002803	0.0114165	0.0048583	207.7216	8.1166293	2.3241953	0.0008065	0.5310556
MT06080.tif	8.47E-05	0.0795864	0.1142339	0.2748767	0.0002122	0.0008389	0.0699961	14.29549	31.642223	2.2609581	0.0007614	0.4404183
RT092107per25.tif	0.041431	0.1236228	0.2032645	0.4249126	0.0045699	0.0413558	0.1222728	0.2040988	0.4348982	5.191229	0.0004558	0.4592107
VG082707.tif	1.896748	0.7204515	0.8307524	0.8877576	4.3065481	1.8177653	0.7316523	0.8718944	0.9249964	2.7284308	0.0001554	0.4680694
ad021607.tif	0.123035	0.384042	0.5676245	0.7139234	0.0028472	0.1231396	0.3563003	0.5777953	0.7087031	1.8694135	0.0007	0.4788496
ad040507.tif	0.013684	0.0590901	0.1397447	0.4451135	0.0003975	0.0009728	0.0547434	0.1268875	0.4088937	2.2254721	0.0003205	0.4358558
ag031907.tif	0.00049	0.031114	0.0634416	0.2385105	0.0003699	0.0015096	0.030418	5.191229	8.1815854	1.6600368	0.0003394	0.5783522
ag061307rab185.tif	0.001509	0.0229917	0.0399529	0.1128409	0.0002789	0.0249478	0.0233027	2.728431	1.3668481	2.6823436	0.0003782	0.4906969
ag061307rab186.tif	0.001128	0.4839217	0.5994166	0.7186771	0.0169241	0.0645555	0.5079838	1.869414	2.8069342	2.3241953	0.0002342	0.2188102
ak051007rab131.tif	0.0527808	0.2963984	0.4515505	0.588603	0.1425968	0.2778204	0.2807663	2.225472	18.280879	2.2609581	0.0003546	0.4437984
ao061407.tif	0.106644	0.1021557	0.3171887	0.7266503	7.1282355	2.8274449	0.1049062	1.660037	32.915128	5.191229	0.0003168	0.477453
ar031607rab68.tif	0.0025273	0.0520763	0.1009447	0.3154338	0.0002953	0.0025659	0.0530102	1.233093	43.000231	2.7284308	0.0005197	0.4831184
as051707.tif	0.0571936	0.1757821	0.2753245	0.4662522	0.0169322	0.0498429	0.1631525	1.738003	8.1815854	0.5900483	0.000152	0.4523374
as062807.tif	1.629E-05	0.0276437	0.0623614	0.3317375	0.0005612	0.0015823	0.0298791	2.205513	1.3668481	0.635539	0.0001035	0.4305905
as070307rab211.tif	1.601E-05	0.1031661	0.1698406	0.3524828	0.0001751	0.0005454	0.1069668	1.772034	2.8069342	0.553628	0.0007451	0.4818513

Table B.1. (continued)

as070307rab212.tif	1.554E-05	0.0122354	0.0338684	0.1487594	0.0005794	0.0050984	0.0095495	33.512488	3.0066529	0.5212668	0.0006272	0.4523374
as073107.tif	1.554E-05	0.0110924	0.030803	0.1271246	0.0004781	0.0041248	0.0099996	9.3526417	1.9813587	0.7263614	0.0005485	0.4305905
as080207.tif	0.0098714	0.005778	0.0166219	0.1693723	0.0017434	0.2344313	0.0056956	105.18012	1.6644698	0.3420264	0.0009142	0.4818513
as090507dru85.tif	1.495E-05	0.0019135	0.0055258	0.0308713	0.0006793	0.5716975	0.0020789	100.36354	2.1859093	0.6322727	0.0008187	0.3985019
as090507dru86.tif	0.009027	0.1213527	0.1908684	0.3434386	0.0002598	0.0147215	0.1235483	177.30908	1.5176304	0.6204184	0.000867	0.4870886
as101807rab369.tif	0.0072639	0.018885	0.038222	0.1512248	0.0003715	0.0023732	0.0192506	490.19368	3.6555092	0.6635257	0.0006068	0.4408031
bb061107.tif	0.0282375	0.1748557	0.2804666	0.4782605	0.000321	0.0598299	0.174355	8.0967701	3.0538332	0.5620911	0.0008065	0.4226971
br112107.tif	0.0013459	0.2476242	0.3861233	0.4985628	0.0001325	0.0040867	0.2436954	52.055302	2.8651332	0.4532973	0.0007614	0.4545866
bw070307.tif	0.0001181	0.1314006	0.2186648	0.4941046	0.0001976	0.0004378	0.1232472	5.7368903	2.7004747	0.5340379	0.0004558	0.4689225
ca022807.tif	0.0024049	0.0318095	0.0682294	0.2425111	0.0003369	0.1360276	0.0316412	4.1042482	0.2515447	0.700823	0.0001554	0.4698622
cb071607.tif	0.0012341	0.0112979	0.0241204	0.0786765	0.016059	0.3581755	0.0122742	8.1166293	0.0836014	0.6933562	0.0006272	0.4798544
cc080307.tif	0.0688089	0.0755079	0.1281384	0.2595819	0.1445787	3.1750936	0.0772633	31.642223	0.255023	0.4534201	0.0005485	0.3903849
cd112107.tif	0.0002261	0.0760454	0.1222544	0.2583267	0.0001579	0.0075267	0.0767419	41.786191	2.2609581	0.6998613	0.0009142	0.4436904
cj082207.tif	0.003531	0.4232117	0.8668666	0.9215824	0.014922	0.0001694	0.4293628	177.67954	5.191229	0.3929777	0.0008187	0.4273502
ck111907.tif	1.725E-05	0.1634576	0.263686	0.454196	0.0001432	0.0018134	0.150905	197.05816	2.7284308	0.7549116	0.000867	0.4019248
cl050307.tif	0.1658914	0.1848707	0.3460254	0.5248931	0.4258198	2.0944613	0.1845834	41.954267	1.8694135	0.4028561	0.0007614	0.4877273
cm052507.tif	0.1171222	0.2548052	0.7622574	1.9875577	2.6248394	1.0205214	0.2728543	2.0752244	2.2254721	0.4018181	0.0005599	0.3874436
cn101807.tif	0.0011631	0.1370045	0.2364359	0.4153713	0.014303	0.072775	0.1369566	2.4883115	1.6600368	0.4442316	0.0008054	0.3723526
cp050707.tif	0.6481867	4.3523554	7.2118049	1.8602377	0.0268048	0.4795468	4.4955729	2.3453323	1.2330926	0.1205205	0.0004194	0.3488946
cp060107rolla110.tif	0.0018272	0.246139	0.3598793	0.7137358	0.0094958	0.000629	0.2465714	70.143315	1.7380031	0.5321231	0.0004104	0.3856373
cp060107rolla112.tif	1.5351733	0.9241612	1.0410077	1.1038232	1.962825	1.9910687	0.9313186	9.5444202	2.2055129	0.8674713	0.0003656	0.5177088
cs071807rolla163.tif	0.0189435	0.1841296	0.2767028	0.5189532	0.0154361	0.0729041	0.1733034	2.25968	1.7720335	0.6425118	0.0003439	0.2972667
cw021907.tif	1.402E-05	0.1794885	0.3292158	0.5428299	0.000151	0.0002972	0.1691801	12.601404	1.7178698	0.5389909	0.0006847	0.430367
da102607dru100.tif	0.0002241	0.1576216	0.2538558	0.4666342	0.0001412	0.0003267	0.1500843	88.985262	1.6692679	0.5956739	0.000753	0.4378501
da102607dru99.tif	1.57E-05	0.1437159	0.29615	0.5942813	0.0002014	0.0003636	0.1396069	207.72164	2.2609581	0.484149	0.0004558	0.4135216
db021207.tif	1.236E-05	0.0604522	0.1727026	0.4034684	0.0002972	0.0005919	0.0633148	14.295493	5.191229	0.6818169	0.0001554	0.4629101
db070307.tif	0.0314434	0.291947	0.4746185	0.5797126	0.0001153	0.0033299	0.2975864	8.1815854	2.7284308	0.544792	0.0007	0.3382678
dc061907.tif	0.0430643	0.3739454	0.5052923	0.6821246	0.775811	0.3965642	0.3188649	1.3668481	0.5747088	0.4361444	0.0007614	0.3704933
dd070207.tif	1.257E-05	0.0131433	0.0304821	0.0841947	0.0002825	0.0032133	0.0118506	41.786191	0.0879978	0.6192531	0.0005599	0.3172567
dd081307rolla188.tif	0.1985612	0.3627218	0.5848488	0.8095323	0.2932974	1.0207207	0.3924826	177.67954	0.8547629	0.4056603	0.0008054	0.3453716

Table B.1. (continued)

de122106.tif	0.0004611	0.0443533	0.067062	0.2681819	0.1555266	0.111545	0.0439464	0.0696565	0.2697715	0.6385426	0.0001035	0.446026
dh081007.tif	0.5995607	0.9844595	0.8335146	1.0359016	1.9941034	2.3606536	0.9714599	0.8316436	1.0555029	0.4858783	0.0007451	0.4364314
dl022307.tif	0.0625743	0.3689183	0.5408876	0.7711418	0.078001	0.0963887	0.3676414	0.4939336	0.7082423	0.4488238	0.0010047	0.3799
dl111407dru111.tif	0.0018299	0.0751223	0.1448019	0.222954	0.0039319	0.0005437	0.0719196	0.1472231	0.2251831	0.6552278	0.0002808	0.4359667
dl111407dru112.tif	1.223E-05	0.0925152	0.1662618	0.3598568	0.0001816	0.0004608	0.088459	0.1883478	0.3944556	0.5513854	0.0002326	0.3254089
dm042307.tif	0.0108127	0.1569688	0.275708	0.5570471	0.0007592	0.0478698	0.1585269	0.244143	0.5381865	0.5449341	0.0010204	0.408372
dn081707.tif	0.0003163	0.1791056	0.3902585	0.5861008	0.002022	0.000309	0.1564624	0.380073	0.529817	0.4291217	0.0001752	0.393597
dr031207.tif	0.0544662	0.0356114	0.0660603	0.1854058	0.0110589	1.6529209	0.0337948	0.0668543	0.1857913	0.6399304	0.0016104	0.4998543
ds042307.tif	0.3758523	1.0502048	1.1590423	0.9827375	0.0092961	0.23977	1.1132978	1.1944389	1.0493377	0.4760974	0.0006989	0.3644158
dt062507.tif	0.0603088	0.3131877	0.4856806	0.8813551	0.0099916	0.0919491	0.3086036	0.4914632	0.8856463	0.6415523	0.0008679	0.4826219
dz101107.tif	1.181E-05	0.0289305	0.0608096	0.1709431	0.0177913	0.0011403	0.0291097	0.0651133	0.1751409	0.6913818	0.0019544	0.4592039
eb032607.tif	1.198E-05	0.1763011	0.2597162	0.5586257	0.0001277	0.0002527	0.158085	0.2511378	0.5059199	0.6085842	0.000391	0.5310556
eb053107rolla105.tif	0.0044086	0.3985042	0.6905472	0.8500405	0.0223565	0.0077248	0.38053	0.6831418	0.8287227	0.5720004	0.0013736	0.4404183
es090507rab296.tif	1.065E-05	0.0299816	0.0652375	0.2471694	0.0002768	0.0011941	0.0247923	0.0667413	0.2320318	0.7479627	0.0008443	0.4148058
ew022807.tif	0.0549816	0.1503539	0.2910877	0.513998	0.0001405	0.8837145	0.1446476	0.2809375	0.4881261	0.5583172	0.0005666	0.3157924
ew101907.tif	0.0210787	0.1124503	0.1771424	0.4137031	0.1178965	0.2447268	0.112656	0.1745038	0.4241759	0.6185033	0.0001035	0.4592107
fh080607rolla182.tif	1.377E-05	0.1321707	0.2029696	0.3646536	0.0071374	0.0013013	0.1271266	0.1938967	0.3440512	0.6667603	0.0007451	0.4680694
gm110507dru106.tif	1.012E-05	0.0109707	0.0376634	0.1739897	0.0004719	0.002967	0.0104113	0.0352751	0.1592054	0.5848125	0.0010047	0.4788496
gm110507dru107.tif	1.087E-05	0.0534652	0.1250811	0.470938	0.0003388	0.0006629	0.0504997	0.1306699	0.5116604	0.5448029	0.0009302	0.4358558
gm110507dru108.tif	0.1539684	0.3818041	0.6162377	0.8084992	0.0001095	0.2096947	0.3932555	0.5982302	0.8161471	0.514682	0.0015584	0.5783522
gt071207.tif	1.091E-05	0.0511181	0.0926607	0.276406	0.0001772	0.0007156	0.0462218	0.0913321	0.2478735	0.603344	0.0011179	0.4906969
gw100807.tif	27.980327	7.0301164	2.541707	0.9506946	0.1774415	1.6318773	6.7704743	2.4318767	0.874936	1.8960276	0.0002948	0.2188102
hc051407.tif	0.0126423	0.1791631	0.359217	0.7028859	0.0001429	0.0002104	0.1746587	0.3475455	0.6798488	0.5640202	0.0006691	0.4437984
hn060107.tif	0.0101133	0.072088	0.1597228	0.3710165	0.0093169	0.0742305	0.0718463	0.1554679	0.3887012	0.5751455	0.0005141	0.477453
hs061407rolla123.tif	0.1655542	0.1720706	0.3722129	0.6907581	0.0078017	0.871317	0.1835962	0.3724819	0.7133102	0.4605053	0.0003939	0.4831184
ja061807.tif	5.479E-05	0.0204197	0.0781033	0.8348973	0.031109	0.2954922	0.0200547	0.081691	0.8744027	0.5964233	0.0021953	0.446026
jb072007.tif	0.0071733	0.0710155	0.1434233	0.3330325	0.0332359	0.5839043	0.0703723	0.15065	0.3487478	0.5538586	0.0025882	0.4364314
jb080607rolla181.tif	0.0121832	0.0856443	0.16893	0.4268636	0.3142665	0.2808267	0.0847672	0.175594	0.4402836	0.4826662	0.0012216	0.3799
jc050307.tif	0.0028974	0.006265	0.0146473	0.0865312	0.0003829	0.0047297	0.0063152	0.014076	0.0810418	0.5578622	0.0017183	0.4359667
jd020707.tif	0.0217161	0.1227093	0.2008594	0.3542684	0.0168178	0.0002819	0.1236438	0.2103034	0.3570834	0.5788163	0.0003252	0.3254089

Table B.1. (continued)

jd070607.tif	1.302E-05	0.0249958	0.0451434	0.1828412	0.0216458	0.118106	0.0260788	0.0455843	0.1744164	0.6108739	0.0007	0.3903849
jf051007.tif	9.511E-06	0.071004	0.1372211	0.3474353	0.0678631	0.1780803	0.0714152	0.1459969	0.3439809	0.6041299	0.0003205	0.4436904
jh022307.tif	0.009763	0.1847807	0.3820307	0.7542897	0.0141077	0.0299635	0.162538	0.3956985	0.6780973	0.5537242	0.0003394	0.4273502
jh050207.tif	0.006105	0.246292	0.3981762	0.6506532	0.0012721	0.0001461	0.2494888	0.3889504	0.6372194	0.5094165	0.0003782	0.4019248
jh051007.tif	0.0128671	0.2379266	0.3770884	0.5121844	0.0032651	0.0039003	0.233851	0.390292	0.5304441	0.6837021	0.0002342	0.4877273
jk032807.tif	0.0676242	0.5525886	0.7004022	0.797766	6.813E-05	0.0594709	0.5512799	0.7540174	0.8194353	0.5343687	0.0003546	0.3874436
jk053007rab166.tif	0.1063516	0.4117714	0.6347122	0.8369235	0.0771195	0.5221024	0.3929387	0.6666026	0.8163656	0.3809786	0.0003168	0.3723526
jl111407.tif	9.487E-06	0.0754501	0.1538365	0.3007977	0.0001274	0.0004672	0.0858837	0.1355861	0.2731559	0.3311653	0.0005197	0.3488946
jm031207.tif	0.0273588	0.0611285	0.1951631	0.6997835	0.0003317	0.0005114	0.0626268	0.1853263	0.6494154	0.4235758	0.000152	0.3856373
jm080107rab247.tif	8.53E-06	0.0136954	0.0339853	0.1380473	0.0002398	0.0017651	0.0132215	0.0330212	0.1360225	0.6617664	0.0001035	0.5177088
jn091707rol208.tif	0.755952	2.7611024	1.4577904	0.9277827	0.0070809	0.1389414	2.7414539	1.4246617	0.9196776	0.7636217	0.0007451	0.2972667
jp030907rab56.tif	7.569E-06	0.0152322	0.0298618	0.1343731	0.0012793	0.0015647	0.0140838	0.0290668	0.1239493	0.7585893	0.0010047	0.430367
jp030907rab57.tif	0.0002126	0.0507518	0.0811658	0.1712315	9.265E-05	0.0043235	0.0517552	0.0825766	0.1761049	0.5983078	0.0002808	0.4378501
jp051707rab143.tif	0.0001992	0.085293	0.193118	0.3991463	0.0007672	0.0146182	0.0948433	0.1909111	0.4283177	0.5524479	0.0002326	0.4135216
jp051707rab144.tif	0.0007226	0.1007116	0.1654532	0.2895221	0.0003368	0.011147	0.103574	0.1544125	0.2777149	0.4345661	0.0010204	0.4629101
jp062507rab197.tif	0.0141043	0.2855961	0.5339403	0.9341531	9.859E-05	0.1150101	0.2694477	0.5379446	0.874951	0.542976	0.0001752	0.3382678
jp062507rab198.tif	8.748E-06	0.1213863	0.2576817	0.4694014	0.0004061	0.0002021	0.1250512	0.2499222	0.495458	0.5983785	0.0016104	0.3704933
jp062507rab199.tif	1.002E-05	0.0290971	0.0679527	0.2432795	0.0002296	0.0008061	0.0308854	0.0670415	0.2852227	0.5004422	0.0006989	0.3172567
jp070207.tif	6.946E-06	0.0456899	0.0873852	0.1881955	9.355E-05	0.0005018	0.0459731	0.0794388	0.1867024	0.6638464	0.0004025	0.3453716
js070907.tif	6.817E-06	0.0006892	0.0015592	0.0132336	0.0004503	0.0284836	0.0007147	0.0015419	0.0158312	0.6577912	0.0001233	0.4343519
js091807rol215.tif	0.0396266	0.1160225	0.2005682	0.5513286	0.6071834	0.5027488	0.1137984	0.1963716	0.5289149	0.6516292	0.0006842	0.3026624
js091807rol216.tif	0.0082115	0.2349264	0.3939955	0.8254075	0.0028414	0.1088512	0.2416919	0.3916152	0.8452794	0.7104585	0.0006609	0.4020819
jt082807.tif	0.0074143	0.0604389	0.1196154	0.3547679	0.0001442	0.0469203	0.0610176	0.1038213	0.3369109	0.4646375	0.001046	0.3877888
jv013007 .tif	0.3431444	0.6632216	0.8359538	0.7516713	0.5317041	0.3719048	0.6655205	0.9037746	0.7633444	0.7391242	0.0006272	0.2687043
kb022707.tif	0.0005997	0.0084413	0.0225358	0.1087654	0.0030093	0.0376531	0.008594	0.0218946	0.1044155	0.573251	0.0005485	0.3351377
kd100807.tif	1.049382	4.7447494	5.9849416	1.8283032	0.326155	0.6865249	4.7190702	6.0419864	1.81054	0.3549183	0.0009142	0.3623769
kp012907.tif	1.518E-05	0.1002694	0.2253965	0.3182004	0.0001576	0.0004943	0.1048447	0.2123594	0.3193389	0.1513973	0.0008187	0.4110149
kp042607.tif	7.713E-06	0.0323215	0.0565362	0.1569574	0.0014945	0.0035457	0.0337936	0.0528748	0.1585896	0.6426066	0.000867	0.3597402
ks070907rolla151.tif	6.468E-06	0.1632771	0.3057455	0.5034589	0.0012193	0.0001427	0.1591294	0.2819485	0.5034789	0.5513322	0.0006068	0.272418
kv090707rol200.tif	7.788E-06	0.0119877	0.0169758	0.0632712	0.0001048	0.0663441	0.0127559	0.0168079	0.0663357	0.6462078	0.0008065	0.3903849

Table B.1. (continued)

lc052207.tif	0.0882246	0.3973086	0.4291608	0.5731264	0.1873418	0.2837623	0.3575207	0.4484954	0.5255902	0.6474965	0.0003656	0.4592039
lg081707rolla193.tif	0.0118399	0.2295228	0.4878628	0.7844746	0.0109863	0.0176828	0.2325699	0.4986096	0.8071019	0.5815117	0.0003439	0.5310556
ll040307.tif	0.008562	0.2482546	0.476626	0.8856592	7.611E-05	9.134E-05	0.2238227	0.4884767	0.8348474	0.6021101	0.0006847	0.4404183
lp020907.tif	0.0069477	0.1161359	0.255905	0.7147776	0.0050071	0.0001744	0.1142617	0.264402	0.6948394	0.5208344	0.000753	0.4148058
lp092407rol217.tif	6.069E-06	0.0159876	0.0321327	0.0848108	9.804E-05	0.0012786	0.0146223	0.0292371	0.0768209	0.5328533	0.0004558	0.3157924
ls012607.tif	5.395E-06	0.000157	0.0005129	0.0019733	0.0002117	14.167133	0.0001568	0.0005421	0.0020919	0.5753116	0.0001554	0.4592107
lt030207.tif	0.0003017	0.1063932	0.2099776	0.4372286	0.0027285	0.0066221	0.1106015	0.2124268	0.4692587	0.5973589	0.0007	0.4680694
lt111407.tif	5.108E-06	0.0661266	0.1178338	0.3371	8.996E-05	0.0002913	0.0518876	0.1160231	0.3094377	0.7123958	0.0003205	0.4788496
lz032907.tif	5.908E-06	0.0211034	0.0485103	0.154782	0.0001303	0.0009217	0.0192098	0.0475668	0.1417059	0.4728727	0.0003394	0.4358558
mc041307.tif	5.055E-06	0.2440201	0.3740319	0.5309163	4.342E-05	8.013E-05	0.2556319	0.4038049	0.542968	0.5323404	0.0003782	0.5783522
mc111507dru115.tif	5.906E-06	0.084716	0.137403	0.3062271	6.086E-05	0.0002016	0.0863231	0.1380467	0.3025883	0.5784969	0.0002342	0.4906969
mc111507dru116.tif	4.691E-06	0.0394554	0.0835871	0.3247204	0.0001376	0.0003914	0.0370688	0.0725242	0.3523627	0.6474263	0.0003546	0.2188102
mc111507dru117.tif	4.672E-06	0.0176258	0.0314028	0.1019375	8.394E-05	0.0008279	0.0186119	0.0314755	0.1016111	0.5906922	0.0003168	0.4437984
mc111507dru118.tif	5.578E-06	0.044521	0.064604	0.1303316	5.053E-05	0.0056802	0.0479943	0.0635675	0.1395098	0.5308226	0.0005197	0.477453
md032607rab79.tif	0.1048233	0.1216229	0.2221259	0.5292834	0.1778955	1.1169743	0.1326343	0.2210905	0.5801958	0.4868129	0.0005882	0.4831184
md032607rab80.tif	0.0707765	0.1718082	0.477539	0.9973481	0.1088691	0.5437489	0.1779508	0.4837595	0.9981751	0.3482617	0.0009627	0.4523374
md033007.tif	0.0009877	0.0360588	0.087272	0.2640994	0.003158	0.011677	0.0360829	0.087137	0.2704702	0.547682	0.0002917	0.4305905
mg080607.tif	4.115E-06	0.0467546	0.1058962	0.3009409	8.934E-05	0.0134253	0.0532351	0.1043495	0.3304953	0.511465	0.0010087	0.4818513
mo082207.tif	0.0066692	0.0076606	0.0211056	0.0824376	0.0001341	1.5960823	0.0079317	0.0232102	0.0885144	0.5926474	0.0035742	0.3985019
mr022007rolla47.tif	0.4509042	0.4472713	0.6189199	0.9628639	1.2541053	1.8323717	0.4443186	0.62283	1.0405487	0.6029017	0.0005369	0.4870886
nd112007.tif	3.677E-06	0.0150667	0.0399742	0.1638363	0.0001268	0.0006975	0.0171059	0.0420648	0.1822913	0.5627435	0.0010044	0.4408031
nm081407rab263.tif	3.712E-06	0.102357	0.2105708	0.4169169	5.077E-05	0.0001498	0.0962144	0.2057209	0.3397552	0.453725	0.00097	0.4226971
nz010807.tif	3.906E-06	0.2273645	0.3450857	0.5205181	3.124E-05	0.0006185	0.223982	0.3518011	0.5294324	0.6856738	0.0009302	0.4545866
nz052307.tif	3.914E-06	0.1136341	0.1832607	0.4030512	0.0007227	0.0001175	0.1182269	0.2044681	0.4209044	0.4571983	0.0015584	0.4689225
ob092407.tif	0.015796	0.1504716	0.3625944	0.6689969	0.0100621	0.0563739	0.1493594	0.3639207	0.7224173	0.6078149	0.0011179	0.4698622
pg080707.tif	3.526E-06	0.1519831	0.240925	0.4832989	4.291E-05	8.446E-05	0.1347015	0.2570357	0.5096573	0.6135444	0.0002948	0.4798544
pk082907rab281.tif	0.0003085	0.0598028	0.1353939	0.2995706	5.885E-05	0.0001767	0.0576651	0.1415312	0.3341982	0.578008	0.0006691	0.3903849
pw062907.tif	3.161E-06	0.180002	0.3950978	0.6756717	4.378E-05	6.241E-05	0.1917924	0.3947658	0.7038656	0.5019588	0.0005141	0.4436904
ra091207rab305.tif	0.0159358	0.059631	0.1401624	0.362335	1.6799421	2.9948296	0.0656839	0.1596354	0.383687	0.3671194	0.0003939	0.4273502
ra091207rab306.tif	0.0193605	0.1846659	0.2665605	0.4368889	0.0033264	0.082843	0.1980985	0.2590768	0.4615326	0.5328502	0.0005882	0.4019248

Table B.1. (continued)

rb091007.tif	2.726E-06	0.0595767	0.1221288	0.260229	3.808E-05	0.0001481	0.0608565	0.1212469	0.2580507	0.60903	0.0001035	0.3856373
rc082707rab275.tif	0.0018269	0.1206885	0.2208739	0.4323782	0.0014978	0.006195	0.1228135	0.2092746	0.3994342	0.5080493	0.0007451	0.5177088
rh091707rab314.tif	2.565E-06	0.02987	0.054064	0.1693372	5.261E-05	0.0003439	0.0285622	0.0575826	0.1536169	0.425787	0.0010047	0.2972667
rh091907.tif	2.553E-06	0.0168861	0.0310833	0.0866697	4.698E-05	0.0004671	0.0177148	0.0336154	0.1010047	0.5415546	0.0002808	0.430367
rm022707.tif	0.0176815	0.0901087	0.2392626	0.5748445	0.4168057	0.5376282	0.0946611	0.2399738	0.5708947	0.4817723	0.0002326	0.4378501
rp100907rab348.tif	0.0379991	0.0643998	0.1193441	0.2501183	3.029E-05	0.0001339	0.059963	0.1086006	0.2273855	0.5649283	0.0010204	0.4135216
rr031207.tif	0.9586131	0.999221	1.1601064	1.0913112	2.3973968	1.9006145	0.9984901	1.1750831	1.0820661	0.6449997	0.0001752	0.4629101
rs091407.tif	2.194E-06	0.0982887	0.1735553	0.3913075	2.945E-05	8.565E-05	0.1112846	0.1928156	0.3456418	0.3467101	0.0016104	0.3382678
sl072307dru5.tif	3.71E-05	0.0038059	0.0158203	0.2109607	0.1214051	0.1147338	0.003791	0.0166537	0.2073208	0.4382605	0.0006989	0.3704933
sl072307dru56.tif	9.964E-05	0.096398	0.1738975	0.3716556	0.0028378	0.0077779	0.0908768	0.173024	0.3648705	0.7303	0.0008679	0.3172567
sm071607.tif	2.211E-06	0.1825178	0.266889	0.4053288	1.479E-05	4.645E-05	0.174964	0.2200729	0.3202615	0.4057084	0.0019544	0.3453716
sm092507.tif	1.547E-06	0.0166405	0.0305624	0.1475605	4.413E-05	0.0003253	0.0171847	0.0290259	0.1365336	0.5167273	0.000391	0.4343519
sp051007.tif	0.0747876	0.3395118	0.5107515	0.6307184	0.0008476	0.117318	0.333192	0.5077855	0.6324287	0.4602384	0.0013736	0.3026624
sr110807.tif	0.0175417	0.1957314	0.2974965	0.48914	1.429E-05	0.0006575	0.2034421	0.3294618	0.5341934	0.584453	0.0008443	0.4020819
ss032007.tif	0.0010494	0.0278658	0.0527671	0.1342252	0.0013027	0.0001514	0.0281216	0.0501806	0.1374544	0.5905159	0.0005666	0.3877888
ss080307 CNP.tif	0.0366067	0.2445348	0.3606094	0.5890306	0.4811741	0.4717596	0.2472041	0.3681371	0.6365848	0.5280788	0.0001035	0.2687043
sw021507.tif	0.001596	0.1166383	0.2356989	0.5277697	0.0003617	0.0208656	0.1252724	0.2271775	0.5604479	0.4755623	0.0007451	0.3351377
sz110607.tif	9.903E-07	0.1199198	0.216313	0.5394597	1.595E-05	3.217E-05	0.1142524	0.2167616	0.5011344	0.5022576	0.0010047	0.3623769
tb091007_.tif	0.0258614	0.1235427	0.2304788	0.4723714	0.0012835	0.250933	0.1214384	0.2389073	0.4349412	0.610401	0.0009302	0.4110149
tc101907rolla241.tif	0.2325009	0.4881553	0.7076872	0.9593713	0.4435041	0.5059689	0.4973719	0.7100088	0.96009	0.6681936	0.0015584	0.3597402
tc101907rolla242.tif	0.00144	0.0743632	0.1534629	0.3606471	0.001049	0.0048967	0.0732702	0.1624527	0.3557394	0.6256198	0.0011179	0.272418
tl073107.tif	0.0054075	0.2140232	0.2721392	0.4509727	0.0130736	0.0402315	0.2289635	0.2692999	0.4711418	0.5660621	0.0002948	0.4620578
tw052507 .tif	4.518E-07	0.0266962	0.0765623	0.3029874	1.5E-05	5.11E-05	0.0243116	0.0767636	0.3007401	0.6515404	0.0006691	0.3773013
wb080707dru72.tif	0.0064396	0.0800265	0.1355437	0.269653	0.0041362	0.0871418	0.0806355	0.1395226	0.2721668	0.6737839	0.0005141	0.3468289
wr052407_01dru3.tif	0.0002961	0.0849762	0.1920055	0.5591589	4.835E-06	0.004521	0.0766402	0.1854968	0.5191284	0.5860464	0.0003939	0.5020753
wr052407_02dru4.tif	0.0056258	0.2880112	0.4722486	0.6512233	1E-06	0.0025061	0.2913283	0.4926851	0.6524281	0.6391315	0.0021953	0.3535929
wv072607.tif	0.0099147	0.3622103	0.5504387	0.7585595	9.755E-08	0.0009807	0.3294575	0.4779758	0.701996	0.539279	0.0025882	0.3117682
HG061807per3.tif	0.8388888	0.6700665	0.9084005	1.6951333	9.4808078	3.1655824	0.6570279	0.894016	1.6623658	0.3891427	0.0012216	0.3660661
HW011108per5.tif	0.1363769	0.7076602	0.7293308	0.8176301	0.5385586	0.2682078	0.7068111	0.7195365	0.811409	0.988657	0.0017183	0.4805954
JW092807per2.tif	0.7493409	1.1143925	1.7093926	1.2832223	0.762225	1.3227572	1.1371882	1.7020336	1.2819436	0.413238	0.0001035	0.3856373

Table B.1. (continued)

LF071307.tif	0.1604898	0.3018201	0.6753959	0.9774539	0.2004552	1.2841085	0.3030409	0.6870045	0.9753946	0.3435382	0.0001233	0.4377109
WM083007per1.tif	0.0010523	0.1760683	0.2233574	0.3941312	0.0004084	0.0037133	0.1740633	0.2256196	0.380328	0.8559941	0.0006842	0.446026
ak051007rab131.tif	0.0534312	0.2940554	0.4479004	0.5921505	0.1446264	0.2826683	0.2785315	0.4858889	0.5878311	0.6029199	0.0006609	0.4364314
bb040407rab96.tif	0.2257032	0.387531	0.5942197	0.8217096	0.5810117	0.7140582	0.3592666	0.6312081	0.8400318	0.6625108	0.001046	0.3799
bw072307.tif	0.9083668	1.008551	1.060433	1.2207463	0.5440718	0.8237135	0.9565162	1.0543751	1.1572976	0.7360603	0.0006272	0.4359667
cd030907.tif	2.4555557	1.9987404	2.0981438	1.2684277	9.3389451	4.1775635	1.989409	2.1947652	1.3546063	0.5766366	0.0005485	0.3254089
ch121907rab487.tif	0.2775699	1.8906754	3.7676685	2.7229409	0.0774154	0.5328779	1.890053	3.7446868	2.7477734	0.2722646	0.0009142	0.408372
cs042607rab11.tif	0.4226573	0.6818488	0.953826	0.9976293	0.2463561	1.2745951	0.727633	0.9239721	1.0610651	0.4181307	0.0008187	0.393597
dk042408rab68.tif	0.6315286	1.0295168	1.0966179	1.0551217	0.5755678	0.6068411	1.0048967	1.1186153	1.0488627	0.937388	0.000867	0.4998543
dm040907.tif	0.1583115	0.7479944	1.2587471	1.0914637	1.2103582	0.4057662	0.7343874	1.2229604	1.0458715	0.3789164	0.0006068	0.3644158
dp070507rab21.tif	0.1636808	0.4777012	0.6126061	0.9919218	0.6767326	0.1518752	0.47085	0.6509808	0.9744733	0.5591379	0.0008065	0.4826219
ea012108rab530.tif	4.9385981	1.3768198	1.9758581	2.5271361	2.7194065	3.2057428	1.375427	1.9991352	2.544849	1.1710585	0.0007614	0.4592039
es101207.tif	0.4584417	0.6895916	0.9446068	0.8761712	0.5612449	1.2555145	0.6705687	0.9662225	0.8651446	0.6069247	0.0005599	0.5310556
ev060507rol11.tif	0.1417443	0.2971896	0.4363053	0.7320607	1.0149758	1.9062607	0.2807839	0.3837612	0.6775595	0.4669366	0.0008054	0.4404183
fw083007rab28.tif	0.6035615	1.1109575	1.3455693	1.5637561	0.2494057	0.4771573	1.2318387	1.1936895	1.4689593	0.3570735	0.0004194	0.4148058
gc121907rol26.tif	0.3593839	0.8774056	0.9718447	0.9334593	0.8477813	0.712718	0.9280674	0.9861033	0.9870832	0.495751	0.0004104	0.3157924
gt030907rab5.tif	41.622258	4.0726625	2.3169624	1.8681335	4.9673584	1.7022282	4.0425445	2.3320886	1.870623	5.6447044	0.0003656	0.4592107
hf020708rab55.tif	4.571728	1.9354627	1.8831178	1.0493752	4.7811149	5.5501527	1.9197095	1.7649848	1.0265548	0.4816282	0.0003439	0.4680694
hh031207rol1.tif	0.1048445	0.4791911	0.7660451	0.9908391	2.0470406	0.9813981	0.5219182	0.7679471	1.0095811	0.193989	0.0006847	0.4788496
hk030508rab58.tif	0.0057307	0.1828478	0.3196076	0.5415978	0.0014203	0.5910636	0.1816481	0.3338417	0.5472789	0.5372355	0.000753	0.4358558
hs061407rolla124.tif	0.754351	0.7435939	0.7581151	0.8882525	1.0600134	0.9360242	0.7672828	0.7595344	0.8765664	0.9007135	0.0004558	0.5783522
hs061507rab18.tif	0.2785686	0.8537756	1.0933424	1.0168553	0.0308104	0.0615315	0.858638	1.1582345	1.1382942	0.4053418	0.0001554	0.4906969
hv062207.tif	4.3676565	0.8711462	0.8614421	1.0130461	3.3921951	3.919344	0.8464736	0.8642381	1.0416343	1.0430702	0.0007	0.2188102
im011707rab.tif	0.4182198	0.6757266	0.8219189	1.0664334	0.0001928	0.5445601	0.6750075	0.8252943	1.0774751	0.545988	0.0003205	0.4437984
jb080607rolla18.tif	0.1629995	0.2440402	0.3699123	0.481834	0.5071877	1.1495047	0.2307962	0.3653936	0.4861462	0.5974102	0.0003394	0.477453
jf022108rab57.tif	0.1113897	0.6477064	0.7327142	0.8450459	2.498E-05	0.0002573	0.6434873	0.7187107	0.7966397	0.9375778	0.0003782	0.4831184
jf022108rab57.tif	3717.1856	64.013201	3.1593522	1.2623322	1.2150433	1.5846818	63.56775	3.0858731	1.2450259	25.449967	0.0002342	0.4377109
jg030308rol32.tif	0.7317225	0.5644983	0.4475976	0.5834926	1.3173884	1.9048497	0.5494369	0.4785549	0.6018715	0.788823	0.0003546	0.446026
jg100807.tif	22.436144	4.1969559	2.1439591	1.8730186	0.7686798	2.5374756	4.172665	2.1673275	1.8867524	1.3704776	0.0003168	0.4364314
jk051508rab71.tif	0.0532676	0.1903393	0.3697528	0.6753898	0.2039865	0.6272359	0.1830468	0.3763239	0.6180799	0.4791999	0.0005197	0.3799

Table B.1. (continued)

jk053007rab16.tif	137.62824	1.2767585	0.4984475	0.5532774	4.5184174	5.2625622	1.2876887	0.4841963	0.5538465	39.452644	0.0008679	0.3985019
jk061107rol12.tif	0.0281346	0.3660828	0.4198716	0.5991001	0.1529579	0.0343667	0.3577929	0.4200186	0.5937297	0.7276364	0.0019544	0.4870886
jr021808rab56.tif	1.2233093	0.9692536	1.046987	1.1603818	1.1789594	1.4945675	0.9241566	1.0341337	1.1211266	0.6665642	0.000391	0.4408031
lm040407rab9.tif	0.0832923	0.4933763	0.649807	0.862543	0.0283207	0.1784914	0.5097353	0.6574225	0.8787743	0.5725261	0.0013736	0.4226971
lr013007rab1.tif	4.0280625	1.3472542	122.93145	19.690974	1004.4389	30.747107	1.4307556	121.43008	20.178523	0.1408245	0.0008443	0.4545866
lr013007rab14.tif	0.2908721	0.3797	0.5471565	0.6745001	0.3336669	1.6565585	0.3692998	0.5951997	0.6675375	0.5727073	0.0005666	0.4689225
md052107.tif	0.1195016	0.3392762	0.529389	0.68736	6.9103734	4.0321503	0.3424442	0.5350554	0.668088	0.5049484	0.0005882	0.4698622
mh110507dru10.tif	0.975	0.9892473	0.9928058	0.9963899	0.9783394	0.9855072	0.9892473	0.9928058	0.9963899	0.9964286	0.0009627	0.4798544
mm011708rab52.tif	0.4489286	0.661623	0.7687589	0.7830471	1.5901583	2.2084019	0.668075	0.7568918	0.7810587	0.6114941	0.0002917	0.3903849
mr111207rab411.tif	2.7436152	1.5522275	10.287486	2.1730263	16.643343	9.1540236	1.5594751	10.46631	2.1632909	0.2754887	0.0010087	0.4436904
ms041808rab66.tif	0.0315254	0.4077548	0.6534478	0.7949238	0.1061893	0.0677923	0.3834724	0.5725002	0.7386312	0.5036384	0.0035742	0.4273502
mv021607.tif	0.5100714	1.0011142	1.2142038	0.9469136	1.2392147	2.1812616	1.0136614	1.2899469	0.9913795	0.2695807	0.0005369	0.4019248
nc061107rab18.tif	0.1291687	0.3372669	0.5468805	0.7273588	0.1434151	0.3865445	0.3455727	0.549016	0.7550727	0.4711949	0.0010044	0.4877273
ng021207rab2.tif	0.6219833	0.9403609	0.9770744	0.981486	0.0607151	0.600171	0.9537939	1.0384083	1.0188423	0.7006492	0.00097	0.3874436
pr100907a.tif	2.6130814	5.0146102	3.1686299	3.7885451	87.330798	15.339065	4.9240899	3.0962955	3.7783784	0.0705893	0.0009302	0.3723526
rb031207rab5.tif	0.941939	0.5724818	0.6907554	0.7941209	1.4504048	2.6094885	0.5627603	0.6764509	0.7719486	0.6719327	0.0015584	0.3488946
rr041508rol36.tif	0.3002016	0.3129635	0.4604815	0.6036784	0.7498855	2.4193732	0.2989807	0.4438687	0.5835413	0.6804251	0.0011179	0.3856373
rr070507.tif	0.255175	0.2640738	0.4813312	0.6986745	1.8169889	3.0446565	0.2545994	0.4883909	0.6946104	0.3267761	0.0002948	0.5177088
rw113007rab371.tif	0.4398583	0.5752082	1.1713054	1.1158207	0.271653	1.4806617	0.5694474	1.1110526	1.041646	0.3458478	0.0006691	0.2972667
sa082207rab27.tif	0.03687	0.5584431	0.7425882	0.8109658	0.1007009	0.2447279	0.5445223	0.7875627	0.8266689	0.5181255	0.0005141	0.430367
sh091407dru9.tif	0.0002289	0.0599726	0.1048682	0.2241857	0.000586	0.0190558	0.0640345	0.1065943	0.2095549	0.5174658	0.0003939	0.4378501
sp092007dru9.tif	0.3065822	0.4672158	0.7788108	1.3767002	1.5103673	2.3968661	0.5169465	0.7964853	1.5681031	0.2387341	0.0021953	0.4135216
sw042808rab68.tif	6.0061756	6.548109	4.3354052	1.9450291	5.6330002	3.3730858	6.5073878	4.2849594	1.9219478	0.2707689	0.0025882	0.4629101
sw080907rab25.tif	2.3373846	2.9482544	1.375403	1.5132034	14.540383	9.0482476	2.9481019	1.3783005	1.4906433	0.1077436	0.0012216	0.3382678
sz121107dru13.tif	0.1438742	0.8096283	0.7787053	0.8048895	0.7736692	0.4927193	0.7582892	0.7183535	0.8735095	0.4659716	0.0017183	0.3704933
tb013107 .tif	0.5490564	1.1808514	0.9839843	0.9025327	0.012044	0.5468328	1.1866505	0.940076	0.906966	0.5465668	0.0003252	0.3172567
tb092807rab34.tif	0.0764266	0.3074659	0.5172025	0.7336372	0.0007304	0.285901	0.3303047	0.498154	0.7752483	0.39762	0.0005748	0.3453716
ts101707.tif	2.46903	2.0525153	1.9801286	1.3638318	1.450323	1.1736518	2.0459238	1.9392515	1.3600229	0.9947047	0.0004895	0.4343519
ty032107rab7.tif	0.3685226	0.6896663	1.1598362	1.1405037	1.5937425	1.6994859	0.6086858	1.0678122	1.0447109	0.3497272	0.0016547	0.3026624
wc031407.tif	0.0914287	0.1959839	0.3877407	0.610628	1.4094176	3.3952738	0.1956414	0.3656836	0.5854871	0.3270371	0.0012947	0.4020819

Table B.1. (continued)

wg030107.tif	0.0842158	0.2845785	0.4788789	0.7733965	0.4477354	0.359474	0.2853128	0.4691057	0.7173779	0.4561817	0.0002326	0.4629101
wh052907rol10.tif	0.3782254	0.7895362	0.9725306	0.9669168	1.0471105	1.0817957	0.7857591	0.9846367	0.9800741	0.3548368	0.0010204	0.3382678
wt061507rab18.tif	0.7916365	0.2677731	0.3067296	0.7654154	30.046469	14.669655	0.2470051	0.3061592	0.7595462	0.2713306	0.0001752	0.3704933
ww053008rol39.tif	0.0294777	0.8075129	1.0240728	1.0445635	0.2447115	0.0584898	0.7741368	1.06806	1.0329101	0.4378957	0.0016104	0.3172567
yr042308dru14.tif	4.2752173	3.9528684	4.52048	1.6904753	10.131136	6.2220382	4.1385307	4.6903344	1.7746609	0.2026504	0.0006989	0.3453716

APPENDIX C

EXCEL SHEET FOR NEURAL NETWORK – LESIONS NOT TOUCHING THE IMAGE BORDER

Table C.1. Lesions not touching the image border

FileName	Image Features											
	c14	c34	c35	c39	c44	c59	c60	c82	c84	c89	c95	c97
CT110907.tif	0.00049	0.00239	0.0802267	0.3291136	0.047344	0.0030192	0.0239846	41.78619	31.642223	1.7448213	0.0001884	0.3638154
DT111507per45.tif	0.001509	0.044012	0.0157129	0.1061539	0.0011556	0.0104142	0.0056726	177.6795	81.732974	3.0066529	0.0004025	0.4377109
DT111507per46.tif	0.001128	6.14E-05	0.0135329	0.0542715	0.000536	0.0104701	0.0051152	197.0582	12.952221	1.9813587	0.0001233	0.446026
EH112607.tif	0.440423	0.1852897	0.0521003	0.3577581	0.0910605	0.4247815	0.0238748	41.95427	13.037599	1.6644698	0.0006842	0.4364314
JG071807per11.tif	2.649926	6.9039593	2.6181451	2.4380749	3.3826152	2.73047	0.4819429	2.075224	2.3292459	2.1859093	0.0006609	0.3799
JG071807per12.tif	7.152495	7.4353308	1.0937441	2.835976	26.616778	7.1619764	0.4020041	2.488312	6.628313	1.5176304	0.001046	0.4359667
LB110907per42.tif	0.549034	0.995239	0.8237443	0.883152	0.0269488	0.5423588	0.4264242	2.345332	5.4195539	3.6555092	0.0006272	0.3254089
MG100507.tif	1.793E-05	0.0048315	0.0087781	0.0264731	0.0002803	0.0114165	0.0048583	70.14332	3.6656622	3.0538332	0.0005485	0.408372
MT060807.tif	0.0009779	0.0795864	0.1142339	0.2748767	0.0002122	0.0008389	0.0699961	9.54442	7.3041338	2.8651332	0.0009142	0.393597
ad021607.tif	0.0978504	0.384042	0.5676245	0.7139234	0.0028472	0.1231396	0.3563003	2.25968	0.2223631	0.8240546	0.0008187	0.4998543
ad040507.tif	1.673E-05	0.0590901	0.1397447	0.4451135	0.0003975	0.0009728	0.0547434	12.6014	4.0563036	0.4540087	0.000867	0.3644158
ag031907.tif	1.631E-05	0.031114	0.0634416	0.2385105	0.0003699	0.0015096	0.030418	88.98526	1.0737588	2.6823436	0.0006068	0.4826219
ag061307rab185.tif	0.0002859	0.0229917	0.0399529	0.1128409	0.0002789	0.0249478	0.0233027	207.7216	8.1166293	2.3241953	0.0008065	0.4592039
ak051007rab131.tif	0.0527808	0.2963984	0.4515505	0.588603	0.1425968	0.2778204	0.2807663	14.29549	31.642223	2.2609581	0.0007614	0.5310556
ar031607rab68.tif	0.0025273	0.0520763	0.1009447	0.3154338	0.0002953	0.0025659	0.0530102	0.2040988	0.4348982	5.191229	0.0004558	0.4404183
as051707.tif	0.0571936	0.1757821	0.2753245	0.4662522	0.0169322	0.0498429	0.1631525	0.2715529	0.4624516	0.5900483	0.0001554	0.4148058
as070307rab211.tif	1.601E-05	0.1031661	0.1698406	0.3524828	0.0001751	0.0005454	0.1069668	0.1623319	0.3212362	0.553628	0.0007	0.3157924
as070307rab212.tif	1.554E-05	0.0122354	0.0338684	0.1487594	0.0005794	0.0050984	0.0095495	0.0349045	0.1137231	0.5212668	0.0003205	0.4592107
as073107.tif	1.554E-05	0.0110924	0.030803	0.1271246	0.0004781	0.0041248	0.0099996	0.0305348	0.1159972	0.7263614	0.0003394	0.4680694
as080207.tif	0.0098714	0.005778	0.0166219	0.1693723	0.0017434	0.2344313	0.0056956	0.0163169	0.156478	0.3420264	0.0003782	0.4788496
as090507dru85.tif	1.495E-05	0.0019135	0.0055258	0.0308713	0.0006793	0.5716975	0.0020789	0.0056136	0.0322183	0.6322727	0.0002342	0.4358558
as101807rab369.tif	0.0072639	0.018885	0.038222	0.1512248	0.0003715	0.0023732	0.0192506	0.0365955	0.1566441	0.6635257	0.0003546	0.5783522
br112107.tif	0.0013459	0.2476242	0.3861233	0.4985628	0.0001325	0.0040867	0.2436954	0.3763203	0.4894825	0.4532973	0.0003168	0.4906969
bw070307.tif	0.0001181	0.1314006	0.2186648	0.4941046	0.0001976	0.0004378	0.1232472	0.2254489	0.4516291	0.5340379	0.0005197	0.2188102
cb071607.tif	0.0012341	0.0112979	0.0241204	0.0786765	0.016059	0.3581755	0.0122742	0.0251051	0.0836014	0.6933562	0.0001884	0.4437984
cd112107.tif	0.0002261	0.0760454	0.1222544	0.2583267	0.0001579	0.0075267	0.0767419	0.120834	0.2588462	0.6998613	0.0004025	0.477453
cj082207.tif	0.003531	0.4232117	0.8668666	0.9215824	0.014922	0.0001694	0.4293628	0.9388007	0.9533874	0.3929777	0.0001233	0.4831184

Table C.1. (continued)

ck111907.tif	1.725E-05	0.1634576	0.263686	0.454196	0.0001432	0.0018134	0.150905	0.2615466	0.472483	0.7549116	0.0005666	0.5177088
cl050307.tif	0.1658914	0.1848707	0.3460254	0.5248931	0.4258198	2.0944613	0.1845834	0.3166465	0.4870717	0.4028561	0.0005882	0.2972667
cm052507.tif	0.1171222	0.2548052	0.7622574	1.9875577	2.6248394	1.0205214	0.2728543	0.7785858	1.9936079	0.4018181	0.0009627	0.430367
cp050707.tif	0.6481867	4.3523554	7.2118049	1.8602377	0.0268048	0.4795468	4.4955729	7.0585668	1.8206254	0.1205205	0.0002917	0.4378501
cp060107rolla110.tif	0.0018272	0.246139	0.3598793	0.7137358	0.0094958	0.000629	0.2465714	0.352726	0.7034996	0.5321231	0.0010087	0.4135216
cs071807rolla163.tif	0.0189435	0.1841296	0.2767028	0.5189532	0.0154361	0.0729041	0.1733034	0.2780839	0.4902634	0.6425118	0.0035742	0.4629101
cw021907.tif	1.402E-05	0.1794885	0.3292158	0.5428299	0.000151	0.0002972	0.1691801	0.3237337	0.5086367	0.5389909	0.0005369	0.3382678
da102607dru100.tif	0.0002241	0.1576216	0.2538558	0.4666342	0.0001412	0.0003267	0.1500843	0.2338335	0.4325018	0.5956739	0.0010044	0.3704933
da102607dru99.tif	1.57E-05	0.1437159	0.29615	0.5942813	0.0002014	0.0003636	0.1396069	0.2487168	0.5543069	0.484149	0.00097	0.3172567
db021207.tif	1.236E-05	0.0604522	0.1727026	0.4034684	0.0002972	0.0005919	0.0633148	0.1696028	0.5025638	0.6818169	0.0009302	0.3453716
db070307.tif	0.0314434	0.291947	0.4746185	0.5797126	0.0001153	0.0033299	0.2975864	0.4535181	0.5847809	0.544792	0.0015584	0.4343519
dc061907.tif	0.0430643	0.3739454	0.5052923	0.6821246	0.775811	0.3965642	0.3188649	0.4621023	0.5747088	0.4361444	0.0011179	0.3026624
dd070207.tif	1.257E-05	0.0131433	0.0304821	0.0841947	0.0002825	0.0032133	0.0118506	0.0292504	0.0879978	0.6192531	0.0002948	0.4020819
dd081307rolla188.tif	0.1985612	0.3627218	0.5848488	0.8095323	0.2932974	1.0207207	0.3924826	0.5765113	0.8547629	0.4056603	0.0006691	0.3877888
de122106.tif	0.0004611	0.0443533	0.067062	0.2681819	0.1555266	0.111545	0.0439464	0.0696565	0.2697715	0.6385426	0.0005141	0.2687043
dl022307.tif	0.0625743	0.3689183	0.5408876	0.7711418	0.078001	0.0963887	0.3676414	0.4939336	0.7082423	0.4488238	0.0003939	0.3351377
dl111407dru111.tif	0.0018299	0.0751223	0.1448019	0.222954	0.0039319	0.0005437	0.0719196	0.1472231	0.2251831	0.6552278	0.0021953	0.3623769
dl111407dru112.tif	1.223E-05	0.0925152	0.1662618	0.3598568	0.0001816	0.0004608	0.088459	0.1883478	0.3944556	0.5513854	0.0025882	0.4110149
dm042307.tif	0.0108127	0.1569688	0.275708	0.5570471	0.0007592	0.0478698	0.1585269	0.244143	0.5381865	0.5449341	0.0012216	0.3597402
dn081707.tif	0.0003163	0.1791056	0.3902585	0.5861008	0.002022	0.000309	0.1564624	0.380073	0.529817	0.4291217	0.0017183	0.272418
dr031207.tif	0.0544662	0.0356114	0.0660603	0.1854058	0.0110589	1.6529209	0.0337948	0.0668543	0.1857913	0.6399304	0.0003252	0.4620578
ds042307.tif	0.3758523	1.0502048	1.1590423	0.9827375	0.0092961	0.23977	1.1132978	1.1944389	1.0493377	0.4760974	0.0005748	0.3773013
dz101107.tif	1.181E-05	0.0289305	0.0608096	0.1709431	0.0177913	0.0011403	0.0291097	0.0651133	0.1751409	0.6913818	0.0004895	0.3468289
eb032607.tif	1.198E-05	0.1763011	0.2597162	0.5586257	0.0001277	0.0002527	0.158085	0.2511378	0.5059199	0.6085842	0.0005666	0.5020753
es090507rab296.tif	1.065E-05	0.0299816	0.0652375	0.2471694	0.0002768	0.0011941	0.0247923	0.0667413	0.2320318	0.7479627	0.0005882	0.3535929
ew022807.tif	0.0549816	0.1503539	0.2910877	0.513998	0.0001405	0.8837145	0.1446476	0.2809375	0.4881261	0.5583172	0.0009627	0.3117682
gm110507dru106.tif	1.012E-05	0.0109707	0.0376634	0.1739897	0.0004719	0.002967	0.0104113	0.0352751	0.1592054	0.5848125	0.0002917	0.3660661
gm110507dru107.tif	1.087E-05	0.0534652	0.1250811	0.470938	0.0003388	0.0006629	0.0504997	0.1306699	0.5116604	0.5448029	0.0010087	0.4805954
gt071207.tif	1.091E-05	0.0511181	0.0926607	0.276406	0.0001772	0.0007156	0.0462218	0.0913321	0.2478735	0.603344	0.0035742	0.5177088
gw100807.tif	27.980327	7.0301164	2.541707	0.9506946	0.1774415	1.6318773	6.7704743	2.4318767	0.874936	1.8960276	0.0005369	0.2972667

Table C.1. (continued)

hc051407.tif	0.0126423	0.1791631	0.359217	0.7028859	0.0001429	0.0002104	0.1746587	0.3475455	0.6798488	0.5640202	0.0001554	0.4359667
hn060107.tif	0.0101133	0.072088	0.1597228	0.3710165	0.0093169	0.0742305	0.0718463	0.1554679	0.3887012	0.5751455	0.0007	0.3254089
ja061807.tif	5.479E-05	0.0204197	0.0781033	0.8348973	0.031109	0.2954922	0.0200547	0.081691	0.8744027	0.5964233	0.0003205	0.408372
jb072007.tif	0.0071733	0.0710155	0.1434233	0.3330325	0.0332359	0.5839043	0.0703723	0.15065	0.3487478	0.5538586	0.0003394	0.393597
jc050307.tif	0.0028974	0.006265	0.0146473	0.0865312	0.0003829	0.0047297	0.0063152	0.014076	0.0810418	0.5578622	0.0003782	0.4998543
jd020707.tif	0.0217161	0.1227093	0.2008594	0.3542684	0.0168178	0.0002819	0.1236438	0.2103034	0.3570834	0.5788163	0.0002342	0.3644158
jd070607.tif	1.302E-05	0.0249958	0.0451434	0.1828412	0.0216458	0.118106	0.0260788	0.0455843	0.1744164	0.6108739	0.0003546	0.4826219
jf051007.tif	9.511E-06	0.071004	0.1372211	0.3474353	0.0678631	0.1780803	0.0714152	0.1459969	0.3439809	0.6041299	0.0003168	0.4592039
jh022307.tif	0.009763	0.1847807	0.3820307	0.7542897	0.0141077	0.0299635	0.162538	0.3956985	0.6780973	0.5537242	0.0005197	0.5310556
jh050207.tif	0.006105	0.246292	0.3981762	0.6506532	0.0012721	0.0001461	0.2494888	0.3889504	0.6372194	0.5094165	0.000152	0.4404183
jh051007.tif	0.0128671	0.2379266	0.3770884	0.5121844	0.0032651	0.0039003	0.233851	0.390292	0.5304441	0.6837021	0.0001035	0.4148058
jk032807.tif	0.0676242	0.5525886	0.7004022	0.797766	6.813E-05	0.0594709	0.5512799	0.7540174	0.8194353	0.5343687	0.0007451	0.3157924
jk053007rab166.tif	0.1063516	0.4117714	0.6347122	0.8369235	0.0771195	0.5221024	0.3929387	0.6666026	0.8163656	0.3809786	0.0010047	0.4592107
jl111407.tif	9.487E-06	0.0754501	0.1538365	0.3007977	0.0001274	0.0004672	0.0858837	0.1355861	0.2731559	0.3311653	0.0002808	0.4680694
jm031207.tif	0.0273588	0.0611285	0.1951631	0.6997835	0.0003317	0.0005114	0.0626268	0.1853263	0.6494154	0.4235758	0.0002326	0.4788496
jm080107rab247.tif	8.53E-06	0.0136954	0.0339853	0.1380473	0.0002398	0.0017651	0.0132215	0.0330212	0.1360225	0.6617664	0.0010204	0.4358558
jp030907rab56.tif	7.569E-06	0.0152322	0.0298618	0.1343731	0.0012793	0.0015647	0.0140838	0.0290668	0.1239493	0.7585893	0.0001752	0.5783522
jp030907rab57.tif	0.0002126	0.0507518	0.0811658	0.1712315	9.265E-05	0.0043235	0.0517552	0.0825766	0.1761049	0.5983078	0.0016104	0.4906969
jp051707rab143.tif	0.0001992	0.085293	0.193118	0.3991463	0.0007672	0.0146182	0.0948433	0.1909111	0.4283177	0.5524479	0.0006989	0.2188102
jp051707rab144.tif	0.0007226	0.1007116	0.1654532	0.2895221	0.0003368	0.011147	0.103574	0.1544125	0.2777149	0.4345661	0.0008679	0.4437984
jp062507rab197.tif	0.0141043	0.2855961	0.5339403	0.9341531	9.859E-05	0.1150101	0.2694477	0.5379446	0.874951	0.542976	0.0019544	0.477453
jp062507rab198.tif	8.748E-06	0.1213863	0.2576817	0.4694014	0.0004061	0.0002021	0.1250512	0.2499222	0.495458	0.5983785	0.000391	0.4831184
jp062507rab199.tif	1.002E-05	0.0290971	0.0679527	0.2432795	0.0002296	0.0008061	0.0308854	0.0670415	0.2852227	0.5004422	0.0013736	0.4523374
jp070207.tif	6.946E-06	0.0456899	0.0873852	0.1881955	9.355E-05	0.0005018	0.0459731	0.0794388	0.1867024	0.6638464	0.0008443	0.4305905
js070907.tif	6.817E-06	0.0006892	0.0015592	0.0132336	0.0004503	0.0284836	0.0007147	0.0015419	0.0158312	0.6577912	0.0005666	0.4359667
jt082807.tif	0.0074143	0.0604389	0.1196154	0.3547679	0.0001442	0.0469203	0.0610176	0.1038213	0.3369109	0.4646375	0.0005882	0.3254089
kb022707.tif	0.0005997	0.0084413	0.0225358	0.1087654	0.0030093	0.0376531	0.008594	0.0218946	0.1044155	0.573251	0.0009627	0.408372
kp012907.tif	1.518E-05	0.1002694	0.2253965	0.3182004	0.0001576	0.0004943	0.1048447	0.2123594	0.3193389	0.1513973	0.0002917	0.393597
kp042607.tif	7.713E-06	0.0323215	0.0565362	0.1569574	0.0014945	0.0035457	0.0337936	0.0528748	0.1585896	0.6426066	0.0001554	0.4998543
ks070907rolla151.tif	6.468E-06	0.1632771	0.3057455	0.5034589	0.0012193	0.0001427	0.1591294	0.2819485	0.5034789	0.5513322	0.0002326	0.3644158

Table C.1. (continued)

kv090707rol200.tif	7.788E-06	0.0119877	0.0169758	0.0632712	0.0001048	0.0663441	0.0127559	0.0168079	0.0663357	0.6462078	0.0002808	0.4798544
lc052207.tif	0.0882246	0.3973086	0.4291608	0.5731264	0.1873418	0.2837623	0.3575207	0.4484954	0.5255902	0.6474965	0.0002326	0.3903849
ll040307.tif	0.008562	0.2482546	0.476626	0.8856592	7.611E-05	9.134E-05	0.2238227	0.4884767	0.8348474	0.6021101	0.0010204	0.4436904
lp020907.tif	0.0069477	0.1161359	0.255905	0.7147776	0.0050071	0.0001744	0.1142617	0.264402	0.6948394	0.5208344	0.0001752	0.4273502
lp092407rol217.tif	6.069E-06	0.0159876	0.0321327	0.0848108	9.804E-05	0.0012786	0.0146223	0.0292371	0.0768209	0.5328533	0.0016104	0.4019248
ls012607.tif	5.395E-06	0.000157	0.0005129	0.0019733	0.0002117	14.167133	0.0001568	0.0005421	0.0020919	0.5753116	0.0006989	0.4877273
lt030207.tif	0.0003017	0.1063932	0.2099776	0.4372286	0.0027285	0.0066221	0.1106015	0.2124268	0.4692587	0.5973589	0.0008679	0.3874436
lt111407.tif	5.108E-06	0.0661266	0.1178338	0.3371	8.996E-05	0.0002913	0.0518876	0.1160231	0.3094377	0.7123958	0.0019544	0.3723526
lz032907.tif	5.908E-06	0.0211034	0.0485103	0.154782	0.0001303	0.0009217	0.0192098	0.0475668	0.1417059	0.4728727	0.000391	0.3488946
mc041307.tif	5.055E-06	0.2440201	0.3740319	0.5309163	4.342E-05	8.013E-05	0.2556319	0.4038049	0.542968	0.5323404	0.0013736	0.3856373
mc111507dru115.tif	5.906E-06	0.084716	0.137403	0.3062271	6.086E-05	0.0002016	0.0863231	0.1380467	0.3025883	0.5784969	0.0008443	0.5177088
mc111507dru116.tif	4.691E-06	0.0394554	0.0835871	0.3247204	0.0001376	0.0003914	0.0370688	0.0725242	0.3523627	0.6474263	0.0005666	0.2972667
mc111507dru117.tif	4.672E-06	0.0176258	0.0314028	0.1019375	8.394E-05	0.0008279	0.0186119	0.0314755	0.1016111	0.5906922	0.0005882	0.430367
mc111507dru118.tif	5.578E-06	0.044521	0.064604	0.1303316	5.053E-05	0.0056802	0.0479943	0.0635675	0.1395098	0.5308226	0.0009627	0.4378501
md032607rab79.tif	0.1048233	0.1216229	0.2221259	0.5292834	0.1778955	1.1169743	0.1326343	0.2210905	0.5801958	0.4868129	0.0002917	0.4135216
md032607rab80.tif	0.0707765	0.1718082	0.477539	0.9973481	0.1088691	0.5437489	0.1779508	0.4837595	0.9981751	0.3482617	0.0010087	0.4629101
md033007.tif	0.0009877	0.0360588	0.087272	0.2640994	0.003158	0.011677	0.0360829	0.087137	0.2704702	0.547682	0.0035742	0.3382678
mg080607.tif	4.115E-06	0.0467546	0.1058962	0.3009409	8.934E-05	0.0134253	0.0532351	0.1043495	0.3304953	0.511465	0.0005369	0.3704933
mo082207.tif	0.0066692	0.0076606	0.0211056	0.0824376	0.0001341	1.5960823	0.0079317	0.0232102	0.0885144	0.5926474	0.0010044	0.3172567
mr022007rolla47.tif	0.4509042	0.4472713	0.6189199	0.9628639	1.2541053	1.8323717	0.4443186	0.62283	1.0405487	0.6029017	0.00097	0.3453716
nd112007.tif	3.677E-06	0.0150667	0.0399742	0.1638363	0.0001268	0.0006975	0.0171059	0.0420648	0.1822913	0.5627435	0.0009302	0.4343519
nm081407rab263.tif	3.712E-06	0.102357	0.2105708	0.4169169	5.077E-05	0.0001498	0.0962144	0.2057209	0.3397552	0.453725	0.0015584	0.3026624
nz052307.tif	3.914E-06	0.1136341	0.1832607	0.4030512	0.0007227	0.0001175	0.1182269	0.2044681	0.4209044	0.4571983	0.0011179	0.4020819
ob092407.tif	0.015796	0.1504716	0.3625944	0.6689969	0.0100621	0.0563739	0.1493594	0.3639207	0.7224173	0.6078149	0.0002948	0.3877888
pg080707.tif	3.526E-06	0.1519831	0.240925	0.4832989	4.291E-05	8.446E-05	0.1347015	0.2570357	0.5096573	0.6135444	0.0006691	0.2687043
pk082907rab281.tif	0.0003085	0.0598028	0.1353939	0.2995706	5.885E-05	0.0001767	0.0576651	0.1415312	0.3341982	0.578008	0.0005141	0.3351377
pw062907.tif	3.161E-06	0.180002	0.3950978	0.6756717	4.378E-05	6.241E-05	0.1917924	0.3947658	0.7038656	0.5019588	0.0003939	0.3623769
ra091207rab305.tif	0.0159358	0.059631	0.1401624	0.362335	1.6799421	2.9948296	0.0656839	0.1596354	0.383687	0.3671194	0.0021953	0.4110149
ra091207rab306.tif	0.0193605	0.1846659	0.2665605	0.4368889	0.0033264	0.082843	0.1980985	0.2590768	0.4615326	0.5328502	0.0025882	0.3597402
rb091007.tif	2.726E-06	0.0595767	0.1221288	0.260229	3.808E-05	0.0001481	0.0608565	0.1212469	0.2580507	0.60903	0.0012216	0.272418

Table C.1. (continued)

rc082707rab275.tif	0.0018269	0.1206885	0.2208739	0.4323782	0.0014978	0.006195	0.1228135	0.2092746	0.3994342	0.5080493	0.0005485	0.393597
rh091707rab314.tif	2.565E-06	0.02987	0.054064	0.1693372	5.261E-05	0.0003439	0.0285622	0.0575826	0.1536169	0.425787	0.0009142	0.4998543
rh091907.tif	2.553E-06	0.0168861	0.0310833	0.0866697	4.698E-05	0.0004671	0.0177148	0.0336154	0.1010047	0.5415546	0.0008187	0.3644158
rm022707.tif	0.0176815	0.0901087	0.2392626	0.5748445	0.4168057	0.5376282	0.0946611	0.2399738	0.5708947	0.4817723	0.000867	0.4826219
rp100907rab348.tif	0.0379991	0.0643998	0.1193441	0.2501183	3.029E-05	0.0001339	0.059963	0.1086006	0.2273855	0.5649283	0.0006068	0.4592039
rs091407.tif	2.194E-06	0.0982887	0.1735553	0.3913075	2.945E-05	8.565E-05	0.1112846	0.1928156	0.3456418	0.3467101	0.0008065	0.5310556
sl072307dru55.tif	3.71E-05	0.0038059	0.0158203	0.2109607	0.1214051	0.1147338	0.003791	0.0166537	0.2073208	0.4382605	0.0007614	0.4404183
sl072307dru56.tif	9.964E-05	0.096398	0.1738975	0.3716556	0.0028378	0.0077779	0.0908768	0.173024	0.3648705	0.7303	0.0005599	0.4148058
sm071607.tif	2.211E-06	0.1825178	0.266889	0.4053288	1.479E-05	4.645E-05	0.174964	0.2200729	0.3202615	0.4057084	0.0008054	0.3157924
sm092507.tif	1.547E-06	0.0166405	0.0305624	0.1475605	4.413E-05	0.0003253	0.0171847	0.0290259	0.1365336	0.5167273	0.0004194	0.4592107
sr110807.tif	0.0175417	0.1957314	0.2974965	0.48914	1.429E-05	0.0006575	0.2034421	0.3294618	0.5341934	0.584453	0.0004104	0.4680694
ss032007.tif	0.0010494	0.0278658	0.0527671	0.1342252	0.0013027	0.0001514	0.0281216	0.0501806	0.1374544	0.5905159	0.0003656	0.4788496
sw021507.tif	0.001596	0.1166383	0.2356989	0.5277697	0.0003617	0.0208656	0.1252724	0.2271775	0.5604479	0.4755623	0.0003439	0.4358558
sz110607.tif	9.903E-07	0.1199198	0.216313	0.5394597	1.595E-05	3.217E-05	0.1142524	0.2167616	0.5011344	0.5022576	0.0006847	0.5783522
tb091007.tif	0.0258614	0.1235427	0.2304788	0.4723714	0.0012835	0.250933	0.1214384	0.2389073	0.4349412	0.610401	0.000753	0.4906969
tc101907rolla242.tif	0.00144	0.0743632	0.1534629	0.3606471	0.001049	0.0048967	0.0732702	0.1624527	0.3557394	0.6256198	0.0004558	0.2188102
tw052507.tif	4.518E-07	0.0266962	0.0765623	0.3029874	1.5E-05	5.11E-05	0.0243116	0.0767636	0.3007401	0.6515404	0.0001554	0.4437984
wr052407_01dru3.tif	0.0002961	0.0849762	0.1920055	0.5591589	4.835E-06	0.004521	0.0766402	0.1854968	0.5191284	0.5860464	0.0007	0.477453
wr052407_02dru4.tif	0.0056258	0.2880112	0.4722486	0.6512233	1E-06	0.0025061	0.2913283	0.4926851	0.6524281	0.6391315	0.0003205	0.4831184
wv072607.tif	0.0099147	0.3622103	0.5504387	0.7585595	9.755E-08	0.0009807	0.3294575	0.4779758	0.701996	0.539279	0.0003394	0.4523374
LF071307.tif	0.1604898	0.3018201	0.6753959	0.9774539	0.2004552	1.2841085	0.3030409	0.6870045	0.9753946	0.3435382	0.0003782	0.4305905
ak051007rab131.tif	0.0534312	0.2940554	0.4479004	0.5921505	0.1446264	0.2826683	0.2785315	0.4858889	0.5878311	0.6029199	0.0002342	0.4818513
bb040407rab96.tif	0.2257032	0.387531	0.5942197	0.8217096	0.5810117	0.7140582	0.3592666	0.6312081	0.8400318	0.6625108	0.0003546	0.3985019
bw072307.tif	0.9083668	1.008551	1.060433	1.2207463	0.5440718	0.8237135	0.9565162	1.0543751	1.1572976	0.7360603	0.0003168	0.4870886
cd030907.tif	2.4555557	1.9987404	2.0981438	1.2684277	9.3389451	4.1775635	1.989409	2.1947652	1.3546063	0.5766366	0.0005197	0.4408031
dk042408rab681.tif	0.6315286	1.0295168	1.0966179	1.0551217	0.5755678	0.6068411	1.0048967	1.1186153	1.0488627	0.937388	0.000152	0.4226971
dm040907.tif	0.1583115	0.7479944	1.2587471	1.0914637	1.2103582	0.4057662	0.7343874	1.2229604	1.0458715	0.3789164	0.0005485	0.393597
dp070507rab218.tif	0.1636808	0.4777012	0.6126061	0.9919218	0.6767326	0.1518752	0.47085	0.6509808	0.9744733	0.5591379	0.0009142	0.4998543
ev060507rol117.tif	0.1417443	0.2971896	0.4363053	0.7320607	1.0149758	1.9062607	0.2807839	0.3837612	0.6775595	0.4669366	0.0008187	0.3644158
fw083007rab289.tif	0.6035615	1.1109575	1.3455693	1.5637561	0.2494057	0.4771573	1.2318387	1.1936895	1.4689593	0.3570735	0.000867	0.4826219

Table C.1. (continued)

hh031207rol15.tif	0.1048445	0.4791911	0.7660451	0.9908391	2.0470406	0.9813981	0.5219182	0.7679471	1.0095811	0.193989	0.0010047	0.4698622
hk030508rab589.tif	0.0057307	0.1828478	0.3196076	0.5415978	0.0014203	0.5910636	0.1816481	0.3338417	0.5472789	0.5372355	0.0002808	0.4798544
hs061507rab189.tif	0.2785686	0.8537756	1.0933424	1.0168553	0.0308104	0.0615315	0.858638	1.1582345	1.1382942	0.4053418	0.0002326	0.3903849
jg030308rol327.tif	0.7317225	0.5644983	0.4475976	0.5834926	1.3173884	1.9048497	0.5494369	0.4785549	0.6018715	0.788823	0.0010204	0.4436904
jk051508rab716.tif	0.0532676	0.1903393	0.3697528	0.6753898	0.2039865	0.6272359	0.1830468	0.3763239	0.6180799	0.4791999	0.0001752	0.4273502
jr021808rab566.tif	1.2233093	0.9692536	1.046987	1.1603818	1.1789594	1.4945675	0.9241566	1.0341337	1.1211266	0.6665642	0.0016104	0.4019248
lm040407rab93.tif	0.0832923	0.4933763	0.649807	0.862543	0.0283207	0.1784914	0.5097353	0.6574225	0.8787743	0.5725261	0.0006989	0.4877273
lr013007rab13.tif	4.0280625	1.3472542	122.93145	19.690974	1004.4389	30.747107	1.4307556	121.43008	20.178523	0.1408245	0.0008679	0.3874436
md052107.tif	0.1195016	0.3392762	0.529389	0.68736	6.9103734	4.0321503	0.3424442	0.5350554	0.668088	0.5049484	0.0019544	0.3723526
mh110507dru105.tif	0.975	0.9892473	0.9928058	0.9963899	0.9783394	0.9855072	0.9892473	0.9928058	0.9963899	0.9964286	0.000391	0.3488946
mm011708rab523.tif	0.4489286	0.661623	0.7687589	0.7830471	1.5901583	2.2084019	0.668075	0.7568918	0.7810587	0.6114941	0.0013736	0.3856373
ms041808rab666.tif	0.0315254	0.4077548	0.6534478	0.7949238	0.1061893	0.0677923	0.3834724	0.5725002	0.7386312	0.5036384	0.0008443	0.5177088
mv021607.tif	0.5100714	1.0011142	1.2142038	0.9469136	1.2392147	2.1812616	1.0136614	1.2899469	0.9913795	0.2695807	0.0005666	0.2972667
nc061107rab180.tif	0.1291687	0.3372669	0.5468805	0.7273588	0.1434151	0.3865445	0.3455727	0.549016	0.7550727	0.4711949	0.0005882	0.430367
ng021207rab27.tif	0.6219833	0.9403609	0.9770744	0.981486	0.0607151	0.600171	0.9537939	1.0384083	1.0188423	0.7006492	0.0009627	0.4378501
rw113007rab371.tif	0.4398583	0.5752082	1.1713054	1.1158207	0.271653	1.4806617	0.5694474	1.1110526	1.041646	0.3458478	0.0002917	0.4135216
sa082207rab273.tif	0.03687	0.5584431	0.7425882	0.8109658	0.1007009	0.2447279	0.5445223	0.7875627	0.8266689	0.5181255	0.0010047	0.4698622
sh091407dru90.tif	0.0002289	0.0599726	0.1048682	0.2241857	0.000586	0.0190558	0.0640345	0.1065943	0.2095549	0.5174658	0.0002808	0.4798544
sp092007dru93.tif	0.3065822	0.4672158	0.7788108	1.3767002	1.5103673	2.3968661	0.5169465	0.7964853	1.5681031	0.2387341	0.0002326	0.3903849
sz121107dru132.tif	0.1438742	0.8096283	0.7787053	0.8048895	0.7736692	0.4927193	0.7582892	0.7183535	0.8735095	0.4659716	0.0010204	0.4436904
ty032107rab74.tif	0.3685226	0.6896663	1.1598362	1.1405037	1.5937425	1.6994859	0.6086858	1.0678122	1.0447109	0.3497272	0.0001752	0.4273502
wt061507rab188.tif	0.7916365	0.2677731	0.3067296	0.7654154	30.046469	14.669655	0.2470051	0.3061592	0.7595462	0.2713306	0.0016104	0.4019248

APPENDIX D

MATLAB ROUTINE FOR MULTIPLYING BORDER MASK AND LESION IMAGE

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%                    Code to multiply Border Mask and Lesion
% This code can also be used for multiplying White area mask and lesion
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

close all;
clear all;
clc;


dataPath = 'C:\All_lesions'; %Path where all lesions are stored
borderPath = 'C:\All_borders'; %Path where all borders are stored

path_to_save = 'C:\result'; %Path to store the result

eval(['cd ' borderPath]);
fileList1 = dir('*.tif');

for i = 1:length(fileList1)
   fileName = [fileList1(i).name(1:end-4) '.tif'];
   eval(['cd ' borderPath]);
   fileList1 = dir('*.tif');
   wh_img1 = imread(fileName);  %Reading border files

   eval(['cd ' dataPath]);
   fileList = dir('*.jpg');
   fileName1 = [fileList(i).name(1:end-4) '.jpg'];
   img = imread(fileName1);   %Reading lesion images


   % Multiplying one color plane at a time
   R=img(:,:,1);
   R=R.*wh_img1;
   wh_img(:,:,1) = R;
   R=img(:,:,2);
   R=R.*wh_img1;
   wh_img(:,:,2) = R;
   R=img(:,:,3);
   R=R.*wh_img1;
   wh_img(:,:,3) = R;

   % Saving the multiplied lesions
   eval([' cd ' path_to_save]);
   outName = [fileName(1:end-12) 'whiteout.tif'];
   imwrite(wh_img,outName,'tif');
   clear wh_img;
   clear R;
   clear img;
end
```

APPENDIX E

MATLAB ROUTINE FOR PLOTTING HISTOGRAM

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%                       Subroutine for plotting histogram
% As each color plane is plotted independently, the parameter 'z' passed
% will change. If histogram of Red plane is needed then, if img is the
% input image, then
%
% z = img(:,:,1);
%
% Similarly histogram of Green and Blue color planes are plotted.
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


function ht1 = computeImageHist(z)

ht1 = zeros(1,255);
[l b]=size(z);

for i=1:l
   for j=1:b
      if(z(i,j)~=0)
         ht1(z(i,j))=ht1(z(i,j))+1;
      end
   end
end
plot(ht1);
axis([0 256 0 max(ht1)]);
title('Red Whole Lesion'); % Title depends on parameter passed
```

APPENDIX F

MATLAB ROUTINE FOR CALCULATING THRESHOLD VALUES

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%                                Calculating Threshold values
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

close all;
clear all;
clc;

dataPath = 'C:\Multiplied_lesions'; %Path where multiplied lesions are stored
whitePath = 'C:\whitemask_multiplication'; %Path where the result between the multiplication of lesion and
                                           % marked white areas is stored


eval(['cd ' dataPath]);
fileList = dir('*.tif');

lenF = length(fileList);

% intializing the arrays to all zeros
init_val_lesion_red = zeros(1,lenF);
init_val_lesion_green = zeros(1,lenF);
init_val_lesion_blue = zeros(1,lenF);
mid_val_lesion_red = zeros(1,lenF);
mid_val_lesion_green = zeros(1,lenF);
mid_val_lesion_blue = zeros(1,lenF);
avg_R1 = zeros(1,lenF);
avg_G1 = zeros(1,lenF);
avg_B1 = zeros(1,lenF);
Diff_red = zeros(1,lenF);
Diff_green = zeros(1,lenF);
Diff_blue = zeros(1,lenF);
std_r = zeros(1,lenF);
std_g = zeros(1,lenF);
std_b = zeros(1,lenF);
Ratio_r = zeros(1,lenF);
Ratio_g = zeros(1,lenF);
Ratio_b = zeros(1,lenF);

for abc = 1:length(fileList)
   eval(['cd ' whitePath]);
   fileList = dir('*.tif');
   whitefile = [fileList(abc).name(1:end-4) '.tif'];
   img123 = imread(whitefile);


   %Computing histogram for each color plane
   z=img123(:,:,1);

   ht1 = computeImageHist(z); %Calling routine for computing histogram
   abc4 = 0.8*sum(ht1); %to check for the top 20% brightest pixels

   % Checking for highest gray level value in histogram
   for i=255:-1:1
      if (ht1(i)~= 0 && ht1(i)~=1)
```

```
      break;
   end
end

init_val_lesion_red=i;

% Checking for gray level value corresponding to top 20% brightest
% pixels
total=0;
for i=init_val_lesion_red:-1:1
   total=ht1(i) + total;
   if total>abc4
      break;
   end
end

mid_val_lesion_red=i;

z=img123(:,:,2);
ht1 = computeImageHist(z);

for i=255:-1:1
   if (ht1(i)~= 0 && ht1(i)~=1)
      break;
   end
end

init_val_lesion_green=i;

total=0;
for i=init_val_lesion_green:-1:1
   total=ht1(i) + total;
   if total>abc4
      break;
   end
end

mid_val_lesion_green=i;


z=img123(:,:,3);
ht1 = computeImageHist(z);

for i=255:-1:1
   if (ht1(i)~= 0 && ht1(i)~=1)
      break;
   end
end

init_val_lesion_blue=i;

total=0;
for i=init_val_lesion_blue:-1:1
   total=ht1(i) + total;
   if total>abc4
      break;
```

```
  end
end

mid_val_lesion_blue=i;


% Computing Average and standard deviation values
eval(['cd ' dataPath]);
fileList1 = dir('*.tif');
fileName1 = [fileList1(abc).name(1:end-4) '.tif'];
y = imread(fileName1);
disp([" fileName1]);

total=0;
avg_R=0;
avg_G=0;
avg_B=0;

[row col wid]=size(y);

% Computing Average value
for i = 1:row
   for j = 1:col
      if y(i,j)~=0
         total = total + 1;
         avg_R = double(avg_R) + double(y(i,j,1));
         avg_G = double(avg_G) + double(y(i,j,2));
         avg_B = double(avg_B) + double(y(i,j,3));
      end
   end
end

avg_R1(abc)=double(avg_R/total);
avg_G1(abc)=double(avg_G/total);
avg_B1(abc)=double(avg_B/total);


Diff_red=mid_val_lesion_red-avg_R1(abc);
Diff_green=mid_val_lesion_green-avg_G1(abc);
Diff_blue=mid_val_lesion_blue-avg_B1(abc);


% Computing standard deviation values
yr=y(:,:,1);
yg=y(:,:,2);
yb=y(:,:,3);

[a,b]=find(yr~=0);
total1=size(a,1);

new_y1_r = zeros(1,total1);
new_y1_g = zeros(1,total1);
new_y1_b = zeros(1,total1);

for p=1:total1
   new_y1_r(p)=yr(a(p),b(p));
```

```
        new_y1_g(p)=yg(a(p),b(p));
        new_y1_b(p)=yb(a(p),b(p));
    end

    std_r(abc)=std(double(new_y1_r));
    std_g(abc)=std(double(new_y1_g));
    std_b(abc)=std(double(new_y1_b));


    % Computing the threshold values
    Ratio_r(abc)=Diff_red/std_r(abc);
    Ratio_g(abc)=Diff_green/std_g(abc);
    Ratio_b(abc)=Diff_blue/std_b(abc);

end
```

APPENDIX G

MATLAB ROUTINE FOR AUTOMATIC DETECTION OF WHITE AREAS

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%                    Code for Automatic Detection of White area
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

close all;
clear all;
clc;


dataPath = 'C:\Lesions'; %path where multiplied lesion images are stored
path_to_save = 'C:\Results'; %Path where to store the results

eval(['cd ' dataPath]);
fileList = dir('*.tif');

lenF = length(fileList);

%intializing the arrays to all zeros
init_val_lesion_red = zeros(1,lenF);
init_val_lesion_green = zeros(1,lenF);
init_val_lesion_blue = zeros(1,lenF);
mid_val_lesion_red = zeros(1,lenF);
mid_val_lesion_green = zeros(1,lenF);
mid_val_lesion_blue = zeros(1,lenF);
avg_R1 = zeros(1,lenF);
avg_G1 = zeros(1,lenF);
avg_B1 = zeros(1,lenF);
Diff_red = zeros(1,lenF);
Diff_green = zeros(1,lenF);
Diff_blue = zeros(1,lenF);
std_r = zeros(1,lenF);
std_g = zeros(1,lenF);
std_b = zeros(1,lenF);
Ratio_r = zeros(1,lenF);
Ratio_g = zeros(1,lenF);
Ratio_b = zeros(1,lenF);


for abc = 1:length(fileList)
   eval(['cd ' dataPath]);
   fileList1 = dir('*.tif');
   fileName1 = [fileList1(abc).name(1:end-4) '.tif'];
   y = imread(fileName1);
   disp(['PROCESSING :: ' fileName1]);

   total=0;
   avg_R=0;
   avg_G=0;
   avg_B=0;

   [row col wid]=size(y);

   % Calculating average values
   for i = 1:row
```

```
    for j = 1:col
      if y(i,j)~=0
        total = total + 1;
        avg_R = double(avg_R) + double(y(i,j,1));
        avg_G = double(avg_G) + double(y(i,j,2));
        avg_B = double(avg_B) + double(y(i,j,3));
      end
    end
  end

  avg_R1=double(avg_R/total);
  avg_G1=double(avg_G/total);
  avg_B1=double(avg_B/total);


  % Calculating std values
  yr=y(:,:,1);
  yg=y(:,:,2);
  yb=y(:,:,3);

  [a,b]=find(yr~=0);
  total1=size(a,1);

  new_y1_r = zeros(1,total1);
  new_y1_g = zeros(1,total1);
  new_y1_b = zeros(1,total1);

  for p=1:total1
    new_y1_r(p)=yr(a(p),b(p));
    new_y1_g(p)=yg(a(p),b(p));
    new_y1_b(p)=yb(a(p),b(p));
  end

  std_r=std(new_y1_r);
  std_g=std(new_y1_g);
  std_b=std(new_y1_b);



  %Checking for threshold criteria
  for i = 1:row
    for j = 1:col
      if (((y(i,j,2)>(avg_G1 + 1.1*std_g)) && (y(i,j,3)>(avg_B1 + 1.2*std_b))))
        y(i,j,1) = 255;
        y(i,j,2) = 0;
        y(i,j,3) = 0;
      end
    end
  end


  %Saving the results
  eval([' cd ' path_to_save]);
  outName = [fileName1(1:end-8) '_marked.tif'];
  imwrite(y,outName,'tif');
end
```

APPENDIX H

MATLAB ROUTINE FOR CALCULATING DECILE PERCENTAGES

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%                      Computing the Decile Percentages
% This code calculates the ratio of percentage of white areas in each decile
% The inputs are lesion borders and binary mask of automatically segmented white areas. The output gives
a 2-dimensional array which gives the ratio of marked white areas in each decile
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear all;
close all;
clc;

dataPath = 'C:\All_borders';
bwPath = 'C:\binary_mask';

eval(['cd ' dataPath]);
A = dir('*.tif');

lenF = length(A);

rat=zeros(10,lenF);

for num = 1:lenF
   eval(['cd ' dataPath]);
   fileName1=[A(num).name(1:end-4) '.tif'];
   bw=imread(fileName1);
   disp(['PROCESSING :: ' fileName1]);

   eval(['cd ' bwPath]);
   fileName2 = [A(num).name(1:end-4) '.tif'];
   x=imread(fileName2);

   [row,col]=size(x);
   dist =0;
   distprev = 0;

   for abc=1:10
      pcent=abc/10;

      [L NUM] = bwlabel(bw);
      STATS = regionprops(L);
      lesArea = STATS.Area;
      pcentAr = lesArea*pcent;

      [L NUM] = bwlabel(~bw);
      distIm = bwdist(L);

      fract =0;

      while (fract <= pcent & fract~=1)
         fract = length(find(distIm <= dist & distIm > 0))/lesArea;
         dist = dist+1;
      end

      bwOut = zeros(size(bw));
```

```
        bwOut(find(distIm > distprev & distIm <=dist))=255;

        distprev = dist;

        y=and(x,bwOut); %This gives the required decile

        %Counting number of pixels in the decile
        cnt=0;
        for i=1:row
           for j=1:col
              if(bwOut(i,j)==255)
                 cnt=cnt+1;
              end
           end
        end

        %Counting number of pixels marked as white areas
        cnt1=0;
        for i=1:row
           for j=1:col
              if(y(i,j)==1)
                 cnt1=cnt1+1;
              end
           end
        end

        %Computing the ratio
        rat(abc,num)=cnt1/cnt*100;
     end
  end
```

APPENDIX I

MATLAB ROUTINE FOR CALCULATING RATIO OF MAXIMUM WHITE AREA IN WHOLE LESION TO MAXIMUM WHITE AREA IN OUTERMOST DECILE

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
% Computing Ratio of maximum white area in whole lesion to maximum white area in outermost decile
%
% The inputs are lesion borders and binary mask of automatically segmented
% white areas. The output gives the desired ratio
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear all;
close all;
clc;

dataPath = 'C:\Borders';
bwPath = 'C:\binary_mask';

eval(['cd ' dataPath]);
A = dir('*.tif');

eval(['cd ' bwPath]);
B = dir('*.tif');

ratio = zeros(1,length(A));

for num = 1:length(A)
  eval(['cd ' dataPath]);
  fileName1=[A(num).name(1:end-9) '_mask.tif'];
  bw=imread(fileName1);
  disp(['PROCESSING :: ' fileName1]);

  eval(['cd ' bwPath]);
  fileName2 = [B(num).name(1:end-4) '.tif'];
  x=imread(fileName2);

  dist =0;
  distprev = 0;

  pcent=0.1;

  [L NUM] = bwlabel(bw);
  STATS = regionprops(L);
  lesArea = STATS.Area;
  pcentAr = lesArea*pcent;

  [L NUM] = bwlabel(~bw);
  distIm = bwdist(L);

  fract =0;

  while (fract <= pcent & fract~=1)
    fract = length(find(distIm <= dist & distIm > 0))/lesArea;
    dist = dist+1;
  end

  bwOut = zeros(size(bw));
  bwOut(find(distIm > distprev & distIm <=dist))=255;
```

```
distprev = dist;

y=and(x,bwOut);
maskImg = y;

[L NUM] = bwlabel(maskImg);

STATS = regionprops(L,'Area','Centroid');
areaArr = zeros(1,NUM);

for j=1:NUM
   areaArr(j) = getfield(STATS(j),'Area');
end

% Computing the maximum white area
G_max= max(areaArr);

% Finding label corresponding to maximum white area
for j=1:NUM
   if areaArr(j)==G_max
      break;
   end
end

break_point = j;

[row,col] = size(L);
total = 0;

for i=1:row
   for j=1:col
      if L(i,j)== break_point
         total=total +1;
         xc(total)=i;
         yc(total)=j;
      end
   end
end

[L1 NUM] = bwlabel(x);
lablz = L1(xc(1),yc(1));

% Computing the maximum white area in last decile
STATS = regionprops(L1,'Area','Centroid');
areaArr = zeros(1,NUM);

for j=1:NUM
   areaArr(j) = getfield(STATS(j),'Area');
end

max_area = areaArr(lablz);

G_maximum = max(areaArr);

ratio(num) = G_maximum/max_area;
end
```

APPENDIX J

NEURAL NETWORK

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
%                    Neural network code
%
%                    Author - Dr. Joe Stanley
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear all;
clc

% All files have to be in the same folder
dataPath = 'C:\Neural_network';
outPath = 'C:\Neural_network';
programPath = 'C:\Neural_network';


eval([' cd ' dataPath]);
featureFile = 'newdecile_selected.xls'; % Required Excel sheet
eval([' [features,featureFileList] = xlsread(featureFile); ']);

[numberVectors,numberFeatures] = size(features)

totalEpochs = 15;
% columns 1-6 are for lines
startFeature = 1; % all features is 2 - class label is in column 1
numberFeatures = 8;
[bccIndices] = find(features(:,9) == 1);%find(features(:,1) == 1);
[nobccIndices] = find(features(:,9) == 0);%find(features(:,1) == 0);
for aa = 1:numberFeatures

  bccConfidence = [];
  nobccConfidence = [];
  for q = 1:length(bccIndices)

    trainVect = [];
    noTrainVect = [];
    testVect = [];

    testVect = [features(bccIndices(q),[startFeature:aa])];

    for i = 1:q-1
      trainVect = [trainVect; features(bccIndices(i),[startFeature:aa])];
    end;
    for i = q+1:length(bccIndices)
      trainVect = [trainVect; features(bccIndices(i),[startFeature:aa])];
    end;

    for i = 1:length(nobccIndices)
      noTrainVect = [noTrainVect; features(nobccIndices(i),[startFeature:aa])];
    end;

    eval([' cd ' programPath]);
    [TrainData,TrainTarget] = makeNNTrainingSet(trainVect,noTrainVect);

    trainingTargets = TrainTarget;
```

```
    trainingInputs = TrainData;

    classError1 = 1.0;
    minClassError1 = 1.0;
    maxCorrect = 0;
    maxError = -1.0;

    epochs = 14;
    prevError = 0;
    maxTP = 0;
    maxTN = 0;
    maxScore = 0;
    while (epochs <= totalEpochs)
       numOutputNode = 1;
       if (aa < 4)
          numHiddenNode = [2 2];
       elseif (aa >= 4 & aa <= 8)
          numHiddenNode = [4 2];
       elseif (aa > 8)
          numHiddenNode = [6 4];
       end;
       tf = {'logsig', 'logsig', 'purelin'};
       net = newff(minmax(trainingInputs'), [numHiddenNode, numOutputNode], tf,'trainlm');
       net = init(net);
       net.trainParam.epochs = epochs;
       net.trainParam.goal = 1e-10;

       [Net,trParam] = train(net,trainingInputs',trainingTargets');
       classError1 = trParam.perf(length(trParam.perf));


       crossVector = testVect';
       output = sim(Net,crossVector);
       if (output > maxScore)
          maxScore = output;
          maxEpoch = epochs;
       end;

       epochs = epochs + 1;
    end;
    fprintf('bcc: %d\t%f\n',q,maxScore);
    bccConfidence = [bccConfidence maxScore];

end;
for q = 1:length(nobccIndices)
    trainVect = [];
    noTrainVect = [];
    testVect = [];

    testVect = [features(nobccIndices(q),[startFeature:aa])];

    for i = 1:q-1
       noTrainVect = [noTrainVect; features(nobccIndices(i),[startFeature:aa])];
    end;
    for i = q+1:length(nobccIndices)
       noTrainVect = [noTrainVect; features(nobccIndices(i),[startFeature:aa])];
```

```
    end;

    for i = 1:length(bccIndices)
      trainVect = [trainVect; features(bccIndices(i),[startFeature:aa])];
    end;

    eval([' cd ' programPath]);
    [TrainData,TrainTarget] = makeNNTrainingSet(trainVect,noTrainVect);

    trainingTargets = TrainTarget;
    trainingInputs = TrainData;

    classError1 = 1.0;
    minClassError1 = 1.0;
    maxCorrect = 0;
    maxError = -1.0;


    epochs = 14;
    prevError = 0;
    maxTP = 0;
    maxTN = 0;
    maxScore = 100.0;
    while (epochs <= totalEpochs)
      numOutputNode = 1;
      if (aa < 4)
        numHiddenNode = [2 2];
      elseif (aa >= 4 & aa <= 8)
        numHiddenNode = [4 2];
      elseif (aa > 8)
        numHiddenNode = [6 4];
      end;

      tf = {'logsig', 'logsig', 'purelin'};
      net = newff(minmax(trainingInputs'), [numHiddenNode, numOutputNode], tf,'trainlm');
      net = init(net);
      net.trainParam.epochs = epochs;
      net.trainParam.goal = 1e-10;

      [Net,trParam] = train(net,trainingInputs',trainingTargets');
      classError1 = trParam.perf(length(trParam.perf));


      crossVector = testVect';
      output = sim(Net,crossVector);
      if (output < maxScore)
        maxScore = output;
        maxEpoch = epochs;
      end;

      epochs = epochs + 1;
    end;
    fprintf('nobcc: %d\t%f\n',q,maxScore);
    nobccConfidence = [nobccConfidence maxScore];

end;
```

```
    melsConfidence = bccConfidence;
    nonsConfidence = nobccConfidence;
    mels = length(bccConfidence);
    nons = length(nobccConfidence);

    sortedNonsConfidence = sort(nobccConfidence);

    fn = [];
    tp = [];
    area = 0;
    fnPrevious = 0;
    for i=length(nonsConfidence):-1:1
       confidence = sortedNonsConfidence(i);
       tpCorrect = length(find(melsConfidence > confidence));
       tnCorrect = length(find(nonsConfidence <= confidence));
       fnRate = 1-(tnCorrect/nons);
       tpRate = tpCorrect/mels;
       area = area+((fnRate-fnPrevious)*tpRate);
       fnPrevious = fnRate;
       tp = [tp; tpRate];
       fn = [fn; fnRate];
    end;

    % Plotting the ROC curve
    plot(fn,tp);
    h = gcf;
    figName = sprintf('bestFeatures_081408_%d.fig',aa);
    eval([' cd ' outPath]);
    eval([' save ' figName 'h']);

    fp = fopen('newdecile_results.txt','a'); % Saving results in text file
    fprintf(fp,'\n%d\t%f\n',aa,area);
    fclose(fp);
end;
```

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VITA

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He enrolled for the Master of Science in Electrical Engineering at the Missouri University of Science and Technology in August 2007. He worked as a Graduate Research Assistant with the DERMVIS group from August 2007 to May 2009. He also worked as a Graduate Teaching Assistant for the Electrical Engineering department from January 2008 to December 2008. He completed his Master of Science degree in Electrical Engineering in May 2009.