```cpp
#include <opencv2/opencv.hpp>
#include <iostream>
#include <stdio.h>
#include <stdlib.h>


using namespace std;
using namespace cv;


void preprocessing (const char *);


int main(int argc, char ** argv) {
    const char * imgName = argv[1];
    preprocessing(imgName);
    return 0;
}

void preprocessing(const char * imgName) {
    IplImage * img = cvLoadImage( imgName, CV_LOAD_IMAGE_GRAYSCALE);

    /// ////////////////////////////////////////////////////
    ///                       FILTERING                    ///
    /// ////////////////////////////////////////////////////

    IplImage * F1 = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
    cvSet(F1, 0);
    IplImage * F2 = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
    cvSet(F2, 0);
    IplImage * F3 = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
    cvSet(F3, 0);
    IplImage * F4 = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
    cvSet(F4, 0);

    //                         CV_BLUR
    cvSmooth(img, F1, CV_BLUR, 3, 3);

    //                        CV_MEDIAN
    cvSmooth(img, F2, CV_MEDIAN, 3);

    //                       CV_GAUSSIAN
    cvSmooth(img, F3, CV_GAUSSIAN, 3, 0);

    //                       CV_BILATERAL
    cvSmooth(img, F4, CV_BILATERAL, 9, 0.05, 20);


    /// ////////////////////////////////////////////////////////////
    ///              MORPHOLOGICAL TRANSFORMATION                 ///
    /// ////////////////////////////////////////////////////////////


    IplImage * ERO = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
    cvSet(ERO, 0);
    IplImage * DIL = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
    cvSet(DIL, 0);
    IplImage * OP = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
```

```
59      cvSet(OP, 0);
60      IplImage * CL = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
61      cvSet(CL, 0);
62      //IplImage * TOPHAT = cvCreateImage(cvGetSize(img), IPL_DEPTH_8U, 1);
63      //cvSet(TOPHAT, 0);
64
65      int IT = 1;
66
67      //                          EROSION
68      // Used to reduce speckle while larger regions are not affected
69      cvErode(img, ERO, NULL, IT);
70
71      //                          DILATION
72      // Attempting to find connected components
73      cvDilate(F4, DIL, NULL, IT);
74
75      //                          OPENING
76      // Erode & Dilate = Separate segments close to each other
77      cvMorphologyEx(img, OP, NULL, NULL, CV_MOP_OPEN, IT);
78
79      //                          CLOSING
80      // Dilate & Erode = reduce unwanted noise-driven segments
81      cvMorphologyEx(img, CL, NULL, NULL, CV_MOP_CLOSE, IT);
82
83      //                          TOP HAT
84      // SRC - open(SRC) = Isolate patches that are brighter than immediate neighbours
85      //cvMorphologyEx(img, TOPHAT, NULL, NULL, CV_MOP_TOPHAT, IT);
86
87      /// ////////////////////////////////////////////////////////////
88      ///                     DISPLAY AND SAVE                      ///
89      /// ////////////////////////////////////////////////////////////
90      cvNamedWindow("Image", 0);
91      cvShowImage("Image", img);
92
93      cvNamedWindow("Blur", 0);
94      cvShowImage("Blur", F1);
95      cvSaveImage("Blur.png", F1);
96      cvNamedWindow("Median", 0);
97      cvShowImage("Median", F2);
98      cvSaveImage("Median.png", F2);
99      cvNamedWindow("Gaussian", 0);
100     cvShowImage("Gaussian", F3);
101     cvSaveImage("1-Gaussian.png", F3);
102     cvNamedWindow("Bilateral", 0);
103     cvShowImage("Bilateral", F4);
104     cvSaveImage("2-Bilateral.png", F4);
105
106
107     cvNamedWindow("Erosion", 0);
108     cvShowImage("Erosion", ERO);
109     cvSaveImage("Erosion.png", ERO);
110     cvNamedWindow("Dilation", 0);
111     cvShowImage("Dilation", DIL);
112     cvSaveImage("Dilation.png", DIL);
113     cvNamedWindow("Opening", 0);
114     cvShowImage("Opening", OP);
115     cvSaveImage("Opening.png", OP);
116     cvNamedWindow("Closing", 0);
```

```
117     cvShowImage("Closing", CL);
118     cvSaveImage("Closing.png", CL);
119     cvNamedWindow("Top Hat", 0);
120     //cvShowImage("Top Hat", TOPHAT);
121     //cvSaveImage("Top Hat.png", TOPHAT);
122
123     cvWaitKey(0);
124
125
126     /// ////////////////////////////////////////////////////////
127     ///                          CLEAN-UP                    ///
128     /// ////////////////////////////////////////////////////////
129
130     cvDestroyAllWindows();
131
132     cvReleaseImage(&img);
133     cvReleaseImage(&F1);
134     cvReleaseImage(&F2);
135     cvReleaseImage(&F3);
136     cvReleaseImage(&F4);
137     cvReleaseImage(&ERO);
138     cvReleaseImage(&DIL);
139     cvReleaseImage(&CL);
140     cvReleaseImage(&OP);
141     //cvReleaseImage(&TOPHAT);
142
143 }
144
```