2022S CS205
HCI Presentation

SUSTech
Southern University of Science and Technology

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CONTENT

Part 1

Basic Content.

Basic Content - Tasks

Read & Store Image

Identify Trajectory as Shape

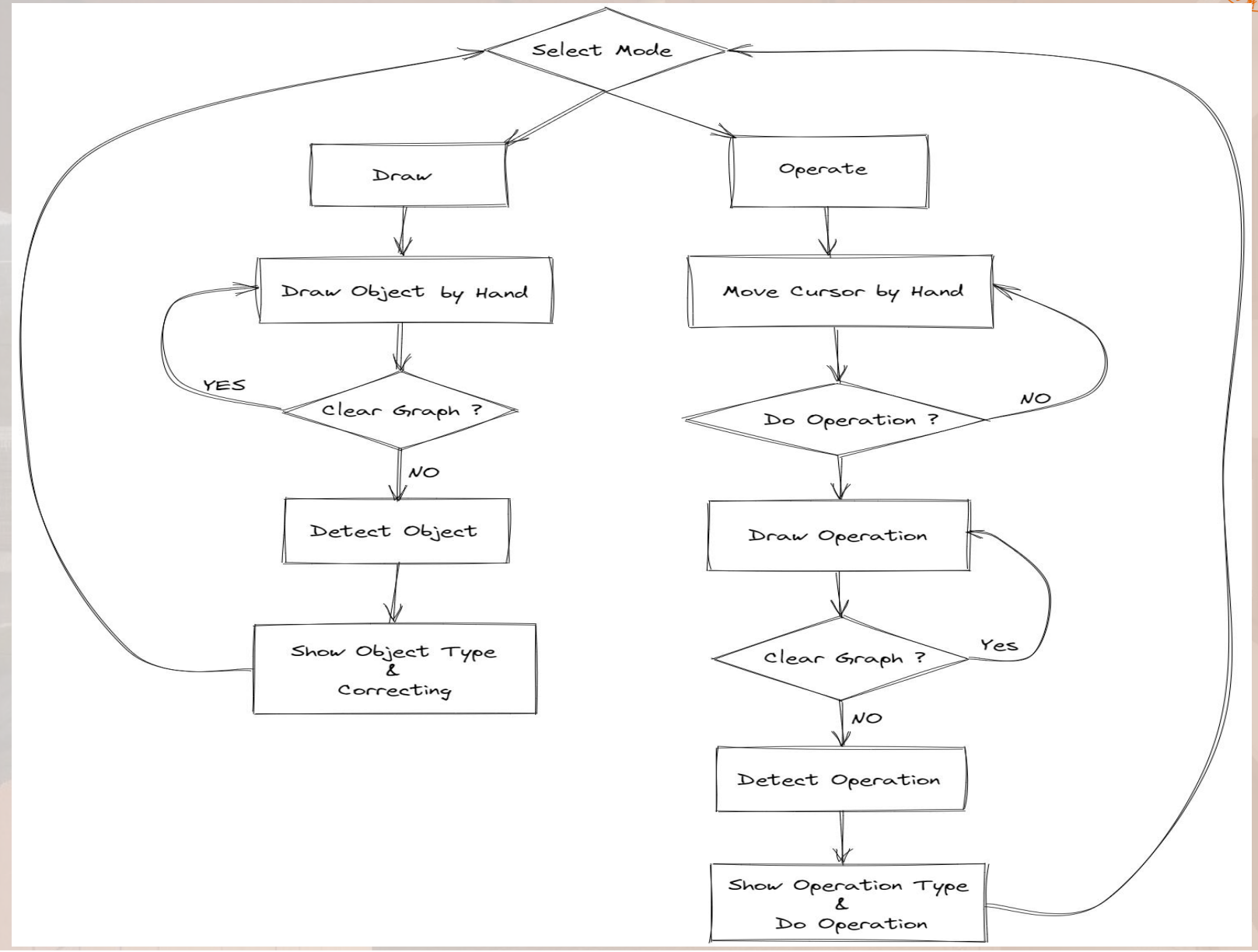
Locate Hand By Rectangle

Correcting Shape

Track Moving Target

Bind MouseEvent with Shape

Basic Content - Finite State Machine



Part 2

HighLights.

HighLights - Skin Detection

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Color Spaces:

HSV：RGB通道并不能很好地反映出物体具体的颜色信息， 而相对于RGB空间，HSV空间能够非常直观的表达色彩的明暗，色调，以及鲜艳程度，方便进行颜色之间的对比。

YCrCb：在人脸检测中也常常用到YCrCb空间，因为一般的图像都是基于RGB空间的，在RGB空间里人脸的肤色受亮度影响相当大，所以肤色点很难从非肤色点中分离出来，也就是说在此空间经过处理后，肤色点是离散的点，中间嵌有很多非肤色，这为肤色区域标定(人脸标定、眼睛等)带来了难题。如果把RGB转为YCrCb空间的话，可以忽略Y(亮度)的影响，因为该空间**受亮度影响很小**，肤色会产生很好的类聚。这样就把三维的空间降为二维的CrCb，肤色点会形成一定得形状。

We *combine* this two methods and get a more stable bipartite-valued image.

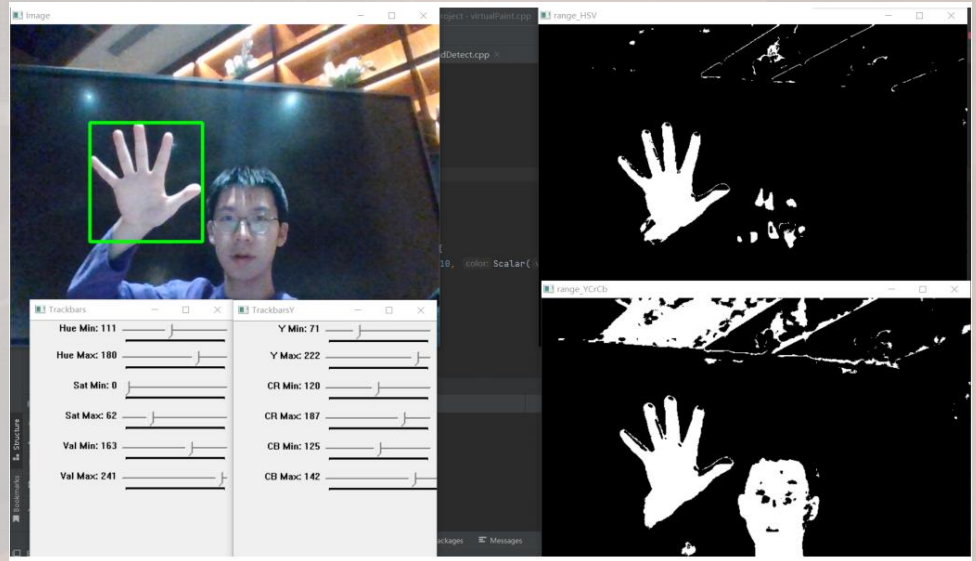
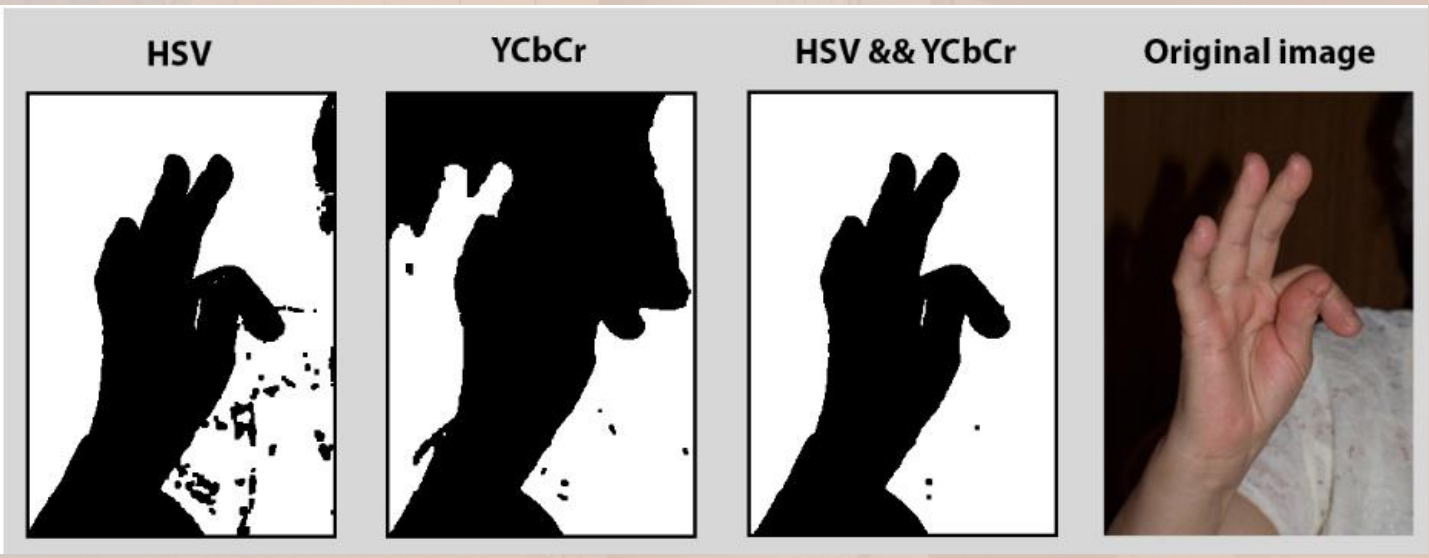
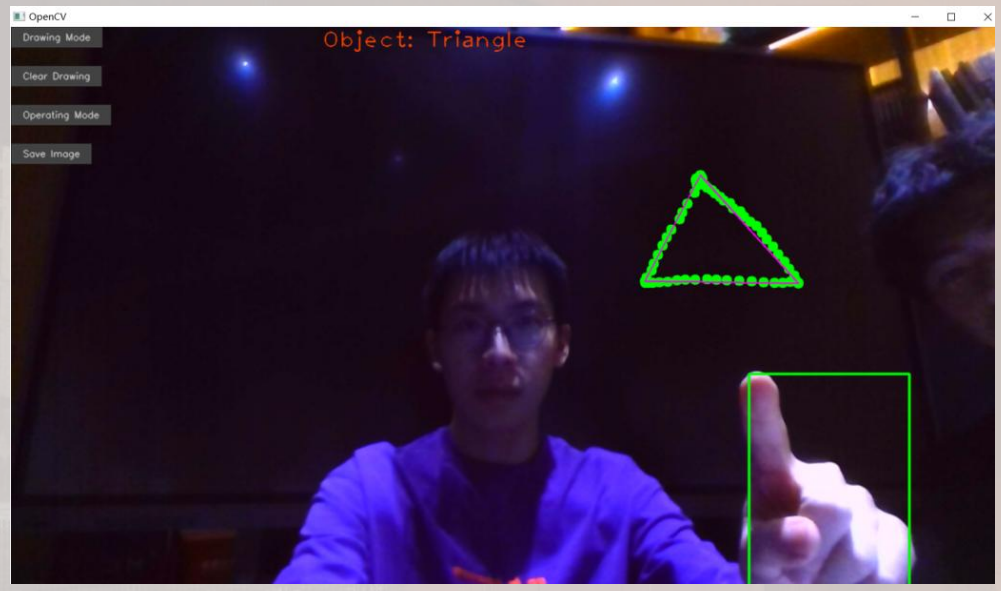


图1 | HSV和YCrCb颜色空间比较



HighLights - Trajectory/Shape Detection



Need a profound understanding of Points, Contours in OpenCV. Using vector to store points that user drawn. Using the number of coner points in a closed contour to itentify the shape.

（1）大致思路

创建一个角点向量集合{**conPoly**}，仅存储轮廓中的角点，然后调用{**arcLength**}函数获取轮廓周长。利用{**approxPolyDP**}函数生成逼近曲线，其中的角点存在conPoly中，然后对conPoly进行判断，若conPoly中点的数量等于3，则为三角形；为4，则为四边形；为5，则为五边形；若大于5，则为圆。

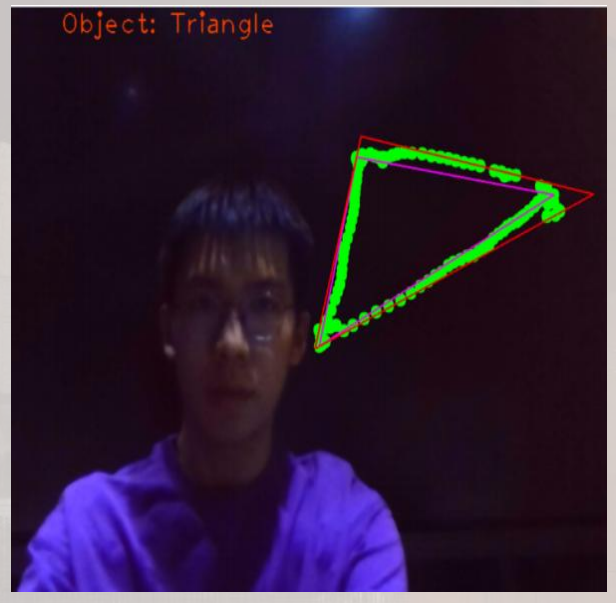
（2）Douglas-Peucker算法

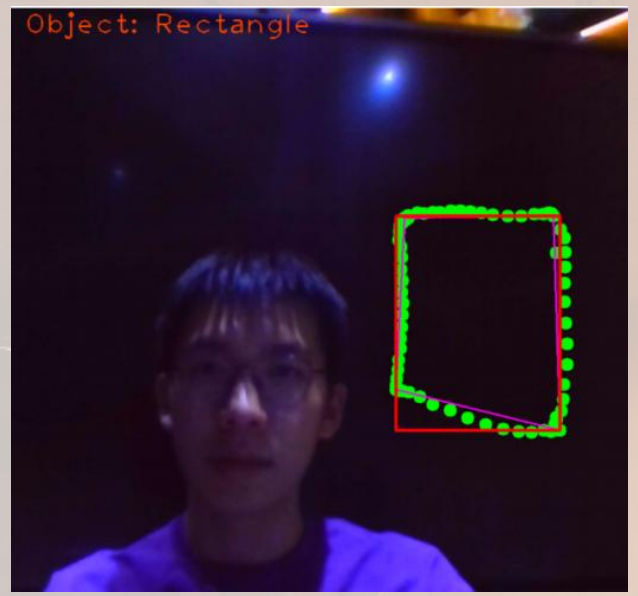
调用OpenCV库中**{approxPolyDP}**函数——生成逼近曲线：该函数采用**Douglas-Peucker算法**（也称迭代终点拟合算法）。可以有效减少多边形曲线上点的数量，生成逼近曲线，简化后继操作。

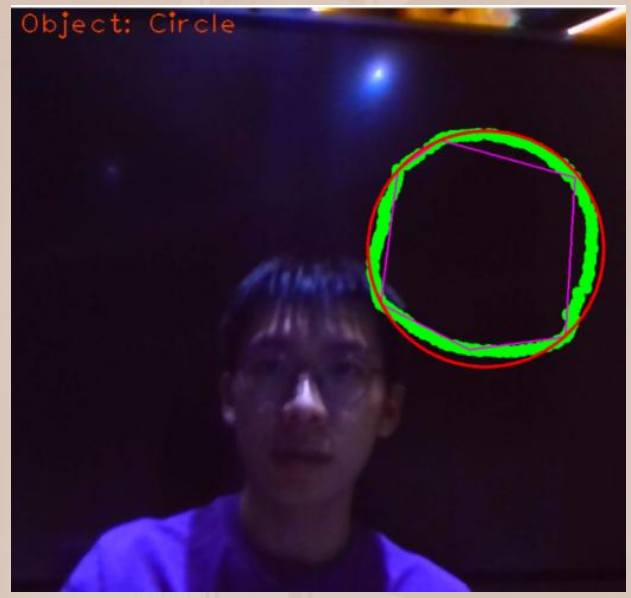
经典的 Douglas-Peucker 算法描述如下：

> 在曲线首尾两点 A，B 之间连接一条直线 AB，该直线为曲线的弦；
>
> 得到曲线上离该直线段距离最大的点 C，计算其与 AB 的距离 d；
>
> 比较该距离与预先给定的阈值 threshold 的大小，如果小于 threshold，则该直线段作为曲线的近似，该段曲线处理完毕。
>
> 如果距离大于阈值，则用 C 将曲线分为两段 AC 和 BC ，并分别对两段曲线进行 1~3 的处理。
>
> 当所有曲线都处理完毕时，依次连接各个分割点形成的折线，即可以作为曲线的近似。

HighLights - Shape Correcting







MinEnclosingTriangle

BoundingRectangle

MinEnclosingCircle

Part 3

Difficulties.

Difficulties - OpenCV Environment Set-up

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1. New way to Install OpenCV——利用Vcpkg来管理第三方库

由于尝试了所给文档中的所有安装方法，均已失败告终，于是在自主摸索下，找到了一个似乎更加方便的安装OpenCV的方法。

(1) 配置CMake和winMG

和其他配置方法一样，先要配CMake和winMG的环境变量，这里不多赘述。

(2) 配置Vcpkg

- [ ] 使用git命令克隆一个当前版本下来，或者直接下载压缩包。

```
//cmd指令
git clone https://github.com/microsoft/vcpkg
```

- [ ] 编译Vcpkg

Vcpkg大量使用的psl脚本，所以官方强烈推荐使用PowerShell而不时CMD命令行来执行各种操作。尽管在使用的时候兼容CMD，但是在编译这一步，请使用PowerShell。

如果指令执行不成功，可以直接在窗口中打开文件夹双击**bootstrap-vcpkg.bat**

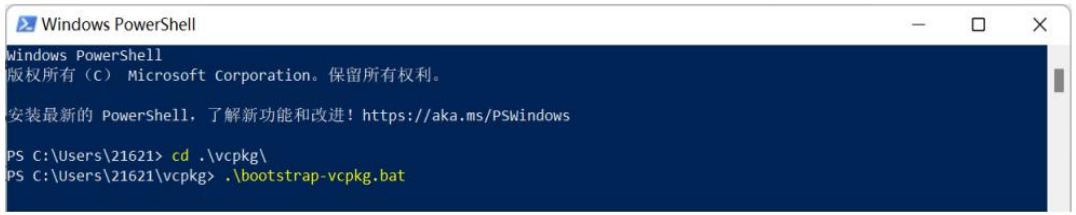


图10 | PowerShell指令

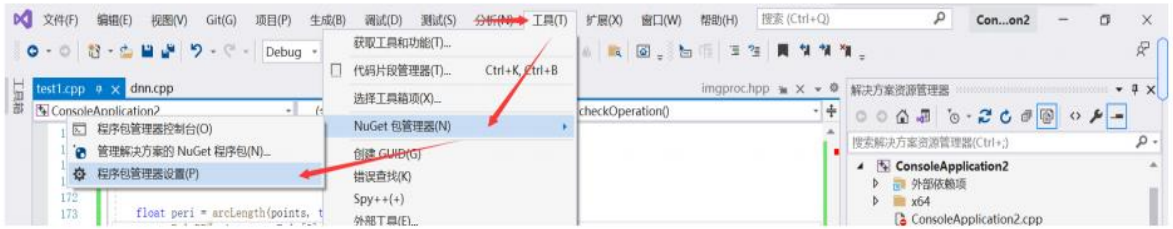
- [ ] 使用Vcpkg安装OpenCV库

```
//cmd指令：在vcpkg目录下
.\vcpkg.exe install opencv:x64-windows
```

- [ ] Vcpkg和visual studio的集成

```
//cmd指令：集成到工程
.\vcpkg integrate project
```

这时候会在“./vcpkg/scripts/buildsystems”目录下，生成nuget配置文件，打开Visual Studio，点击菜单“工具->NuGet包管理器->程序包管理器设置”，进入设置界面，点击“程序包源”。

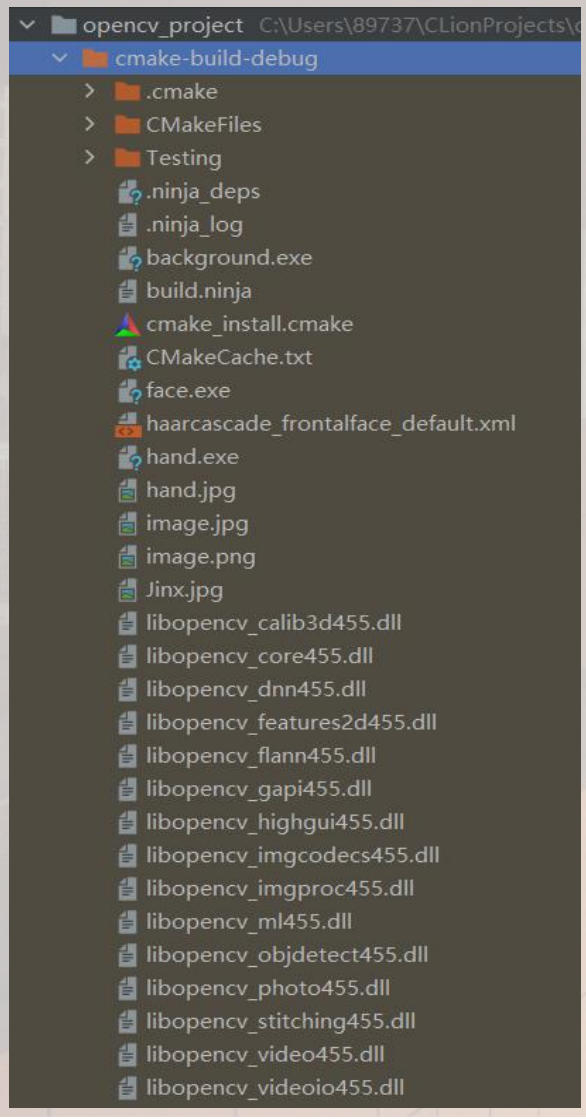


点击“加号”增加一个源。修改源的名字为vcpkg。在“源”的选项中点击右侧的"..."选择vcpkg目录下的“scripts\buildsystems”目录，然后点击右侧的“更新按钮”。点击“确定”，关闭设置对话框。

用Visual Studio 打开一个工程或解决方案。右键点击需要设置的工程，选择“管理NuGet程序包”。在右上角的“程序包源”中选择刚刚设置的“vcpkg”。这样在“浏览”选项卡中就可以看到“vcpkg.H.Repos.vcpkg”。点击最右侧的“安装”。这样就可以集成到某个工程了。

Difficulties - OpenCV Environment Set-up

Clion Set-up



Link OpenCV library using CMake and static library linking

```
set(CMAKE_CXX_STANDARD 14)
#set(CMAKE_CXX_FLAGS "${CMAKE_CXX_FLAGS} -std=c++11")
set(SOURCE_FILES main.cpp)
add_executable(opencv_project ${SOURCE_FILES})
add_executable(test test1.cpp)
add_executable(face faceDetection.cpp)
add_executable(paint virtual.cpp)
add_executable(background backGroundProcess.cpp)
add_executable(hand handDetect.cpp)


set(OpenCV_DIR C:/Users/89737/Downloads/opencv/mingw-build/install)
find_package(OpenCV REQUIRED)
include_directories(${OpenCV_INCLUDE_DIRS})

set(OpenCV_LIBS opencv_core opencv_imgproc opencv_highgui opencv_imgcodecs opencv_objdetect opencv_video opencv_videoio opencv_featu

target_link_libraries(opencv_project ${OpenCV_LIBS})
target_link_libraries(face ${OpenCV_LIBS})
target_link_libraries(paint ${OpenCV_LIBS})
```

Difficulties - Parameters Adjustment

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Using TrackBar to adjusting parameters of different Color Space in order to get a better effect of the image processing in current environment.

```
namedWindow("Trackbars", (640, 200));
createTrackbar("Hue Min", "Trackbars", &hmin, 255);
createTrackbar("Hue Max", "Trackbars", &hmax, 255);
createTrackbar("Sat Min", "Trackbars", &smin, 255);
createTrackbar("Sat Max", "Trackbars", &smax, 255);
createTrackbar("Val Min", "Trackbars", &vmin, 255);
createTrackbar("Val Max", "Trackbars", &vmax, 255);

namedWindow("TrackbarsY", (640, 200));
createTrackbar("Y Min", "TrackbarsY", &Ymin, 255);
createTrackbar("Y Max", "TrackbarsY", &Ymax, 255);
createTrackbar("CR Min", "TrackbarsY", &CRmin, 255);
createTrackbar("CR Max", "TrackbarsY", &CRmax, 255);
createTrackbar("CB Min", "TrackbarsY", &CBmin, 255);
createTrackbar("CB Max", "TrackbarsY", &CBmax, 255);
```

Adjusting parameters to better meet the expected end-drawing condition

Adjusting parameters of the camera to get a better input image.

```
capture.set( propId: CAP_PROP_FRAME_WIDTH, value: 1280);
capture.set( propId: CAP_PROP_FRAME_HEIGHT, value: 720);
capture.set( propId: CAP_PROP_FPS, value: 100);//帧率 帧/秒
capture.set( propId: CAP_PROP_BRIGHTNESS, value: 61);//亮度
capture.set( propId: CAP_PROP_CONTRAST, value: 75);//对比度 40
capture.set( propId: CAP_PROP_SATURATION, value: 80);//饱和度 50
capture.set( propId: CAP_PROP_HUE, value: 128);//色调 50
capture.set( propId: CAP_PROP_EXPOSURE, value: 97);//曝光 50
```

```
如果在画图过程中回到了起点，则结束画图，清空点集
else if (((abs( X: point.x - startPoint.x) < 15) && ((abs( X: point.y - startPoint.y) < 15))) &&
         points.size() > 80) {
    cout << "--------------------" << endl;
    cout << "End Drawing" << endl;
    start_draw = false;
    end_draw = true;
    begin_draw = false;
}
```

Part 4

Novelties.

Novelties - Color Space Mapping


```
//通过两种不同的Kernel矩阵进行形态学计算
kernel = getStructuringElement( shape: MORPH_RECT,  ksize: Size( width: 3,  height: 3));
Mat kernel_combine = getStructuringElement( shape: MORPH_RECT,  ksize: Size( width: 4,  height: 4));
```

```
//用HSV空间识别
cvtColor( src: imgBlur,  dst: imgHSV,  code: COLOR_BGR2HSV);
Scalar lower_HSV( v0: hmin,  v1: smin,  v2: vmin);
Scalar upper_HSV( v0: hmax,  v1: smax,  v2: vmax);
inRange( src: imgHSV,  lowerb: lower_HSV,  upperb: upper_HSV,
erode( src: range_HSV,  dst: range_HSV, kernel);
dilate( src: range_HSV,  dst: range_HSV, kernel);
```

```
//用YCrCb空间识别
cvtColor( src: imgBlur,  dst: imgYCrCb,  code: COLOR_BGR2YCrCb);
Scalar lower_YCrCb( v0: Ymin,  v1: CRmin,  v2: CBmin);
Scalar upper_YCrCb( v0: Ymax,  v1: CRmax,  v2: CBmax);
inRange( src: imgYCrCb,  lowerb: lower_YCrCb,  upperb: upper_YCrC
erode( src: range_YCrCb,  dst: range_YCrCb, kernel);
dilate( src: range_YCrCb,  dst: range_YCrCb, kernel);
```

```
//综合两种识别方式
bitwise_or( src1: range_HSV,  src2: range_YCrCb,  dst: img_final);
medianBlur( src: img_final,  dst: img_final,  ksize: 3);
erode( src: img_final,  dst: img_final,  kernel: kernel_combine);
dilate( src: img_final,  dst: img_final,  kernel: kernel_combine);
```

Novelties - Color Space Mapping

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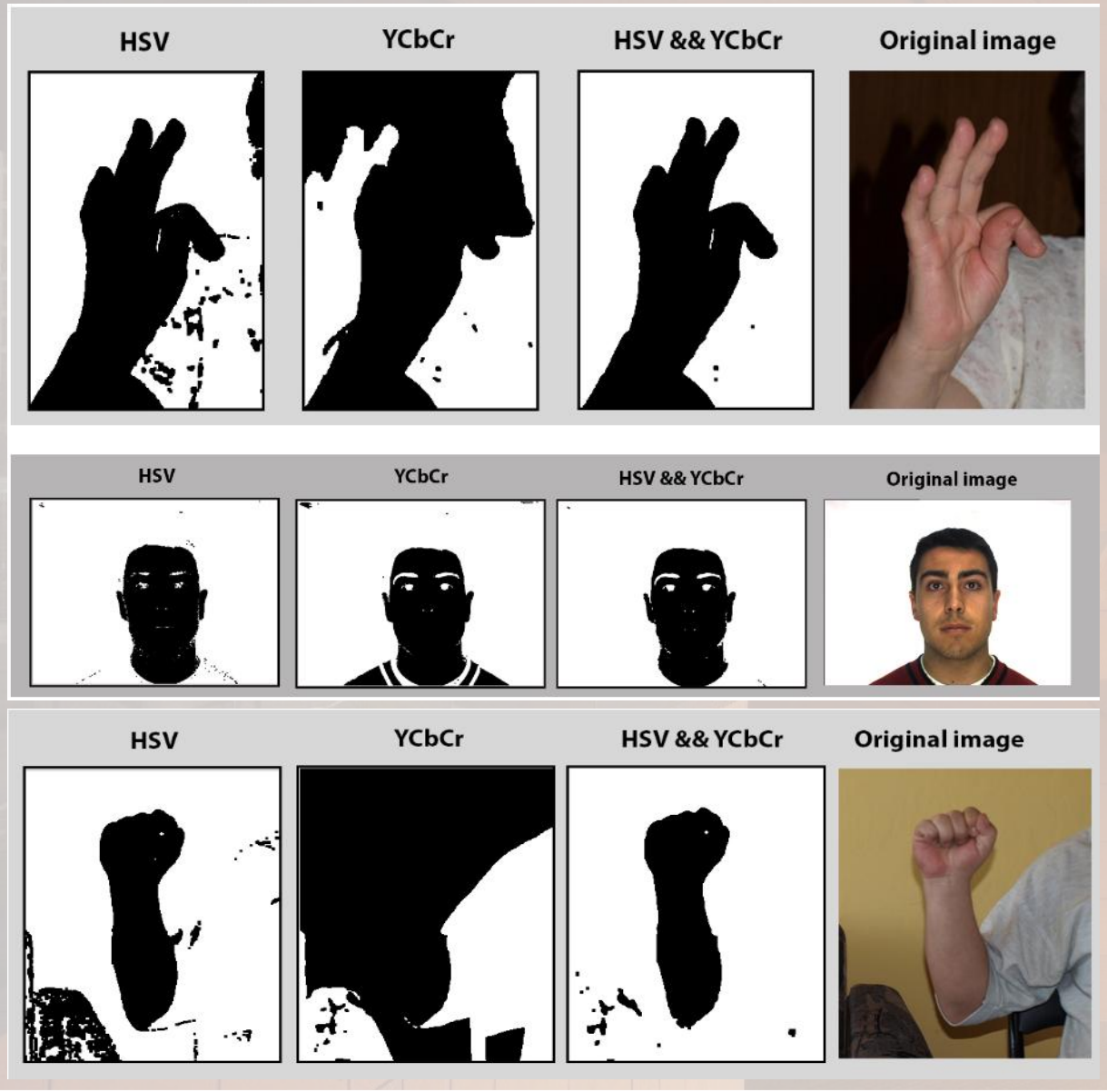
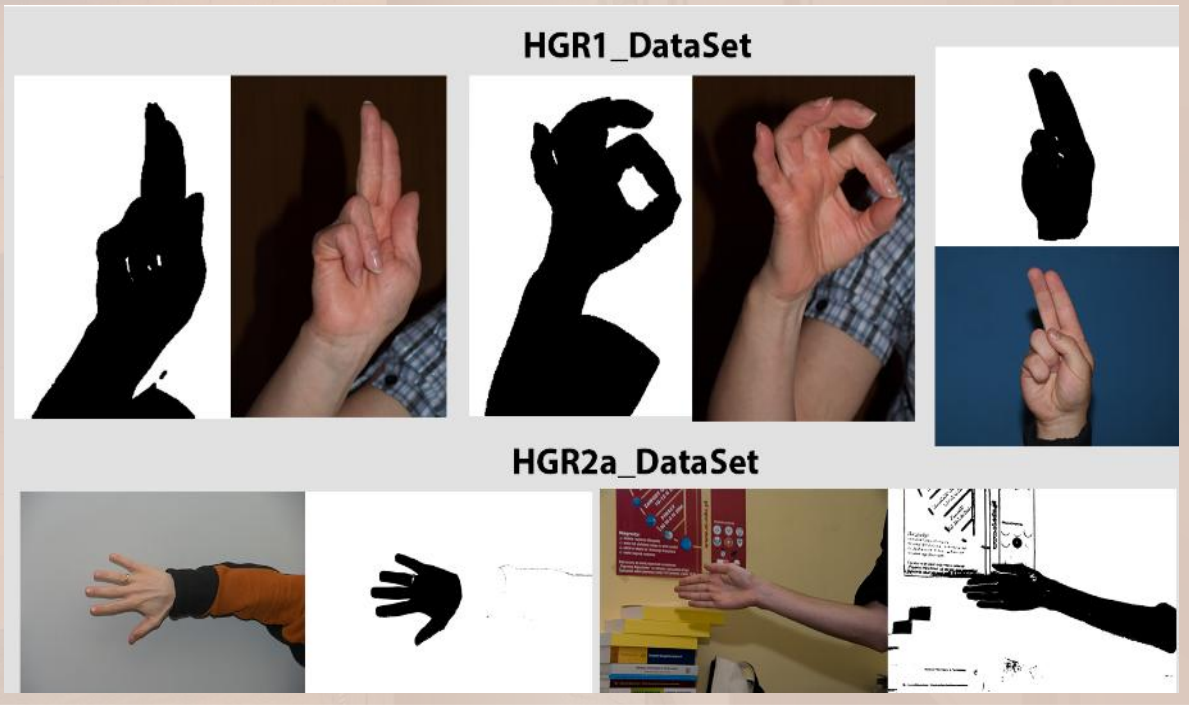


One Shortcoming

Don’t let your skin and face in the image at the same time :(



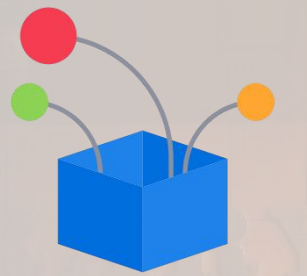
Novelties - MouseEvent

State Machine

```
if (MODE == 1 && !do_operate) {
    let_Mouse_Move( x: point.x,  y: point.y);
}
```

Shape Identification

```
//              通过角点数量识别图形
int objectType;
int objCornerPoints = (int) conPoly[0].size();
if (objCornerPoints == 3) {
    objectType = 3;
} else if (objCornerPoints == 4) {
    objectType = 4;
} else if (objCornerPoints == 5) {
    objectType = 5;
} else if (objCornerPoints > 5) {
    objectType = 6;
} else {
    objectType = 7;
}
```



Operation Binding

```
if (objectType == 3){
    obj = "Triangle";
    operationType = "Click";
}
else if(objectType == 4){
    obj = "Rectangle";
    operationType = "DoubleClick";
}
else if(objectType == 5){
    obj = "Pentagon";
    operationType = "MidClick";
}
else if(objectType == 6){
    obj = "Circle";
    operationType = "RightClick";
}
```

MouseEvent Function

```
void let_Mouse_DoubleClick() {
    INPUT Input = {0};
    Input.type = INPUT_MOUSE;
    Input.mi.dwFlags = MOUSEEVENTF_LEFTDOWN | MOUSEEVENTF_ABSOLUTE;
    SendInput( cInputs: 1,  pInputs: &Input,  cbSize: sizeof(INPUT));
    Input.mi.dwFlags = MOUSEEVENTF_LEFTUP | MOUSEEVENTF_ABSOLUTE;
    SendInput( cInputs: 1,  pInputs: &Input,  cbSize: sizeof(INPUT));
    Input.mi.dwFlags = MOUSEEVENTF_LEFTDOWN | MOUSEEVENTF_ABSOLUTE;
    SendInput( cInputs: 1,  pInputs: &Input,  cbSize: sizeof(INPUT));
    Input.mi.dwFlags = MOUSEEVENTF_LEFTUP | MOUSEEVENTF_ABSOLUTE;
    SendInput( cInputs: 1,  pInputs: &Input,  cbSize: sizeof(INPUT));
    cout << "Double Click" << endl;
}
```

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Thank you for your listening!

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感谢图片分享者：15级摄影师董行