Computer Vision HW3

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一、　程式碼及方法

```
#include <opencv2/opencv.hpp>
#include <vector>
#include <iostream>
#include <string>
#include <filesystem>
```

Include library

```
cv::Mat image,background,original;
std::vector<cv::Point> points; //point 容器保存點擊事件的座標點
```

設置圖片及容器 points，用來存放圖片及點擊事件的座標點

```
void onMouse(int event, int x, int y, int flags, void* param){
  if(event==cv::EVENT_LBUTTONDOWN){
    points.push_back(cv::Point(x,y));
    cv::circle(original,cv::Point(x,y),3,cv::Scalar(0,255,0),-1);
    std::cout<<"["<<x<<","<<y<<"]"<<std::endl;
    cv::imshow("Image",original);
  }
}
```

將點擊位置的座標存放到容器當中，並將座標顯示到終端機上

```
void drawPolygo(){
    background.copyTo(original);
    cv::Mat mask = cv::Mat::zeros(original.size(), CV_8UC1);
    std::vector<std::vector<cv::Point>> pts = { points };
    cv::fillPoly(mask, pts, cv::Scalar(255));
    cv::polylines(original, pts, true, cv::Scalar(255, 0, 0), 2);
    cv::imshow("Image",original);
}
```

將原始導入的圖片 original 複製到 background 中，並將點擊的點連起來

```
void shrinkPolygon(cv::Mat& grad_x,cv::Mat& grad_y,double ALPHA,double BETA,double GAMMA){
  //定義搜索區域大小
  const int searchRegionSize=1;
  //定義能量函數的權重
  const double alpha=ALPHA;
  const double beta=BETA;
  const double gamma=GAMMA;

  for(int i=0;i<points.size();i++){
    double minEnergy = INT_MAX;// 初始化最小能量
    cv::Point point_minus_1 = (i==0)?points[points.size()-1]:points[i-1]; //p_i-1
    cv::Point point_plus_1 = (i==points.size()-1)?points[0]:points[i+1];  //p_i+1
    cv::Point newPoint;


      for(int x=-searchRegionSize;x<=searchRegionSize;x++){
        for(int y=-searchRegionSize;y<=searchRegionSize;y++){

        cv::Point point_s = cv::Point(points[i].x+x,points[i].y+y);   //p_i+s


        cv::Point g_point_s;  //p_i+s 遍歷點的梯度
        g_point_s.x=grad_x.at<double>(point_s.y,point_s.x);
        g_point_s.y=grad_y.at<double>(point_s.y,point_s.x);


        double E_cont = cv::norm(point_s-point_minus_1);
        double E_curv = cv::norm(point_minus_1-2*point_s+point_plus_1);
        double E_img = cv::norm(g_point_s);
        double totalEnergy=alpha*E_cont+beta*E_curv+gamma*E_img;


        if(totalEnergy<minEnergy){
          minEnergy=totalEnergy;
          newPoint=point_s;
        }
      }
    }
    points[i]=newPoint;
    cv::circle(original,cv::Point(points[i].x,points[i].y),3,cv::Scalar(0,255,0),-1); //繪製新的點
  }
}
```

grad_x grad_y 為圖像的梯度、ALPHA BETA GAMMA 能量函數的權重、searchRegionSize 搜索區域的大小、double E_cont = cv::norm(point_s - point_minus_1);: 表示連續性項，即相鄰頂點之間的距離、double E_curv = cv::norm(point_minus_1 - 2 * point_s + point_plus_1);:表示曲率項，即頂點附近的曲率。double E_img = cv::norm(g_point_s);: 表示圖像梯度項。minEnergy 設為一個很大的數，totalEnergy=alpha*E_cont+beta*E_curv+gamma*E_img 計算區域中的能量，如果 totalEnergay 小於 minEnergy 則 minEnergy 就會被更新，用這種方法來算出區域中最小的能量，然後將點更新到能量最小的地方，便可以完成收縮。

```cpp
cv::VideoWriter createVideoWriter(const std::string& filename, const cv::Size& frameSize, double
fps) {
    int fourcc = cv::VideoWriter::fourcc('X', '2', '6', '4'); // 使用 X264 編碼
    cv::VideoWriter writer(filename, fourcc, fps, frameSize);
    if (!writer.isOpened()) {
        std::cerr << "Error: Unable to open video file for writing." << std::endl;
        exit(EXIT_FAILURE);
    }
    return writer;
}

void saveFramesToVideo(const std::string& imgname, const std::vector<cv::Mat>& frames, double fps)
{
  std::filesystem::path imgPath(imgname);
  std::string videoFilename="../result/result"+imgPath.stem().string()+"_video.avi";

  cv::VideoWriter writer = createVideoWriter(videoFilename, frames[0].size(), fps);

  for (const auto& frame : frames) {
      writer.write(frame);
  }
  writer.release();
}
```

將過程存成.avi 的影片

```cpp
void saveImage(const std::string& imgname,const cv::Mat& img){
  std::filesystem::path imgPath(imgname);
  std::string imageFilename="../result/result"+imgPath.stem().string()+"_image.jpg";
  cv::imwrite(imageFilename,img);
}
```

存圖片的 function

```cpp
void pic(std::string imgname,double ALPHA,double BETA,double GAMMA){
  original = cv::imread(imgname);
  cv::resize(original,original,cv::Size(original.cols/2,original.rows/2),0,0);
  background = original.clone();
  cv::cvtColor(original,image,cv::COLOR_RGB2GRAY);
  cv::GaussianBlur(image,image,cv::Size(1,1),0,0);

  cv::Mat grad_x,grad_y;
  cv::Sobel(image,grad_x,CV_64F,1,0); //計算 x 方向梯度
  cv::Sobel(image,grad_y,CV_64F,0,1); //計算 y 方向梯度

  cv::imshow("Image",original);
  cv::setMouseCallback("Image",onMouse,0);  //觸發點擊事件
  cv::waitKey(0);

  //add a vector to save the image of each frame
  std::vector<cv::Mat> frames;

  //add the initial image to frames
  frames.push_back(original.clone());

  if (points.size() >= 3){
    for(int i=0;i<100;i++){
      drawPolygo();
      frames.push_back(original.clone());
      cv::waitKey(3);
      shrinkPolygon(grad_x,grad_y,ALPHA,BETA,GAMMA);
    }
  }
  saveImage(imgname,original);
  saveFramesToVideo(imgname,frames,30.0);
  points.clear();
}
```

把圖片先灰階接著做高斯模糊，然後計算出圖片的梯度，呼叫前面所寫的 function，實現繪圖及收縮的功能，並將影片及圖片存起來

```
int main(int argc, char* argv[]) {
  pic("../test_img/1.jpg",0.2,0.1,0.7);
  pic("../test_img/3.jpg",0.2,0.1,0.7);
  pic("../test_img/5.jpg",0.2,0.1,0.7);
  return 0;
}
```

輸入不同圖片，0.2,0.1,0.7 這個組合這三張照片都有不錯的

二結果

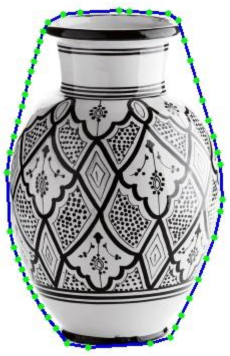
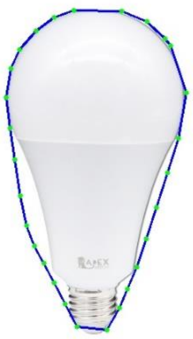
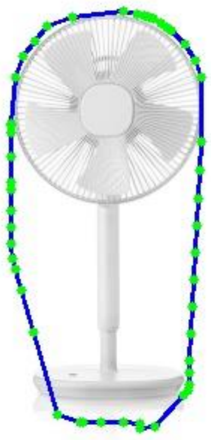
Image1	 Result1

Image3	 Result3
Image5	 Result5

觀察結果:像是的電風扇這張圖的倒影會影響邊緣的偵測，所以結果沒有那麼好。