Surveillance of dairy animals using a smartphone-based system

PROJECT PLAN

DEC1616
Client
MENG LU
Team Members/Roles:
Xin Tong: App development (Skill: X-code)
Di Zhao: Mount design and 3D printing (Skill: Solidworks)
Le Wei: Optical design (Skill: Code V)
Tianqi Luo: Assay development (fluorescence polarization assay kit)
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1 Introduction

1.1 PROJECT STATEMENT

We want to use the smart phone to precede the fluorescence polarization assay kit. Fluorescence polarization techniques are particularly useful for inter-molecular interactions. This method is direct and immediate detection of the bound tracer molecules / free rate. Considering smart phone is popular in these years. Our project will make a new device to replace traditional spectroscopic instruments. We want use CCD camera in smart phone to replace the detector (PMT) to assay the result. In order to reach the purpose for our project. We must to design the new equipment. Different software will be used to design the project. For the first part: Xin Tong studies the X-Code to development the APP for the iPhone, which can provide the picture data for the fit. For the second part: Tianqi Luo learns about Fluorescence polarization assay and Lei Wei and Di Zhao design the optical structure.

1.2 PURPOSE

Fluorescence polarization plays an increasingly important role in many areas of life science. Most hospital use FP assay C-reactive protein to discover disease and follow up the disease. Fluorescence polarization is more safe and reliable, which does not pose a threat to the researchers, it does not produce radioactive waste is difficult to handle. In addition, FP required less sample, high sensitivity, good reproducibility and easy operation. In our project we want use advantage of fluorescence polarization without the inconvenient traditional spectroscopic instruments. Considering a lot of factors. We want to use the smart phone to replace detector (PMT). Because smart phone is popular today and CCD camera can achieve the same function as photomultiplier. Our project uses the advantage of fluorescence polarization and convenience of smart phone, which will be more easily to make medicine assay, blood assay and many areas. So our project will make a big effect in many areas of life science.

1.3 GOALS

For this senior design project has different parts. For the final goal we want to design a device and application for iPhone. Our new device can use iPhone to make a fluorescence polarization assay. So our project will be more easily to make medicine assay, blood assay and many areas than traditional spectroscopic instruments. As a list for our parts' goals:

(1) Designing the correct optical model to allow the laser attach the destination by polarization and reflection.

(2) Using Solidwork to design the structure to hold the optical units and smartphones.

(3) Developing an application for iPhone and use iPhone's camera to read the data.

(4) Using the achieved data to analyze by fluorescence polarization assay.

2 Deliverables

The advantage of our project is that uses CCD camera to replace the traditional detector (PMT). In order to finish our project we must make a new device. There is our to-do list:

(1) Using the Code V to design the optical simulation in the computer. If the optical simulation can success.

(2) We will use the Solidwork to design the structure to hold the optical component and iPhone. Then we will send our Solidwork file to 3D print and get real structure.

(3) Developing app for iPhone will provide necessary data from sample for people to assay.

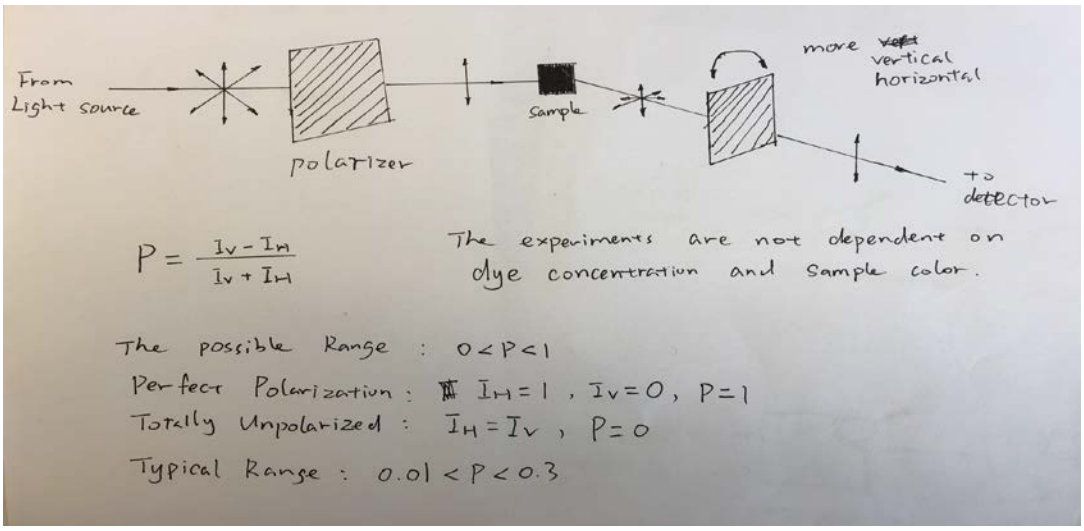
(4) Assaying data by fluorescence polarization way.

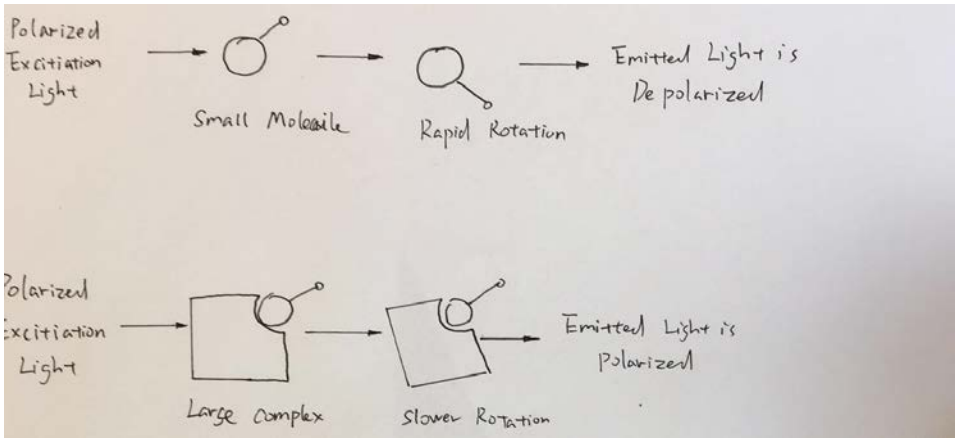
So the optical design, app development, Solidwork design and fluorescence polarization assay are all the most important parts for our project. Just because every part is important and independent. So every goals is necessary for our project. We only finish every goals step by step, which will accomplish the final goals to make a perfect device and app for medicine assay, blood assay and other life sciences.

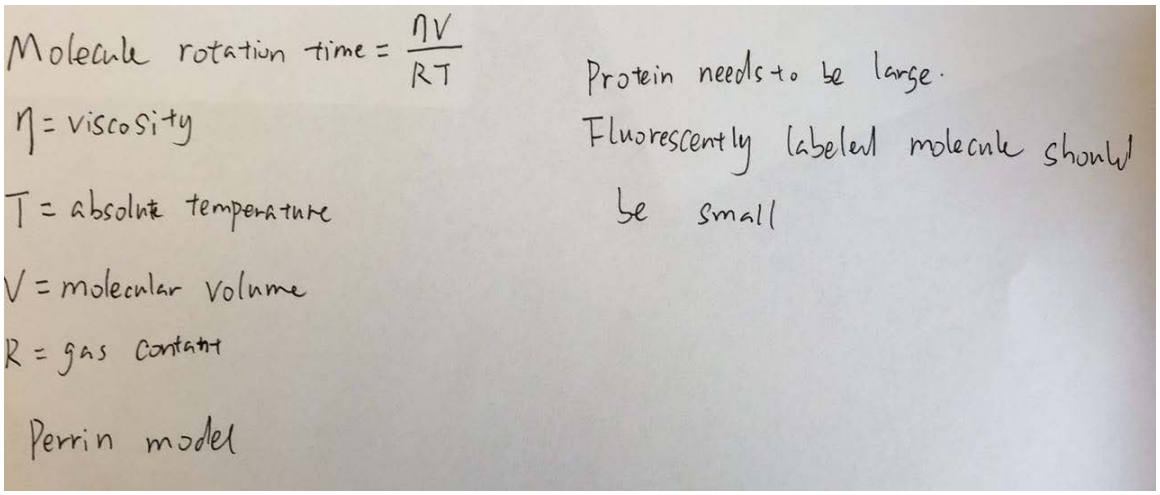
3 Design

3.1 PREVIOUS WORK/LITERATURE

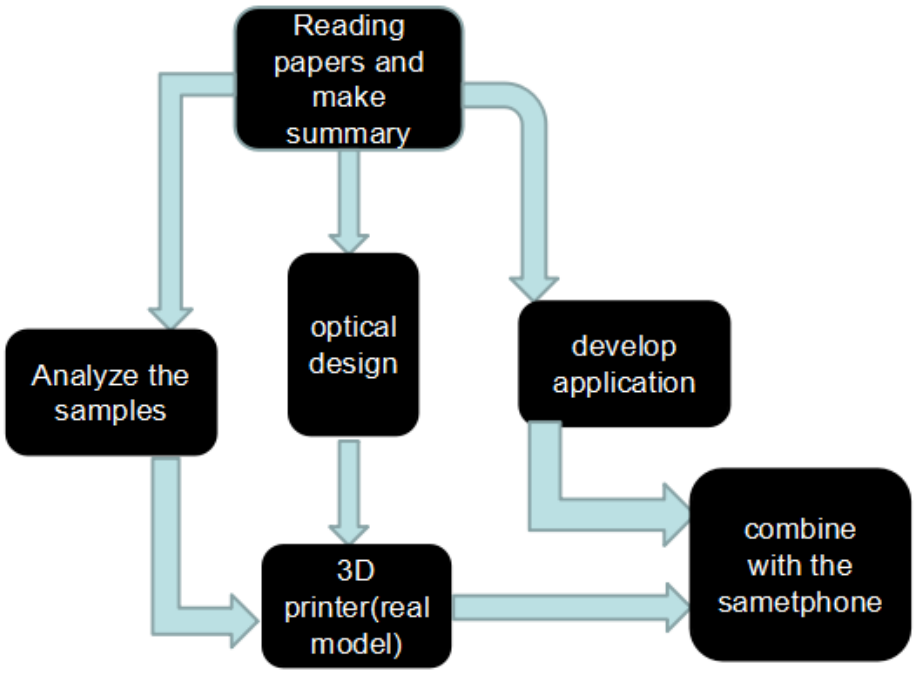
We have read a lot of paper of our projects and we make a summary of these essays.





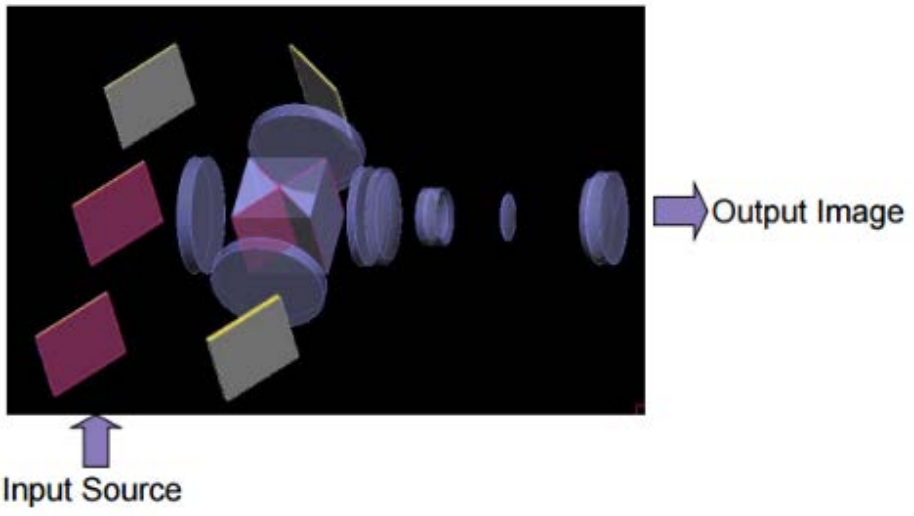


3.2 PROPOSED SYSTEM BLOCK DIAGRAM



3.3 ASSESSMENT OF PROPOSED METHODS

After several weeks' design, we make a great model but that's not so perfect



We need to modified the parameters of all the components, and then it can be made by 3D printer. Finally we can combine the real model with smartphones and set up the application. We believe that it will worked in the end.

3.4 VALIDATION

When we combine all the application or components with our smartphones, then we can collect data by smartphones. If the data we collected is same as the data we analyzed before, that confirm that it worked.

4 Project Requirements/Specifications

4.1 FUNCTIONAL

First part is the mechanical part, we want to use the camera and lens which are in our smartphone. the phone's camera can collect the image accurately, which the essence is to hold the position of the phone well.

Second part is embedded optical part, we can see the reflection dimension of the object clearly from the smartphone camera. The dimension of the object is reflected by two general glasses mirror, and we need to add a some lens to collect the lights.

Another part is application part, during scanning, we can analyze the polarization intensity from the line-chart by clicking on any two spot of the image. Polarization is calculated by the special formula, we programmed it into the app.

4.2 NON-FUNCTIONAL

We need to adjust the lens and mirrors to get the images.we not only need to know how the camera which in the smart phone worked, but also need to know how to operate which is the exact same way for changing the attributes of an image.

We need to know what polarization is, and make sure that we can let others know what it is. We have three EE students, and one of us will explain to others clearly about what the polarization is so clients would know what effect such analysis can create.

People need to provide their email addresses ,and then we can sent the analysis information of the image to them. The analysis data could only be collected by sending emails, otherwise, when starting the analysis, the previous one will be deleted.

5 Challenges

Include any concerns or dThere are a lot of challenges for our project. First, we have a lot of software to learn. For example, the Solidwork, X-code and Code V, which we never learn these software before. But we want to make a successful design, we must take a lot of time to become familiar. For the app development part, which is difficult to develop a perfect app for iPhone. It will take a long time to develop an app. For the structure design, we must use simulation experiment on computer. If the simulation is successful, we will use 3D printer to print the real structure. We will do our personal best and try again and again to make a perfect design for our structure. For the Fluorescence Polarization assay part, we must read a lot of paper and watch a lot of videos to learn about what Fluorescence Polarization is and how to use Fluorescence Polarization to assay the sample. In our group, all group members are not native speakers. So language is also a challenge for us.

6 Timeline

6.1 FIRST SEMESTER

The first week we need to read papers. And then we will use 3-6 weeks to do the basic design and collection of data. Then the following weeks we will do the testing part. Thus, at the end of this semester, we need to at least do finish one model.Now we start to design our second generation and practice our presentation. Then second semester we can try and design more options of this project.

6.2 SECOND SEMESTER

Base on the first semester, I think we have got one model. But it will not be so perfect. Group members continue their works. Xin Tong will development our app better and better Di Zhao will made her structure on Solidworks well. Le Wei will continue design the whole optical model. Tianqi Luo will continue fluorescence polarization measurements.Thus, in this semester, we will try other options of design. We will change a lot of basic data in the part of optical design and Solidwork design. Then we can get the one which can collect the data very clearly. We will use 2 weeks to re-test the first model. Then maybe use 6-8 weeks to do two or three more designs. Then the following weeks, we will test and compare all the models. And then pick the best one and show it to other groups.

7 Conclusions

Our project is more challenge for us, as we told before we learned more about the knowledge that we never toughed, so we should send much time to study and totally understand every detail about the software that we learned. For our team we separate four parts for four team members. Each week we have our own tasks to do. If we met some problems that during the process, we will send the email to our group mentor: Zijian Zhao or our instructor: Meng Lu. The meeting time with advisor holds on Tuesday 11: 00 every week, our team meeting holds on three times each week. After finished the meeting we should write the TO-DO list and send the advisor to check. The beneficial of this project in the future that is the APP will be appear on the market, it should be make contribution to the field of medicine and life science because through the APP it can easily to get the data to analyze, small molecules substances such as drugs content in the sample.

So far, we have made great progress. We go over and over to change our optical design. Now we succeeded. We can see two different spots in the sensor. This is exactly as our previously thought. The current issue is that, we hope can make this model as small as possible. And we also need time to improve our APP. Thus, We will pay more attention on the developing of APP for next week. We believe that, at the end of this semester, we can use our smart phone to analysis simple samples. And we are going to do the power point to prepare the presentation, we are already practiced for twice, our group mentor an advisor gave us some suggestions when we were presented for the first time, after we presented we should edit the slides and practice for more time. At last month we should pay more efforts for our design and Tong Xin will continue for the code design and Tianqi will analyze the data for the sample.

8 References

Reference for paper:

1>. (Smartphone Fluorescence Spectroscopy)

2>. (Pierce® Fluorescent Protease Assay Kit)

3>. (Fluorescence Polarization in Life Science)

References for videos (YouTube)

4>. SolidWorks Tutorials

http://www.youtube.com/watch?v=cy3ExIAcI2Y (part 1/3)

https://www.youtube.com/watch?v=ll_9D6J2yTo (part 2/3)

https://www.youtube.com/watch?v=0fYL-lCrEv4 (part 3/3)

5> Code V Study:

Code V Optical Design Software:

https://www.youtube.com/watch?v=6-wIkoiwvX0

https://optics.synopsys.com/codev/?gclid=CICXjtu6hMsCFQgxaQod01ILJg

https://optics.synopsys.com/learn/learn-student-license.html

6> optical design

https://lightmachinery.com/optical-design-center/

http://www.zemax.com/

http://www.atmos-software.it/Atmos.html

7> Fluorescence Polarization assay kit

https://www.youtube.com/watch?v=HiG6KWkkrV4

https://www.youtube.com/watch?v=OdBNVrPvJMY

9 Appendices

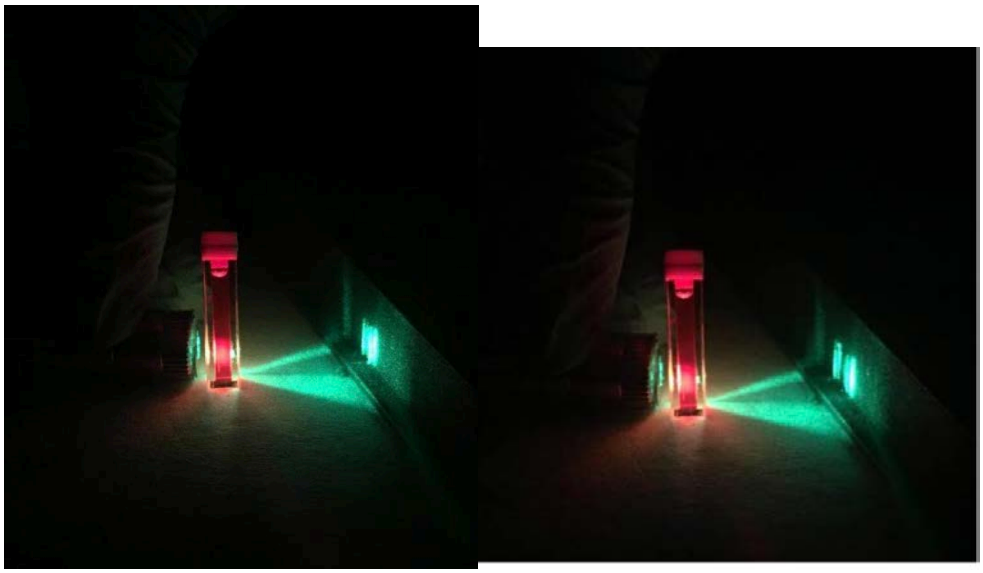


Figure 1 &2: Tianqi's Sample

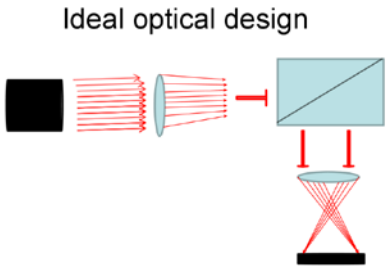
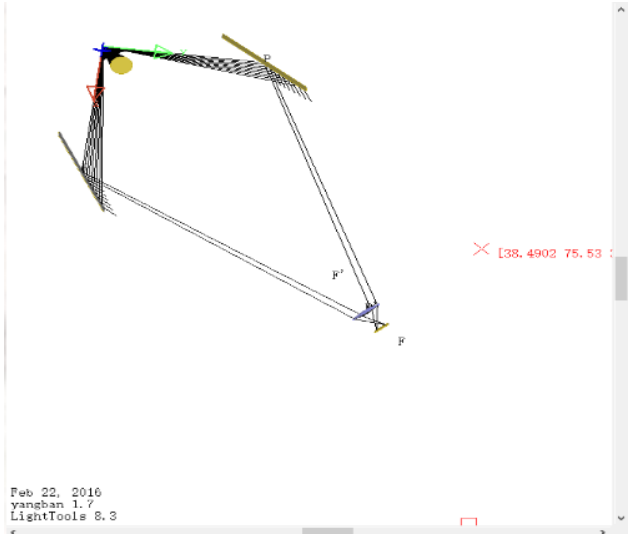
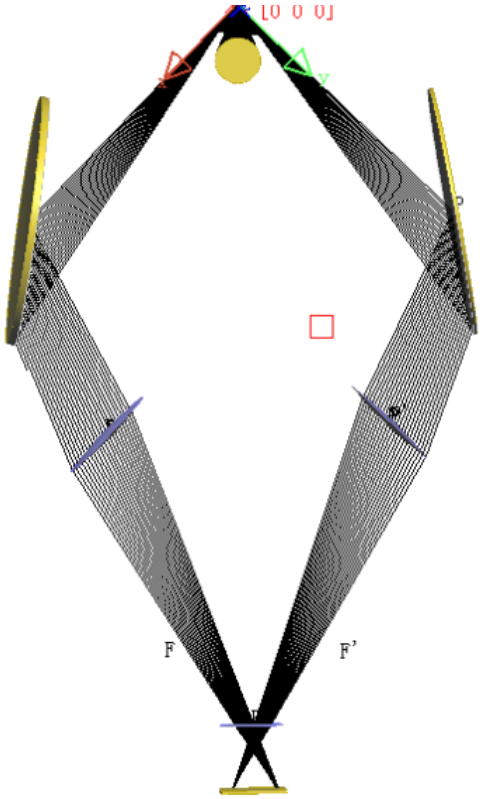


Figure 3 Le Wei's design






```
//changing shape, TODO:
- (void)drawRect:(CGRect)rect {
    CGContextRef context = UIGraphicsGetCurrentContext();
    CGContextSaveGState(context);

    // (1) Draw the bounding box.
    CGContextSetLineWidth(context, 1.0);
    CGContextSetStrokeColorWithColor(context, [UIColor blueColor].CGColor);
    CGContextAddRect(context, CGRectInset(self.bounds, kSPUserResizableViewInteractiveBorderSize/2,
        kSPUserResizableViewInteractiveBorderSize/2));
    CGContextStrokePath(context);

    // (2) Calculate the bounding boxes for each of the anchor points.
    CGRect upperLeft = CGRectMake(0.0, 0.0, kSPUserResizableViewInteractiveBorderSize,
        kSPUserResizableViewInteractiveBorderSize);
    CGRect upperRight = CGRectMake(self.bounds.size.width - kSPUserResizableViewInteractiveBorderSize, 0.0,
        kSPUserResizableViewInteractiveBorderSize, kSPUserResizableViewInteractiveBorderSize);
    CGRect lowerRight = CGRectMake(self.bounds.size.width - kSPUserResizableViewInteractiveBorderSize, self.bounds.size.
        height - kSPUserResizableViewInteractiveBorderSize, kSPUserResizableViewInteractiveBorderSize,
        kSPUserResizableViewInteractiveBorderSize);
    CGRect lowerLeft = CGRectMake(0.0, self.bounds.size.height - kSPUserResizableViewInteractiveBorderSize,
        kSPUserResizableViewInteractiveBorderSize, kSPUserResizableViewInteractiveBorderSize);
    CGRect upperMiddle = CGRectMake((self.bounds.size.width - kSPUserResizableViewInteractiveBorderSize)/2, 0.0,
        kSPUserResizableViewInteractiveBorderSize, kSPUserResizableViewInteractiveBorderSize);
    CGRect lowerMiddle = CGRectMake((self.bounds.size.width - kSPUserResizableViewInteractiveBorderSize)/2, self.bounds.
        size.height - kSPUserResizableViewInteractiveBorderSize, kSPUserResizableViewInteractiveBorderSize,
        kSPUserResizableViewInteractiveBorderSize);
    CGRect middleLeft = CGRectMake(0.0, (self.bounds.size.height - kSPUserResizableViewInteractiveBorderSize)/2,
        kSPUserResizableViewInteractiveBorderSize, kSPUserResizableViewInteractiveBorderSize);
    CGRect middleRight = CGRectMake(self.bounds.size.width - kSPUserResizableViewInteractiveBorderSize, (self.bounds.size.
        height - kSPUserResizableViewInteractiveBorderSize)/2, kSPUserResizableViewInteractiveBorderSize,
        kSPUserResizableViewInteractiveBorderSize);

    // (3) Create the gradient to paint the anchor points.
    CGFloat colors [] = {
```