

Surveillance of dairy animals using a smartphone-based system Project plan

DEC1616

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)

Team Email:

ltq@iastate.edu

lewei@iasatte.edu

xint@iastate.edu

dzhao@iastate.edu

Team Website:

491ofwonderfulfour.weebly.com

Revised: 18/02/2016

Contents

<u>1 Introduction</u>	2
<u>1.1 Project statement</u>	2
<u>1.2 purpose</u>	2
<u>1.3 Goals</u>	2
<u>2 Deliverables</u>	2
<u>3 Design</u>	3
<u>3.1 Previous work/literature</u>	3
<u>3.2 Proposed System Block diagram</u>	4
<u>3.3 Assessment of Proposed methods</u>	5
<u>3.4 Validation</u>	6
<u>4 Project Requirements/Specifications</u>	7
<u>4.1 functional</u>	7
<u>4.2 Non-functional</u>	7
<u>5 Challenges</u>	7
<u>6 Timeline</u>	8
<u>6.1 First Semester</u>	8
<u>6.2 Second Semester</u>	8
<u>7 Conclusions</u>	8
<u>8 References</u>	8
<u>9 Appendices</u>	Error! Bookmark not defined.

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. Fluorescence polarization experiments in the absence of a solid support in a solution that allows analysis of the real balance in the low Pico molar range. We use the different software 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. Fluorescence polarization can be used to study the interaction of molecules in life sciences. Compared with traditional methods, fluorescence polarization technique in solution can be the greatest degree of real life simulation environment. Scientists can track molecules change and separation. 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. And we use smartphone to provide the data analysis. In modern age, smart phones have become the most popular tools for people every day. Considering the convenience of smart phone and advantage of FP assay. Our project will play an important role in many areas of life science.

1.3 GOALS

For this senior design project has different parts. For the final goals we want to design the whole structure and application for iPhone, which can apply our design for medicine assay, blood assay and many areas in life science. Frist, we need design the correct optical model to allow the laser attach the destination by polarization and reflection. Second, we will use Solidworld to design the structure to hold the optical units and smartphones. Third, we want to develop an application for iPhone and use iPhone's camera to read the data. Finally, using the achieved data to analyze by fluorescence polarization assay.

2 Deliverables

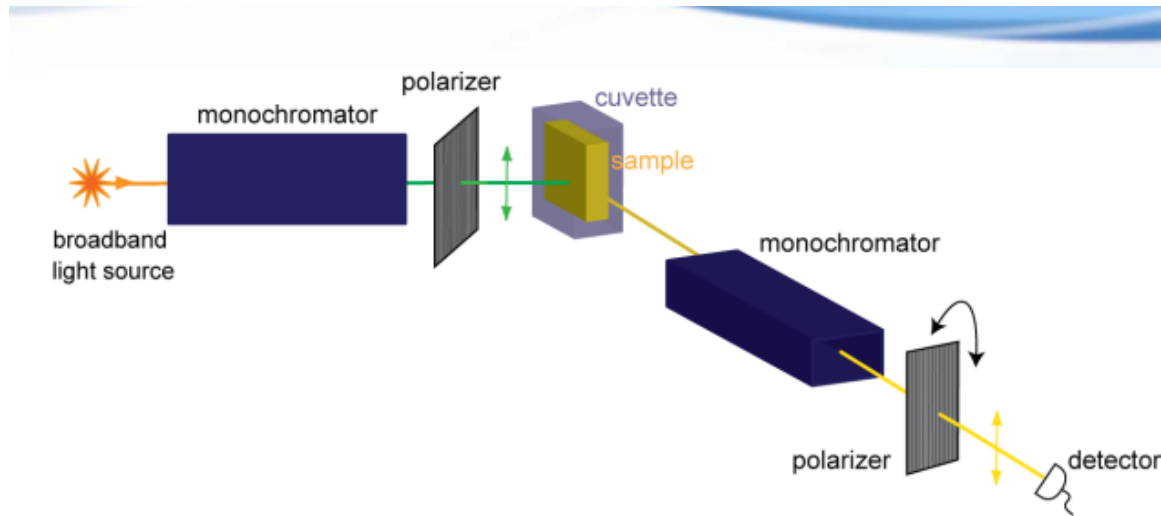
We must use the Code V to design the optical simulation in the computer. If the optical simulation can success. We will use the Solidwork to design the structure to hold the optical component and iPhone. Then we will send our Solidwork file to 3D print and get real structure. And our app for iPhone will provide necessary data from sample for people to assay. 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 will accomplish the final goals to make a perfect optical structure and app for medicine assay, blood assay and life science.

3 Design

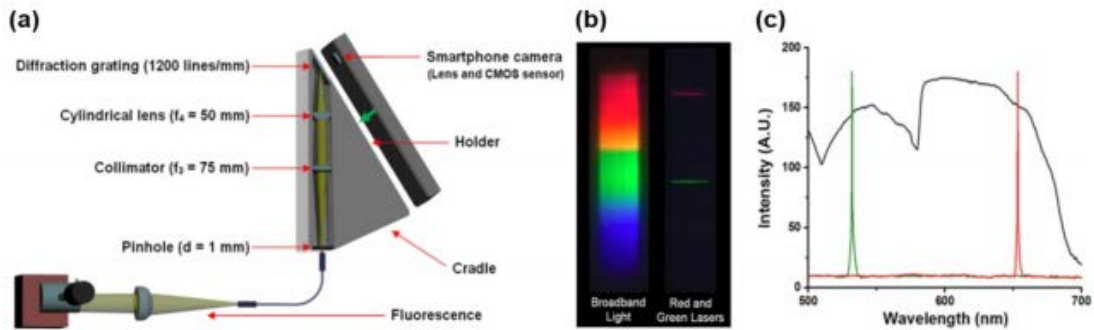
3.1 PREVIOUS WORK/LITERATURE

With the helping of our professor, we have leaned a lot of project-related paper.

First one is the paper “Fluorescence Polarization in Life Sciences” wrote by Ph.D. Turan Erdogan. This article gave us a lot of theoretical knowledge about polarization.



Another article is the project of “Smartphone Fluorescence Spectroscopy” provide by University of Illinois at Urbana-Champaign. In this project, they show us that how to use the smartphone to read data by analyzing the optical properties.

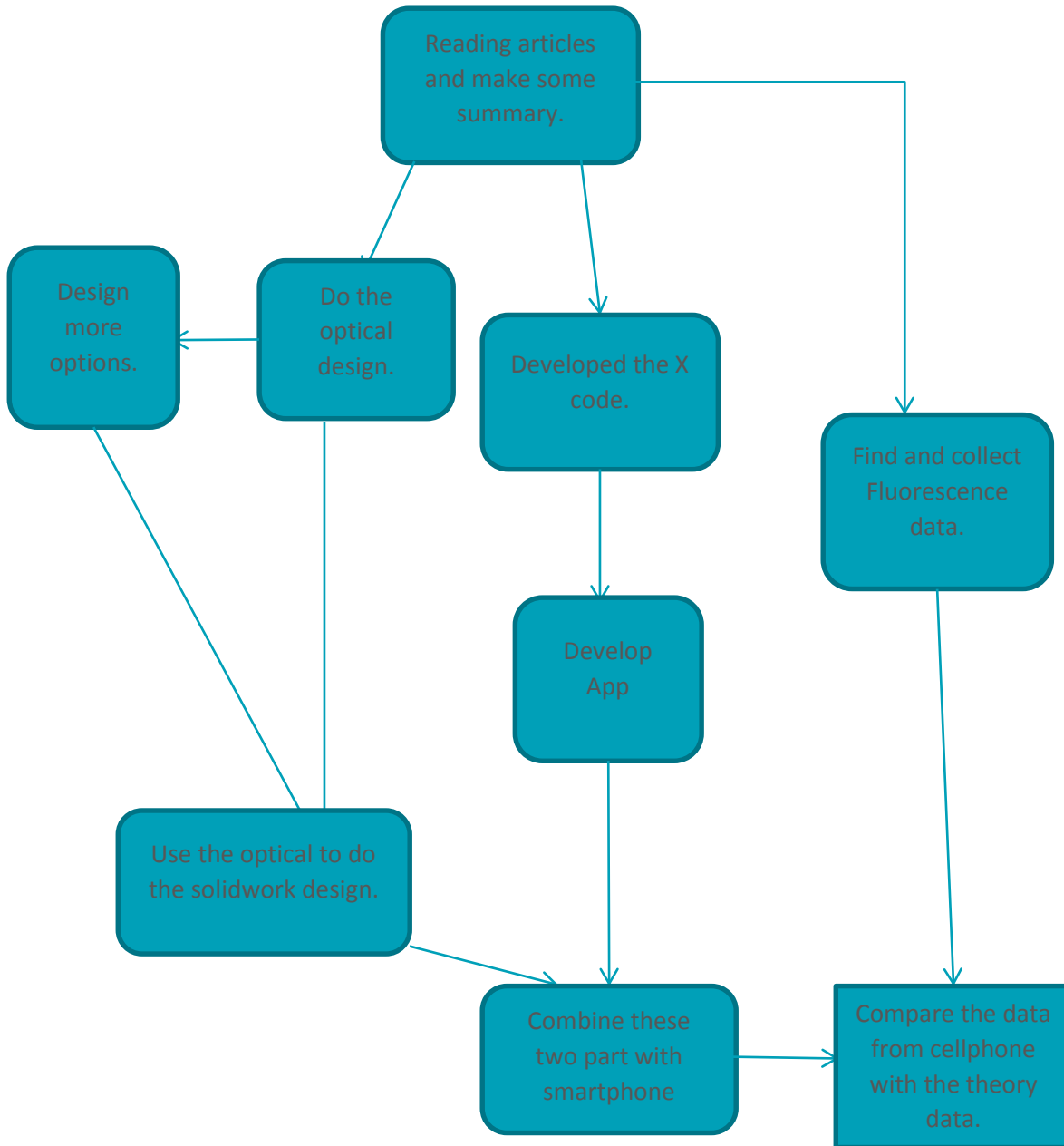


The last one gave us a lot of sample data.

Number	Description
23266	Pierce Fluorescent Protease Assay Kit , sufficient FTC-Casein to assay > 2000 samples (including standards) in 96-well plates Kit Contents: FTC-Casein , 2.5mg, lyophilized, FRET/FP-certified Grade TPCK Trypsin , 50 mg (for use as a standard) BupH™ Tris Buffered Saline , 1 pack, makes a 25mM Tris (pH 7.2), 150mM NaCl when dissolved in 500mL of ultrapure water
23267	FTC-Casein , 2.5mg, lyophilized, FRET/FP Certified Grade Storage: Upon receipt store FTC-Casein and TPCK Trypsin at 4°C. Product shipped at ambient temperature.

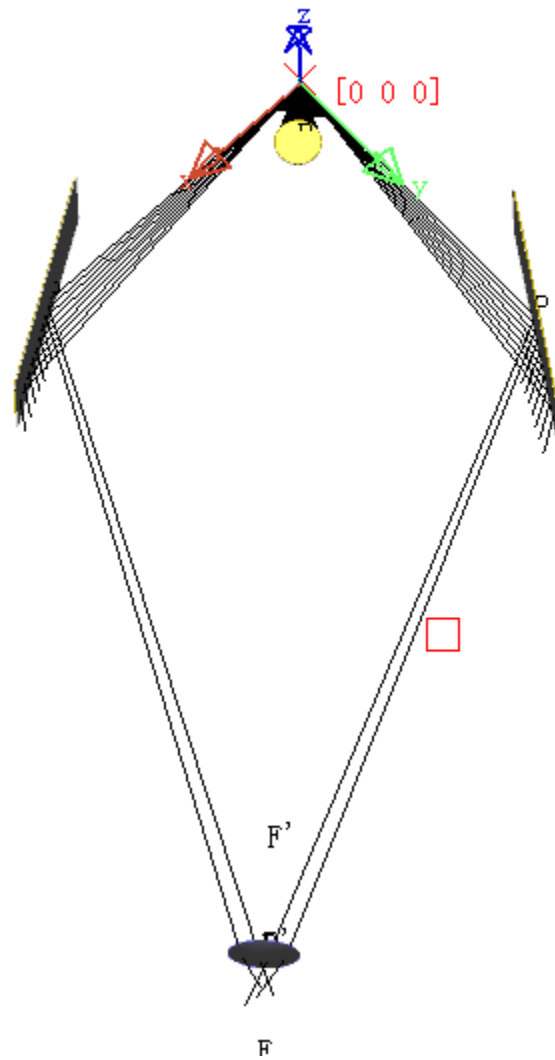
Our task is integrated these three aspects, and use samrtphone to read and analyze samples. We can divide two parts and then shine them to the phone for analysis by using the theory of polarization principle.

3.2 PROPOSED SYSTEM BLOCK DIAGRAM



3.3 ASSESSMENT OF PROPOSED METHODS

The most basic and important is the optical design. Thus, we want to make sure that after several refraction and polarization the light will go into the smartphone accurately. And make it more clearly. Thus, we discuss and design many sets of optical paths. At present, we decided to use this optical path and make a 3D model. We have sent this model to a company of 3D printer.



After we get the real model, we will test this model. Meanwhile, we will also test and simulate another options.

3.4 VALIDATION

In the preliminary investigation, we got a lot of sample parameters. If there are no large errors between the data we obtain from our smartphone and the data we got before. We can make sure that the results are credible.

4 Project Requirements/Specifications

4.1 FUNCTIONAL

- a. For Mechanical part, clients are able to use the scanner from the smartphone, which the position is already precisely set by the holder. Explain: as the reflected image pass through, the phone camera should collect the image accurately, which the essence is to hold the position of the phone well.
- b. For Embedded optical part, clients supposed to see the reflection dimension of the object clearly from the smartphone camera. Explain: the dimension of the object is reflected by two-side optical, and we need to provide a well-reflected image by precisely setting up the optical.
- c. For application part, during scanning, clients are able to analyze the polarization intensity from the line-chart by clicking on any two spot of the image. Explain: polarization is calculated by the formula, and now is programmed into the application.
- d. When analyzing the image, clients should see the object's horizontal and side image as the original object is 3-dimensional. Explain: since the screen is a 2-dimensional, we need to decompose the 3-dimensional real object into 2-dimensional.

4.2 NON-FUNCTIONAL

- a. To have visually of the image, clients need to adjust the brightness, contrast to give them individually a comfortable image. Explain: just like how a camera works, clients need to know how to operate which is the exact same way for changing the attributes of an image.
- b. To analyze the image, make sure clients know what the polarization is. Explain: one of our members, specifically the EE one should explain to the clients clearly about what the polarization is so clients would know what effect such analysis can create.
- c. To get the analysis information of the image, clients need to provide their email addresses. Explain: the analysis data could only be collected by sending emails, otherwise, when starting the analysis, the old one will be deleted.

5 Challenges

There 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. 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. 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 member. 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 hold on Tuesday 11: 00 every week, our team meeting hold on three times each week. After finished the meeting we should write the TO-DO list and send the advisor to check.

This project will spend one year to finished, for previous week we got more process about the optical design. This is also most important part in our project, if the first part progressing smoothly we can go on to the rest of part. So it is a good beginning for us to get.

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.

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=cy3ExIAcl2Y> (part 1/3)

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

<https://www.youtube.com/watch?v=ofYL-lCrEv4> (part 3/3)

5> **Code V Study:**

Code V Optical Design Software:

<https://www.youtube.com/watch?v=6-wIkoiwvXo>

<https://optics.synopsys.com/codev/?gclid=CICXjtu6hMsCFQgxaQodoiLLJg>

<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=HiG6KWkrV4>

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