Smartphone Based Nano-device for Human Breath Sensing

PROJECT PLAN

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Contents

1 Introduction

1.1 PROJECT STATEMENT

Explain what the project is about. What are you trying to do?

The goal of this project is to provide a non-invasive test for diagnosing diseases in a portable, cheap, user friendly package. Our project utilizes the capabilities of an optical spectrometer developed by our mentor to intake a patient's breath and determine the bacteria or virus causing a patient's illness using spectral analysis. Our goal is to attach the spectrometer to a smartphone and develop an app to allow the capabilities of the spectrometer to be utilized in a portable, cheap, user friendly package.

1.2 PURPOSE

Explain what is driving this project. Why is this work of benefit to the society?

This project will benefit society because it could replace more invasive forms of medical diagnostic testing such as blood tests. This means lower cost to diagnose, greater portability, greater patient comfort, more efficient use of doctor's time, and puts greater information into the hands of patients by allowing for self-diagnosis. All these factors give patients a better option for diagnosis than is widely used now. It could also allow third world countries with poor health care access to accurate diagnoses that had previously been too expensive or logistically impossible to achieve. This could save countless lives.

1.3 GOALS

Explain what you hope to accomplish through this particular senior design project. What would you like to achieve? Enlist as many goals as you can envision.

Our goals for this project include becoming better at teamwork as well as improving our technical skills in several areas. Additionally, we have goals for the performance of the product of our project. Below is a listing of specific things we would like to learn and product capabilities we would like to achieve:

-learning to use 3D printer and develop 3D cad designs
-learn how to plan software (Android app) project to make sure all components work together at the end
-determine best places to research android code implementation
-learn how to build a user interface that is user-friendly and can be understood by people with very little technological experience
-learn how to give presentation in a convincing manner and effectively explain project

-learn how to effectively work in a team, delegate tasks, develop schedule, and bring product pieces together in working unit
-learn how to ensure whole team is understanding the project and how their tasks fit into the project
-develop a product that is much easier to use to diagnose diseases than is currently available
-build a product that is cheaper than current testing methods and durable enough to be used in third world countries
-build a product that always diagnoses correctly

2 Deliverables

These tie in with the goals. What deliverables are necessary to meet the goals outlined in the introduction?

-3D Design for spectrometer housing phone case
-3D printed spectrometer housing phone case for spectrometer that our mentor will develop: should be durable, portable, fairly cheap to build
-Android app that can determine frequencies and intensities of light that is focused on the camera by the spectrometer
-App must determine which diseases emit these light frequencies
-App must have easy to use user interface

-App must communicate with user steps to use the app and clearly display what disease is present

3 Design

Include any possible methods and/or solutions for approaching the project at hand. You may want to include diagrams such as flowcharts to, block diagrams, or other types to visualize these concepts.

3.1 PREVIOUS WORK/LITERATURE

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

There are many commercial spectrometers on the market that provide similar functionality as our design although most are much more expensive, less portable, and less user friendly. One example is the Avio 200 ICP Optical Emission Spectrometer.

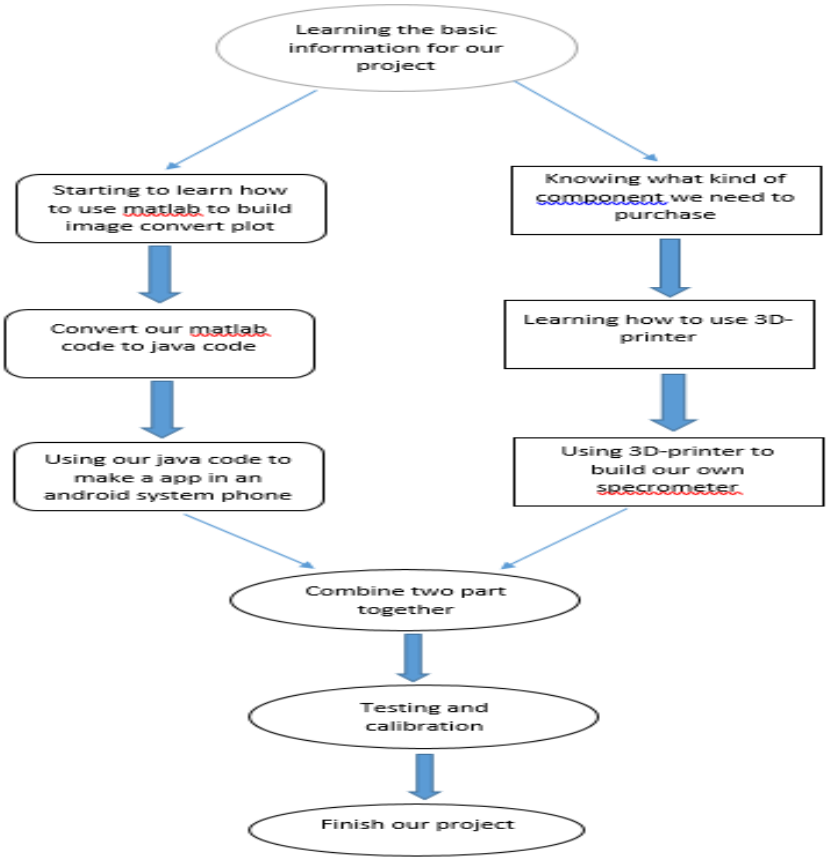
Several other people have done similar projects. The first was created by several professors in Australia and was shown to us by our professor to base out project on. They created a smartphone spectrometer using optical fiber to carry light and a diffraction grating to shine it on a smartphone camera. Additionally, they designed an app capable of determining specific nucleic acid sequences based on the light spectrum shone on the camera by the spectrometer.[2]

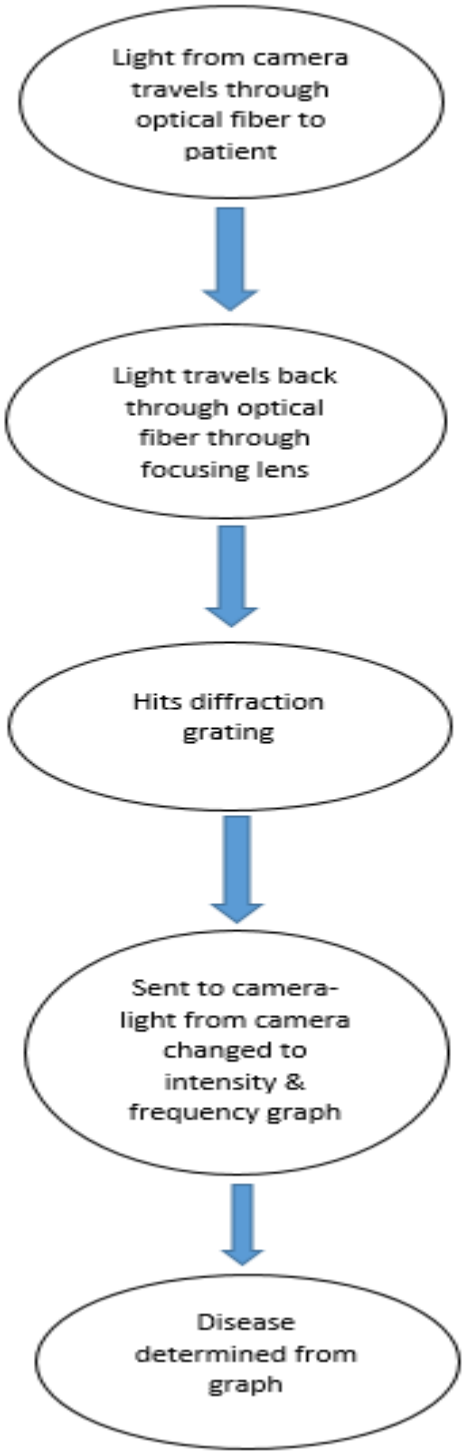
Additionally, several professors at the University of Illinois developed a smartphone spectrometer. They included their software for determining the intensity vs frequency graph that could run on a smartphone as well as their CAD design for the spectrometer. There are some differences between their design and ours. For instance, their spectrometer doesn't look very portable and their software doesn't determine which disease maps to the given spectrum the smartphone senses. They do however give good explanations on the basis of spectrometers that will be helpful in our design.[3]

Consumer Physics has developed a $150 spectrometer that pairs with your smartphone via Bluetooth and sends spectrum pictures via the internet to their servers to be evaluated to determine what the substance is. So far the product can identify medicine and food but there is no mention of determining diseases unlike our design.[1]

3.2 PROPOSED SYSTEM BLOCK DIAGRAM

For most groups you can include a flowchart of how the system will work. In case your project is not about putting together some sort of a system, you may describe the process that you will follow to achieve your deliverables.


Learning the basic information for our project
Starting to learn how to use matlab to build image convert plot
Knowing what kind of component we need to purchase
Convert our matlab code to java code
Learning how to use 3D-printer
Using our java code to make a app in an android system phone
Using 3D-printer to build our own specrometer
Combine two part together
Testing and calibration
Finish our project



3.3 ASSESSMENT OF PROPOSED METHODS

Provide a short discussion about the different approaches available and the approach you want to follow in your work.

Several different aspects of the project present a choice between several options. The first choice is whether we want to develop an Android or iOS app. Another choice is how we want to determine the frequencies of light shown on the camera. The first option used by most commercial spectrometers is to determine what frequency is diffracted to different locations on the camera based on the angle different frequencies of light diffract at. The other method is to determine the frequency of the light based on the color value provided by the camera. Another choice we can envision at this point is whether to send the image data over the internet to be analyzed on a server with more computer power and memory or to do all the analysis on the phone.

Our preliminary decision is to create an android app because there are fewer licenses required and that is the platform that we have the most experience coding in. Additionally, we plan to determine the frequencies by plugging in the angle of diffraction into our app so that it will know where on the camera different frequencies always shine. We believe that if we base the frequency determination on camera color, our answers will change for every smartphone we use the spectrometer on due to different camera designs and color variations. Lastly we plan to do the frequency vs intensity plot and the disease determination on the phone. We believe that the plot will take very little computing power and that many different disease spectrum plots can be saved with very little memory. These plots can then be used to match our plot with and find a disease.

3.4 VALIDATION

How will you confirm that your solutions work?

In order to determine if using the diffraction equations provides a correct spectrum image, we will use java code to make a app. After that, we combine our 3D-printed spectrometer with an android system phone to test it. If it creates a frequency vs intensity plot very similar to a commercial spectrometer pointed at the same substance, we know this solution works. If, however it is off due to unpredictability of the distance to the camera when you attach the spectrometer to your phone, we will have to use color to detect frequency.

To determine if we can successfully identify diseases, we may have to find a lab on campus with access to microscope slides of diseases and determine if we can successfully identify them using only the phone processor and memory of if we must use a central server for the calculations.

We must extensively test our product to ensure that it correctly diagnoses patients. Durability can be tested by repeatedly dropping device on floor and then testing to make sure it still can diagnose. Additionally, we believe that Android is the best solution because it is much more prevalent worldwide than iOS. If we have extra time, we may work on an iOS app.

4 Project Requirements/Specifications

4.1 FUNCTIONAL

List and explain the functional requirements of the project. This would include all the technical requirements you fulfil during your senior design project.

-Android application must include capability to determine all frequencies of light entering camera
-Android application must include capability to determine the intensity of each of these frequencies
-Android application must include capability to graph frequency vs intensity spectra
-Android application must include capability to determine what bacteria or virus would make that intensity spectra
-Android application must include user friendly UI for clearly describing how to run app and clearly displaying results
-Capable of adjusting to installation on different android platforms with different camera's and resolution

4.2 NON-FUNCTIONAL

List and explain the non-functional requirements of the project. This is where you would enlist non-technical requirements. This may still be a fundamental deliverable that your client needs at the end of the semester.

-An app that can run on any Android capable device
-A 3D model and case for the spectrometer to fit over a phone
-Associated 3D CAD model and app design documentation

5 Challenges

Include any concerns or details that may slow or hinder your plan as it is now. These may include anything to do with costs, materials, equipment, knowledge of area, accuracy issues, etc.

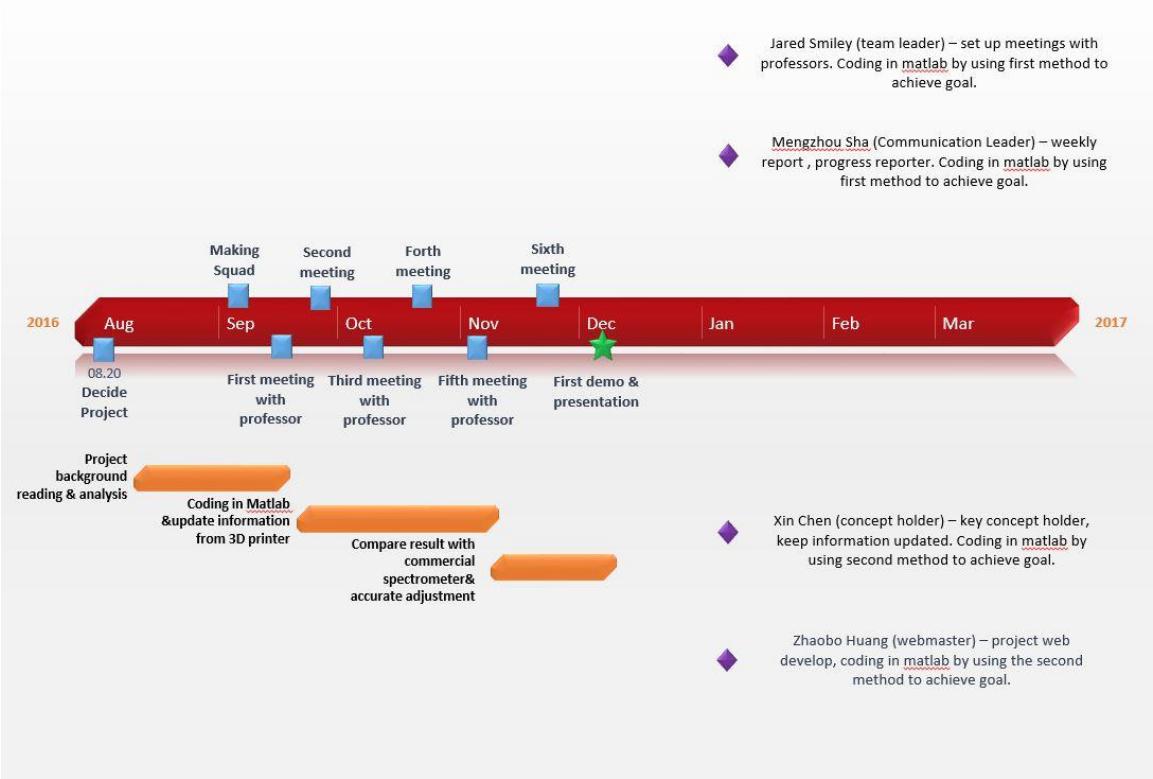
-None of us have a lot of experience with writing an app so it will take a lot of debugging time
-None of us has experience using the 3D printer. It is a new thing that we need to learn.
-None of us have a lot of experience with 3D CAD design so it will take a lot of time to learn
-Need to purchase some parts of the Spectrometer-Roughly $400 cost
-It may be hard to find slides of diseases, viruses, or bacteria to test our device on
-It could be tough getting the spectrometer to work on different phones with different cameras, resolutions, color coding schemes, and distance from spectrometer to camera image detector

6 Timeline

You may want to include a Gantt chart/something similar to help visualize your timeline to complete the project.

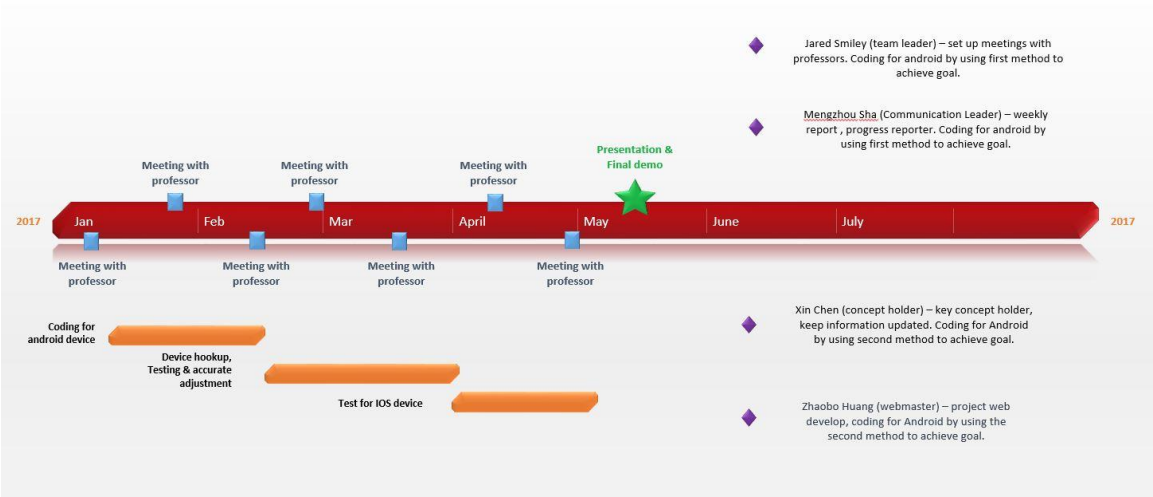
6.1 FIRST SEMESTER

Breakdown your timeline into detail of what needs to be done by the end of the first semester. You may want to include division of work amongst the team.



6.2 SECOND SEMESTER

Detail what needs to be done in the second semester. You may want to include division of work amongst the team.



7 Conclusions

Sum up your project plan. Briefly re-iterate your goals for the project and the plan your team has put in place to achieve these goals.

Our project plan is to build a spectrometer that a patient can breathe into and an app capable of analyzing spectrum data from the spectrometer and shown on the camera. The app should be able to graph the intensity vs spectrum and determine what virus/bacteria gives off this spectrum. We have broken this problem down into several manageable portions that we can incrementally develop and then combine to form the final working project. Additionally, we hope to develop good teamwork and project management skills.

8 References

List all the sources you used in understanding your project statement, defining your goals and your system design. This report will help you collect all the useful sources together so you can go back and use them when you need them.

1. "Consumer Physics." *Consumer Physics*. N.p., n.d. Web. 19 Oct. 2016. <https://www.consumerphysics.com/myscio/scio/>.
2. Md Arafat Hossain, John Canning, Kevin Cook, and Abbas Jamalipour, "Optical fiber smartphone spectrometer," Opt. Lett. 41, 2237-2240 (2016)
3. Scheeline, Alexander, and Kathleen Kelley. "Cell Phone Spectrophotometer."*Cell Phone Spectrometer*. N.p., n.d. Web. 19 Oct. 2016. <http://www.asdlib.org/onlineArticles/elabware/Scheeline_Kelly_Spectrophotometer/>.

9 Appendices

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. You may also include your Gantt chart over here.