Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A1S6

F-air

Re: ENSC 405W Project Proposal for the F-air Mira

Dear Dr. Rawicz,

Please find the proposal of our ENSC 405W project: Mira. Mira is a revolutionary virtual fitting device which is more portable, more affordable, and more user-friendly than any other devices ever exist in the market. It generates the lowest cost in long-term for the developing online clothing shopping.

In the attached proposal, the background will be fully discussed. Base on the background the document provides an overview of our project. The potential risks will be listed with feasible backup plans, following with the benefits which make our program outstanding. We also presented the competition, the budgets, and the project plan. Lastly, a brief introduction of our company is introduced.

The team of F-air is comprised of three students with Computer and Electronics Engineering backgrounds. Our team members are Ninghui (Nick) Yu, Eden Lu and Xinwei (Alex) Zhang.

If you have any questions and concerns, please contact us at xinweiz@sfu.ca.

Sincerely,

Eden Lu

Eden Lu

Project Proposal
Virtual fitting mirror - Mira

Project team H

Alex Zhang
Eden Lu
Nick Yu

Contact Person

Alex Zhang
xinweiz@sfu.ca

Submitted to

Dr. Andrew Rawicz
Mr. Steve Whitmore
School of Engineering Science
Simon Fraser University

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1 EXECUTIVE SUMMARY

> *"Dress way too small, I ordered x-large, this dress looks like a size 8. Very disappointed. Does not fit true to size and is short. Buy bigger and expect tighter fit. Not worth the money."*

This is one comment from a customer who bought a dress online. It may sound familiar since there are thousands of negative comments complaining the fitting problems below products of almost every single online clothing retailers. People are even getting used to adopt the fact that there is a large possibility that clothes bought online may not look like what they expect. Some of the customers even decide to try the garments in stores and then order them online. The concern of returning impedes plenty of customers from purchasing appearances and accessories online.

Because of that, though global online retail sales are growing, it is still not an essential part of total retail sales. For example, UK has world highest percentage of E-commerce sales over total retail sales which is only 15.6% (Saleh, 2018). There is still a huge potential market hindered by fitting issue. Now, our company - Fair wants to give customers the same online shopping experience as a physical store, and help expand the E-commerce market at the same time.

Fair's Mira is a portable smart mirror that gives users a brand-new and convenient experience for online shopping. It allows the user to try on online clothes or other items without visiting the retailer store. For the prototype design, our system consists of one camera to capture the human's motion, a microcontroller will do image processing and a projector will project the real-time image to the wall. This system can let the user see themselves and virtual clothes they are trying on, and it can reduce the waste caused by too many unsatisfied goods be returned. For the customers, Mira can help them save time, money, and energy by shopping at home. For the retailers, Mira will help them increase the sales and reduce cost.

In the e-commercial virtual smart device for market, our product Mira has advantages and disadvantages over some of the other smart mirrors or VR headsets. Our advantage is portable, affordable, and saving space, and it can be used in any indoor environment.

For our project plan, our team plans to spend eight months doing research and design from sketch to our final prototype. The estimated total cost will be around $350 for our final prototype. From the attached proposal, it will show prototype design, marketing analysis, project plan in detail.

2 INTRODUCTIONS

From the 2016 statistic report of Canada Post states, around 80% of Canadians shops online, and more than 45% of them purchase apparel (Growing E-commerce in Canada, 2016). There is a very big market for online apparel shopping. However, these customers usually have a concern - the cloth may not fit well, or may not look good. People are not able to try on the online apparels, which limits the market and increase the transportation waste (for mailing back the product to producer). Even though the majority online fashion retailers choose to undertake the cost generated by returning, the price of the items will then be increasing, which is unfavorable for the customers, and result in a less competitive position for the retailers.

F-air sincerely introduces Mira, which is a system that allows the customers to try on the online product at home. It captures the user and analyses the position of each body parts, such as the head, the arms, and the legs. Then it projects the appearance of the user with selected garments on. This system provides convenient functionalities:

1. Try on online apparel
2. Dynamic cloth adjusts according to body movement
3. Scan existing clothes and import to the Mira

Mira will benefit both the clothing supplies and the customers.

In last couple years, companies like FXMirror and SenseMi have investigated a large amount of money on virtual fitting, they have the same solution - a mirror with AR feature that reflects outfits on user's body. Their products are amazing, but exist some disadvantages:

1. Big and heavy
2. Occupy space
3. Expensive due to its size

Their mirrors were designed for the big retail shop, where these disadvantages won't be obvious. But these two attributes shut the doors for normal customers.

Instead of a big mirror, Mira is a tiny box which combines a projector and a camera to produces the effect of a mirror. Mira is tiny-weighted, and it is low-cost due to its small size and thus reduce the price. These attributes allow it to be portable and more likely to be accessible by the general population.

3 SYSTEM OVERVIEWS

3.1 SCOPE

Mira is a portable smart mirror that gives users a brand-new experience for online shopping. It allows users to try on new clothes by projecting a full-length dressing view and 3D virtual outfits anywhere at any time. The unique small cube design of Mira allows users to carry it around without worrying about the size and fragility like they do with ordinary mirrors. The high-resolution central camera captures human movement and recognizes human body while the projector at the bottom projects mirror image of users along with the clothes they want to try on in a virtual manner.

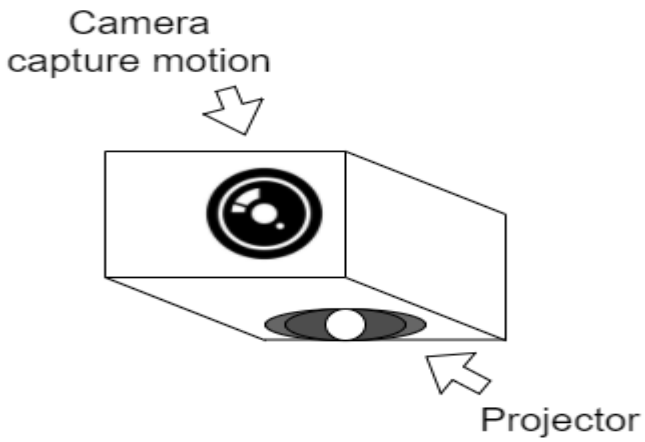

FIGURE 1 HARDWARE DESIGN

Figure 2 illustrated the simple setup requirement --- a wall. Mira can be mounted on any tall, flat surface, providing users with a mobile fitting room almost everywhere. Instead of physically trying on new items, users can now do them without leaving their home. Mira builds an emotional connection between users and the virtual item by applying different state-of-the-art technologies. Body recognition and motion detection techniques allow the virtual piece to react with users' movements, creating the feeling that they are really wearing it.

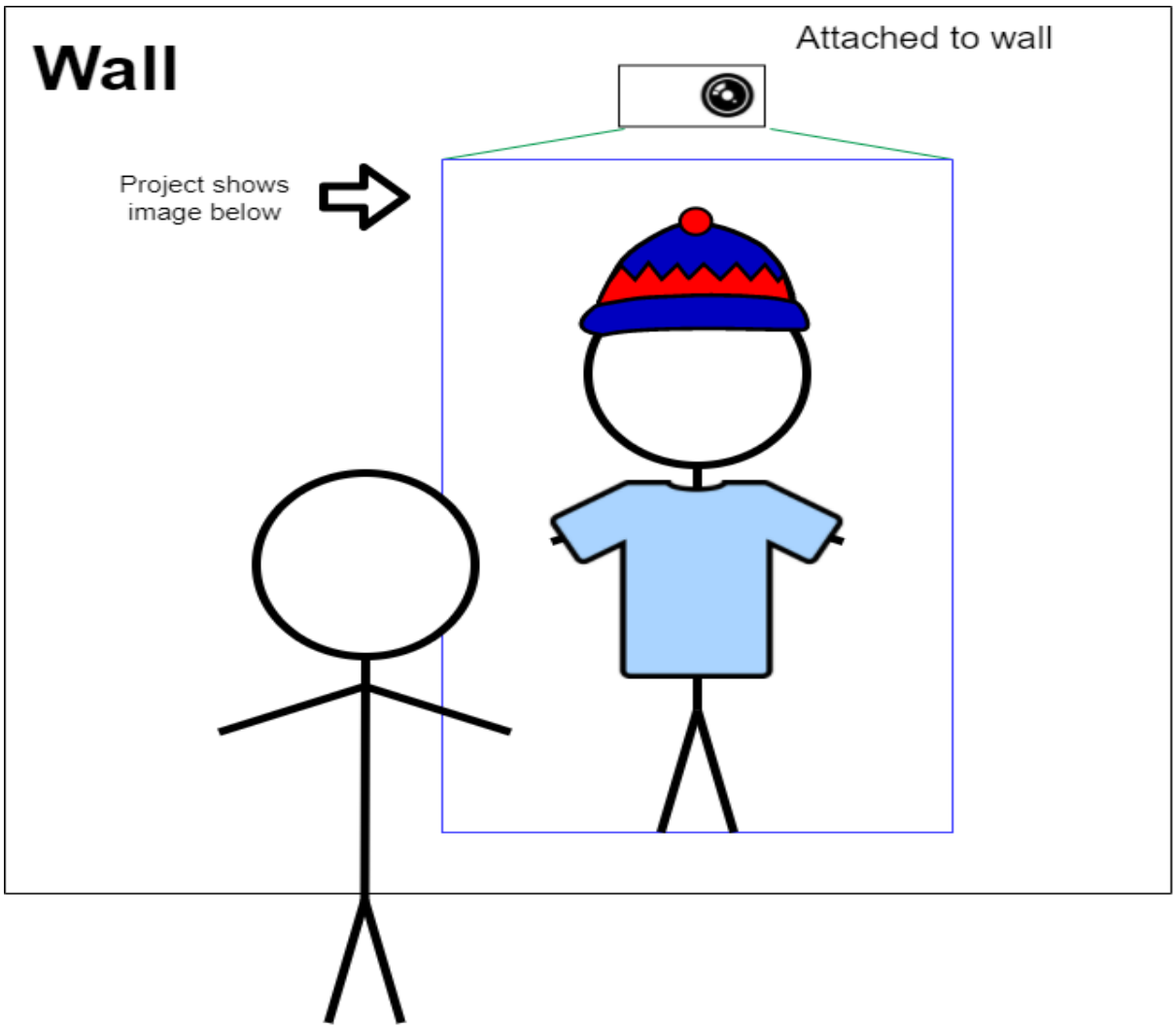

FIGURE 2 MIRA FORM A VIRTUAL FITTING ROOM WITH A WALL

The Following steps show how Mira system works as figure 3 shows:

1. Camera capture image as an input, and process the image accurately through the microcontroller
2. Detecting the human-body in the image, record the coordinates of the body, and recognize each part of the body like the hands or legs
3. Fetch 3D cloth model from storage, and adjust the position and angle of cloth model based on the human-body shape
4. Projecting the output image on the wall through the projector

NOTE: FOR BEST PERFORMANCE AND RESULT, REDUCING LATENCY AND AN ACCURATE IMAGE PROCESSING ALGORITHM ARE NECESSARY FOR OUR PROJECT.

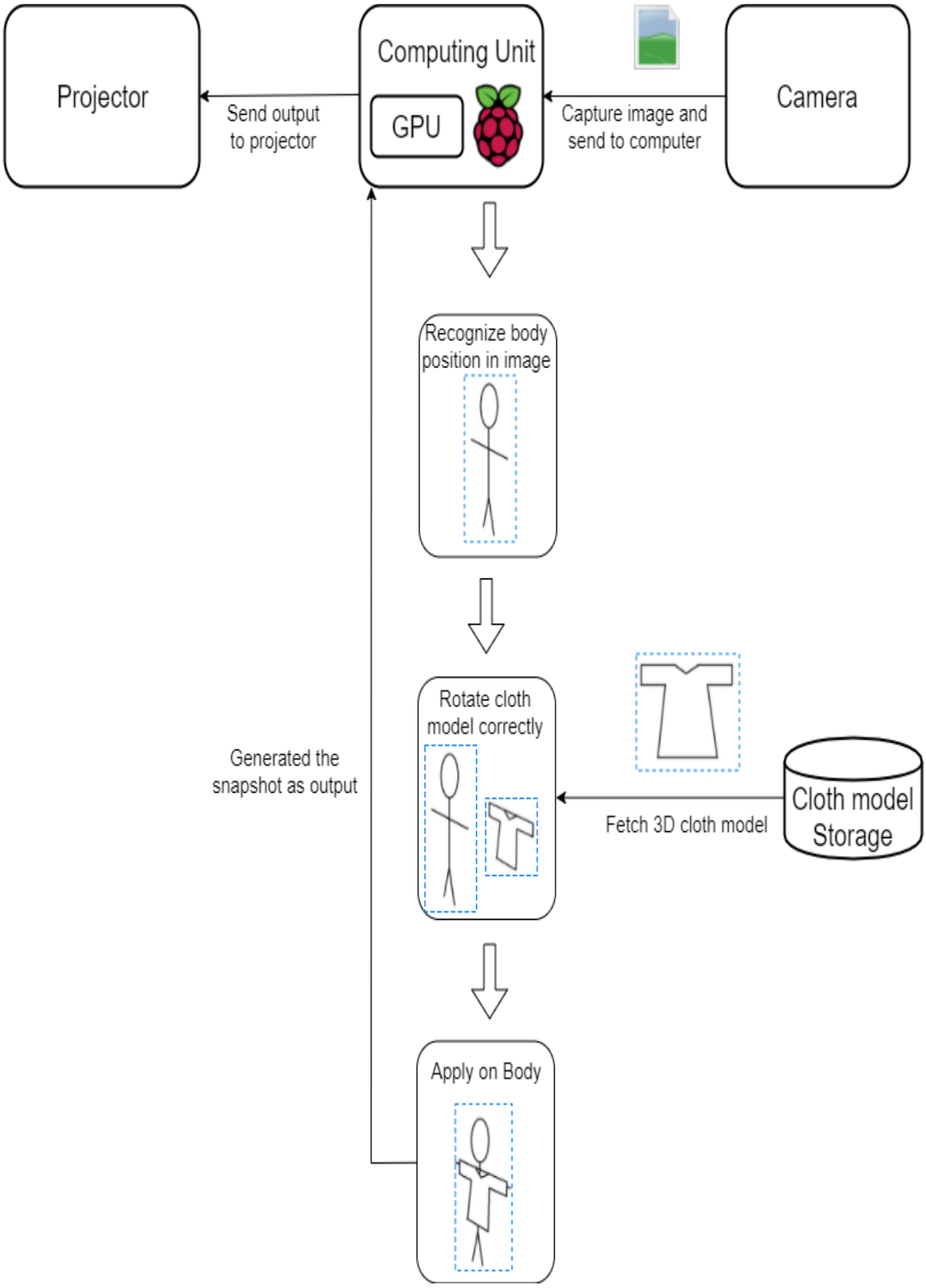

FIGURE 3. DATA FLOW

3.2 BENEFITS

3.2.1 BENEFITS FOR CUSTOMERS

1. SAVE ENERGY AND TIME

Mira offers customers the ability to try on different products and combinations in their home, and many more than they would be able to try on in retailer store. If a customer wants a different size or style, she can simply change clothes by clicking a button on their laptop. This lets the customer be able to quickly compare numerous clothes, and decide which outfit they like most in much less time. Therefore, it would save customer both time and energy without visiting retailer store, but the customer still has the same try-on shopping experience as retailer store.

2. SAVE MONEY

After using Mira to go online shopping, the customers would rarely buy something they do not like or the wrong size of clothes because they tried those clothes on before they bought it. This can help the customers reduce the cost of returns and unworthy expenses on items they do not like.

3. SAVE SPACE

Mira does not like other smart mirrors which need a big place to install, because it is just a small box when customer stop looking in the mirror or online shopping. Mira is portable and takes up much less space than a traditional dressing mirror.

3.2.2 BENEFITS FOR RETAILERS

1. INCREASE SALES

For clothing retailers, let the customer go into a fitting room is an important factor to make sales. Statistics show that 76 percent of customer who tries something in the fitting room will purchase something at the end. Mira can help retailers or online producer bring customers back to the fitting room, and the more things customers try, the more things they would buy.

2. SECURITY

For some expensive items such as jewelry, they are easily becoming the target of theft crime since they are easy to be hidden when the criminals pretend to be fitting. Now customers can try virtual earrings through Mira. This will keep jewelry stores safe when people are making a decision about what they what to wear, because no one can steal a pair of virtual earrings.

3.3 RISK MANAGEMENT

3.3.1 PEOPLE RISK

It is very unlikely for this category of risk to occur but it is worth mentioning. There is a possibility of a team member being ill right before deadlines which causes progress cannot be finished on time. The mitigation strategy would be to split up the leftover work among healthy team members and finish it as soon as possible. A team member might also suddenly drop out of the course. This reduces the size of the group, and can lead to lower project quality. The rest

of the group will have to work harder. Communication is another important factor among team members as this may lead to failure of the final project. It is important for everyone in the group to understand the project and each other's work thoroughly. Conflicts with team members need to be solved before it extends.

3.3.2 Technology Risk

The technologies we found feasible for our project are OpenCV and Blender 3D, where OpenCV is a public image processing library and Blender 3D is an open source software for 3D modelling. We will combine these 2 technologies with deep learning to build up the software part of our project. But we may have some learning curve when we investigate into these tools, which may eventually delay our deadlines.

In the detail, Mira system has the risk in providing real-time information of the human body and allow it interface with virtual 3D models. The performance of image processing work like body and facial detection heavily depends on the GPU and the algorithm. There may be latency between human actions and the image people watching, but we will do research and try to minimize the delay as much as possible.

The power consumption of the whole system can also be a risk for our team. The normal projector electricity use ranges from 150 watts to 800 watts per hour based on image brightness, so our system has to be powered by power adaptor. If we want to use a battery instead of power adaptor as the power source, the capacity and size of the battery will affect the size of Mira device and thus it will affect the portability of Mira.

4 CURRENT MARKET

By 2018, the online clothing shopping is significantly increased. Online shopping has become an essential part of a plenty number of clothing brands, and is taking a greater percentage of total retail. Current online revenue of apparels and accessories in the US has achieved 86.4 billion USD. (Patricio Rivero; Zihan Zhu, 2018)

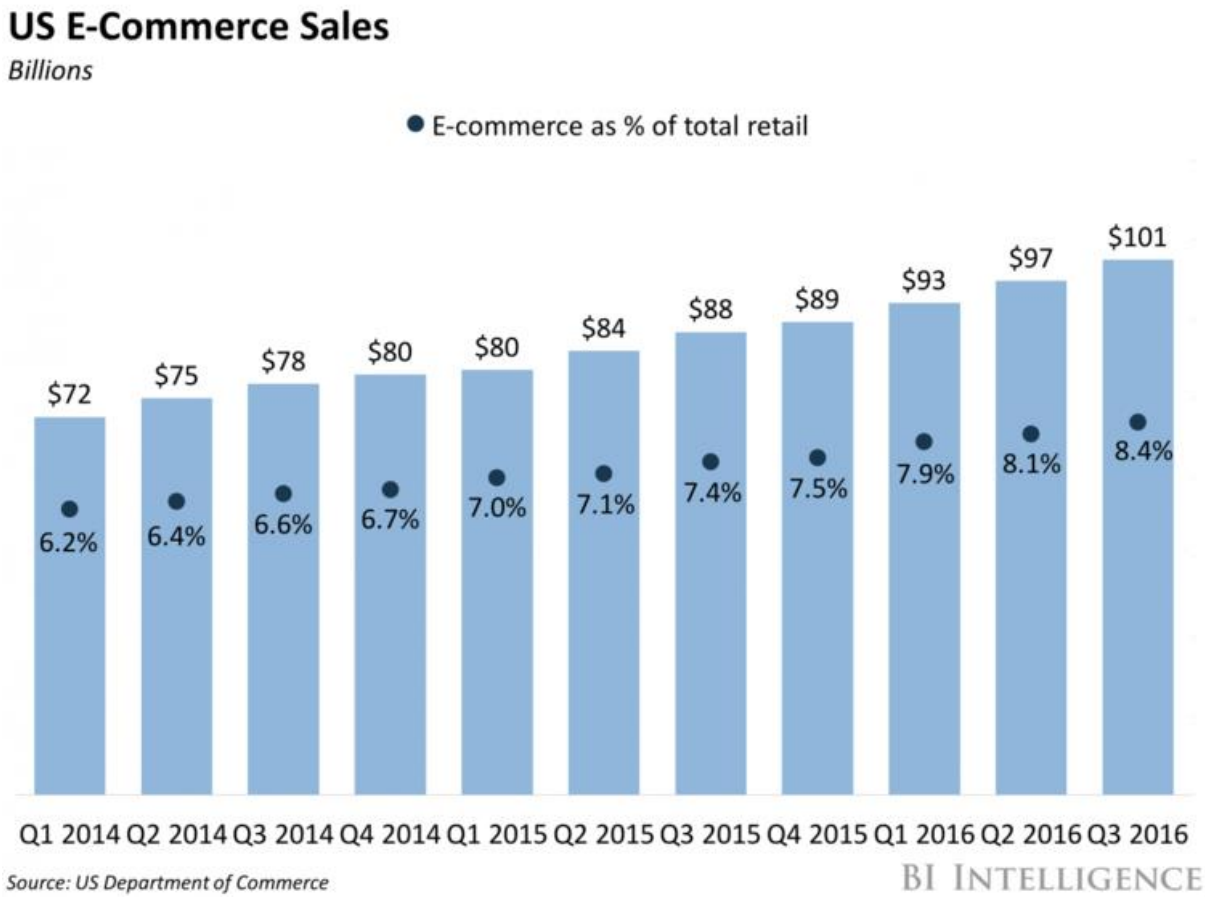

FIGURE 4 US E-COMMERCE SALES (SALEH, 2018)

However, online clothing shopping has some shortages inherent in its method. The key problem among all those shortages is that the customers are not able to view the appearance of the clothes or accessories on themselves. According to research by University of California, Berkeley, 20-30% of the items ordered online will be returned. And the major reason for returning is that the clothes do not fit the customers as they expect: 70% of the total returned apparels and accessories are related to the fitting issue.

Currently, the most common solution is requiring the customers return the items to nearby store, or ship back to suppliers. It will cause the suppliers $3-12 USD to handle with per unit return. Also, some suppliers require their customers to afford the shipping fee for returning. The total cost of returning will eventually result in a huge increase in the cost, which

both the suppliers and the customers will pay for that, but no one benefits from it. Our product, Mira, is designed to avoid this unnecessary waste.

For the individual customers, our product Mira provide them with a revolutionary approach to fitting. Currently, the most basic solution for online fitting is using size charts. But it has been complained it is too basic. Also, it could not show all the detail directly. With our product Mira, the customers with different body types could simply determine if the apparels or accessories conform to their expectation. Furthermore, Mira is a portable mirror which allows the customers to see how the clothes provided by suppliers matches their own pieces. And according to market analysis, social aspect has a significant effect on customers when they are purchasing clothes online. However, currently, there are no similar products which consider that requirement. Mira allows them to share their appearance with others using the internet and communicate with each other.

The clothing suppliers are also one of our target clients. Mira can be placed in clothing stores and assist the customers with fitting. A core advantage for Mira in store is that it saves the frequency of occupying the fitting rooms and decrease the demand of shop assistants. Clothing suppliers will not only benefit from saving the cost of building more fitting rooms but also avoid losing potential customers that abstain purchasing because of waiting to be served. The customers will also be able to fitting pieces that are currently not in stock.

With the incredibly fast development of online clothing shopping, virtual fitting is becoming an inevitable tendency for improving user experiment. At present, the major disadvantage of virtual fitting is that the required hardware device is too large and expensive, and there still exist plenty of functions that could be advanced. Mira will be the foresight solution that totally changes the online clothing shopping market.

5 COMPETITIONS

Current major 3 solutions for online shopping fitting problem is listed below:

1. FITTING CHARTS AND FITTING APPS

Fitting tools including fitting charts and fitting APPs are the most widely used solutions. They have the lowest cost for maintenance. However, fitting charts only provide the most basic information. Customers do not believe fitting charts are reliable. Fitting APPs, for instance, Fits.me and TrueFit, are developed based on fitting charts. They require the users to input parameters including height, B/W/H measurements, age, and other details. It is complained by the users that it is too complex to use. And still, they fail to provide a direct view for the users to see how the garments look like on their own body type.

2. ADVANCED RETURNING PROGRAM

To eliminate the hassle of returning, some fashion retailers have provided advanced returning program to allow their customers to try the garments and accessories before purchasing. Amazon recently released a new returning program called Prime Wardrobe. The items with a box and a preprinted shipping label will be delivered to the customers without purchasing. After trying on the clothes, the customers could pay for the items they want and return the rest using the box with the label. This is a convenient method for the customers, but it will cost Amazon on average $7 to handle with each returned item. The huge cost will result in the increase in price which will be paid by customers, and therefore the retailer will be less competitive.

3. OTHER VIRTUAL FITTING HARDWARE

Virtual fitting is becoming a fresh tendency in the real world for online shopping instead of a sci-fi movie idea. Smart devices, for instance, FXmirror, has been designed to capture the body shape and movement and show the appearance of the user with the selected garment on a large screen. This is the most efficient and cutting-edge solution that has ever occurred. There is no waste cost on shipping. And the customers could still enjoy the shopping experience without actually spend time and cost going to stores in person. Virtual fitting devices are not only easy to use, but also provide a direct appearance.

However, the virtual fitting devices currently exist are only designed for retailers to display in stores. They are large and unaffordable for typical families and individuals. This is a waste of the core advantage of virtual fitting because it is still necessary for customers to be in the nearby stores in person.

6 BUDGET AND FUNDING

6.1 ESTIMATE OF COSTS

For prototyping and the final product, the budget is listed below:

Item	Prototype	Final Product	Cost
Camera	√	√	$40
Laptop	√		$0 (already owned)
Raspberry Pi 3		√	$50
Projector	√	√	$200

	Prototype	Final Product
Subtotal	$240	$290
tax (12%)	$28.8	$34.8
Contingency (25%)	$60	$72.5
Total	$328.8	$397.3

6.2 FUNDING

Up to now applying for support from the Engineering Science Student Endowment Fund and Engineering Science Student Society Parts Library is our fundamental funding source.

Engineering Science Student Endowment Fund (ESSEF) has been supporting engineers from SFU by funding student project since 1997. Our program satisfies the requirements of Category B (Entrepreneurial) and Category C (Class). One of the major advantages of Mira is it has the lowest cost comparing with other virtual fitting devices. So we believe fund from ESSEF will cover most of the cost generated during our program.

In case of unexpected contingency, we will seek support from Wighton Development Fund, which requires a proposal and evaluation by the funding committee.

We will also loan device and electronic pieces from Engineering Science Student Society Parts Library. Some basic parts that will be used for prototyping Mria, for instance, camera, may be able to be found in their collection. However, since we are planning to make irreversible change for some electronic pieces to build the final version of Mira, we still need to purchase new parts from the funds discussed above.

7 PROJECT PLANNING

7.1 MILESTONES

Following are some deadlines outlined in each month:

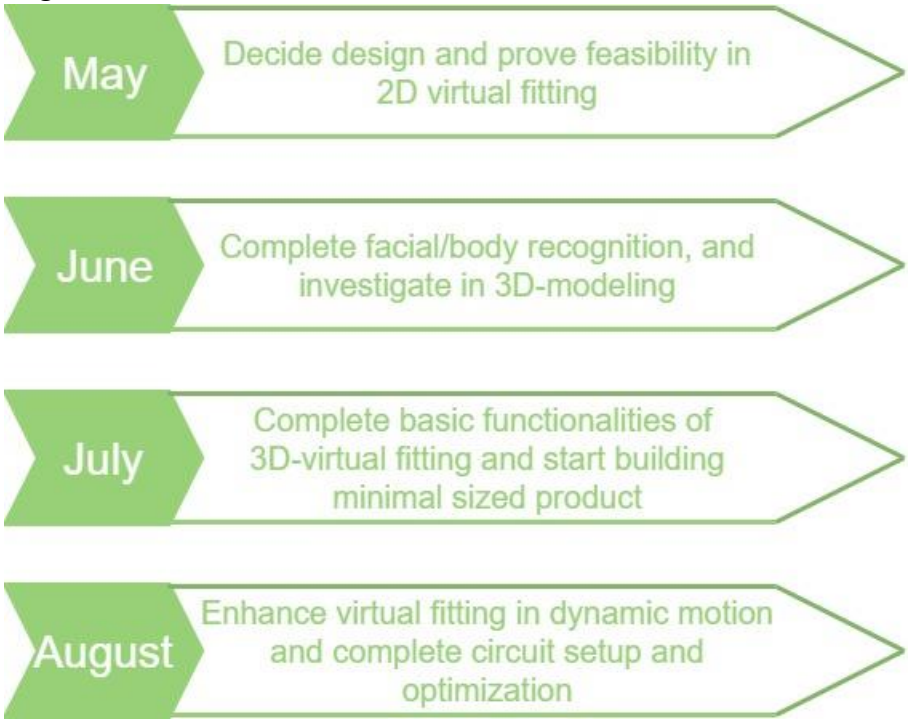

FIGURE 5. MILESTONE FOR EACH MONTH

7.2 DETAILED TASKS

Our project can be mainly separated into 4 sections. The detail components and tasks of each section are list as following:

1. IMAGE PROCESSING
    - Experiment with facial detection
    - Experiment with body detection
    - Experiment on body pose (position) recognition
    - 2D virtual fitting
    - 2D Motion detection (dynamic virtual fitting)
    - 3D virtual fitting
    - 3D Motion detection (dynamic virtual fitting)
2. CAMERA
    - The angle of Camera (need to experiment)
    - Deciding the hardware design (how to place the camera and projector)
3. PROJECTOR
    - Power and resolution analysis (balance, need experiment)
    - Brightness Adjustment

4. FINAL RESULT:

- Size Optimization
- Circuit Setup
- Material Purchases

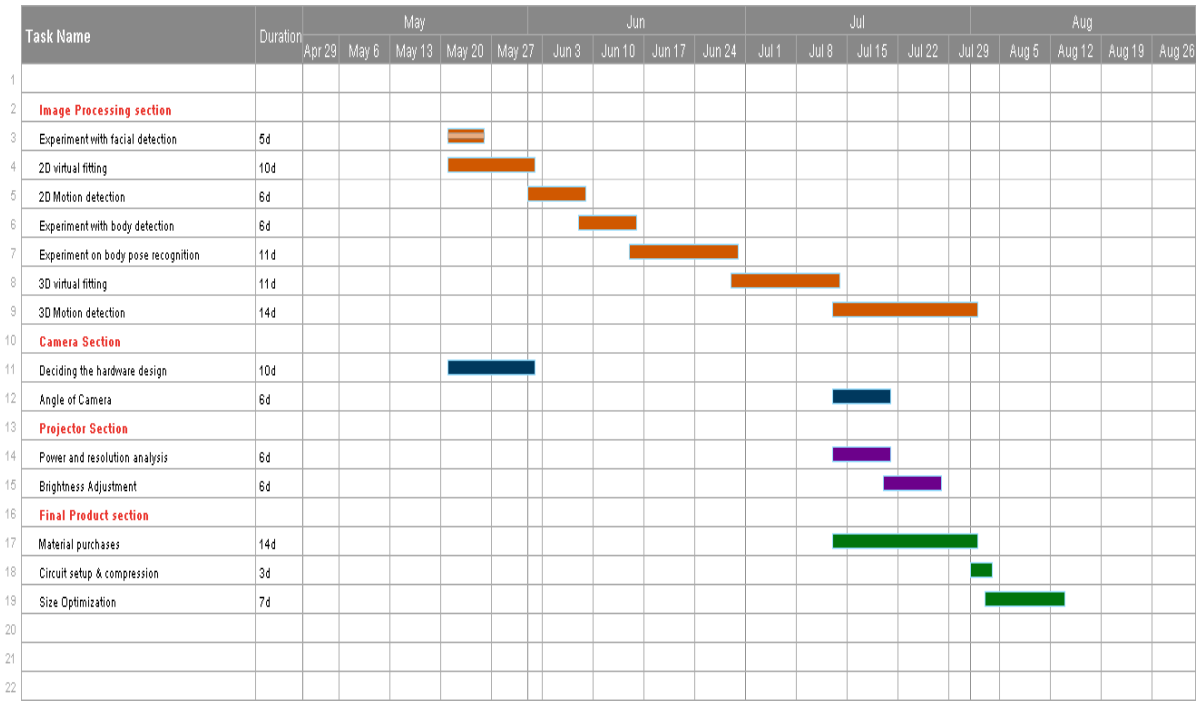

FIGURE 6. TASKS ESTIMATION

8 COMPANY DETAILS

♦ EDEN LU - CEO (CHIEF EXECUTIVE OFFICER)

Eden Lu is a fifth-year Computer Engineering student at Simon Fraser University. In his first Co-op at ACD System, he worked on software development of an image editing software in C++, where he gained a few image processing concepts. In his second Co-op position at SAP, he experienced in full stack web development, which he can help to set up the cloud storage for 3D models of this project. He also likes to investigate in game development in spare time, where he experiences in 3D modelling in Blender 3D and Unreal Engine. It is his pleasure to be involved in this project, he will assist other talented colleagues to make sure the product is completed on time and meets all requirements.

♦ NICK YU - CTO (CHIEF TECHNOLOGY OFFICER)

Nick Yu is a fifth-year Electronics Engineering student at Simon Fraser University. He has eight months of hardware coop experience in Netgear Arlo team, which let him acquired hand on experience in operation various of lab equipment and hardware troubleshooting skills. He can help to do power management design and digital circuit design for the system. Also, he did a research coop in SFU lab, and that research is like a capstone project. He has the experience in how to implement ideas to the real product, and he knows how to select correct components and where to buy it with a good price. He will be responsible for all the technical aspects and to help other team members implement their ideas to the project.

♦ ALEX ZHANG - CKO (CHIEF KNOWLEDGE OFFICER)

Alex Zhang is a fifth-year Electronics Engineering student at Simon Fraser University. She has independent projects on kinesiology and health science engineering project, which benefits her with skills of hardware design and data analysis. She also has working experience with technical documents. She has education background with optics engineering. Nominated as Chief Knowledge Officer, she aims at optimizing the performance of projecting display and improve the image processing solution. She will also involve in the research and design of the hardware part of motion capture.

9 CONCLUSIONS

Through this paper, we demonstrate a new design for the virtual fitting room. It allows customers to virtually try-on the products on an online shop before they making a decision to buy any. This will provide a big improvement over the common online shopping experience, which should significantly reduce the redundant shipping/returning cost due to the dissatisfaction of the online apparels.

Furthermore, we are introducing the dynamic virtual fitting feature to differentiate our product to general fitting room - where the Mira allows applying different background, the wind effect, the light effect to the result. Which provides a more luxury fitting experience.

And due to Mira's design, its size will be impressively much smaller than existing virtual fitting products. This property decreases its manufacturing cost and also makes it more affordable to average beings. Its tiny size also makes it a portable device with extremely easy setup step, which allows the users to bring it on travelling or anywhere.

By spending a large amount of time and cost on image processing research, we found the feasibility of this project and obtain the knowledge of object detection in images. In next step, we will start 3D modelling and begin investigating 3D virtual fitting. What pushes us on this project is our eager to exploit a new possibility to online shopping for everyone, and also, our wish to share the amazing product with every dear customer who supports so much on modern computer technologies these years.

REFERENCES

Growing E-commerce in Canada. (2016). Retrieved from Canada Post: https://www.canadapost.ca/web/assets/pdf/blogs/canada-post-growing-e-commerce-in-canada-2016_en.pdf?ecid=display%7Cpdn%7Ccs%7C104

Patricio Rivero; Zihan Zhu. (2018). *Online Clothes Shopping: An Industry Landscape Study Focusing on Returns.* Retrieved from University of California, Berkeley: http://scet.berkeley.edu/wp-content/uploads/zhuzihan_late_4894259_68726596_Final-Presentation-1.pdf

Saleh, K. (2018). *Global Online REtail Spending - Statistics and Trends.* Retrieved from Invesp: https://www.invespcro.com/blog/global-online-retail-spending-statistics-and-trends/

US E-commerce Market Maintains Healthy Growth. (2016, November 21). Retrieved from Business Insider: http://www.businessinsider.com/us-e-commerce-market-maintains-healthy-growth-2016-11