January 24, 2016

Dr. Andrew Rawicz

School of Engineering Science

Simon Fraser University

Burnaby, BC V5A 1S6

Re: ENSC 440 Project Proposal for a Smart Baby Cradle

Dear Dr. Rawicz,

The following document is the proposal of our Smart Baby Cradle Project. We aim to design and implement a smart baby cradle that can help young parents to take care of the babies with a mobile device application. Our desired product contains four key features such as automatic cradle swing, baby crying detection, webcam monitoring and mobile toy spinning.

The purpose of this proposal is to provide an overview and introduction of product, scope/risks/benefits, the market/competition, the company details, the project planning and the cost considerations.

Our company, BABY ROCK, consists of four talented engineering science students: Fanchao Meng, Yu Liu, Xiaoye Lu and Kiru Sri. If you have any questions or concerns about our proposal, please feel free to contact me by phone at (778) 990-3591 or by e-mail at fanchaom@sfu.ca.

Sincerely,

Fanchao Meng

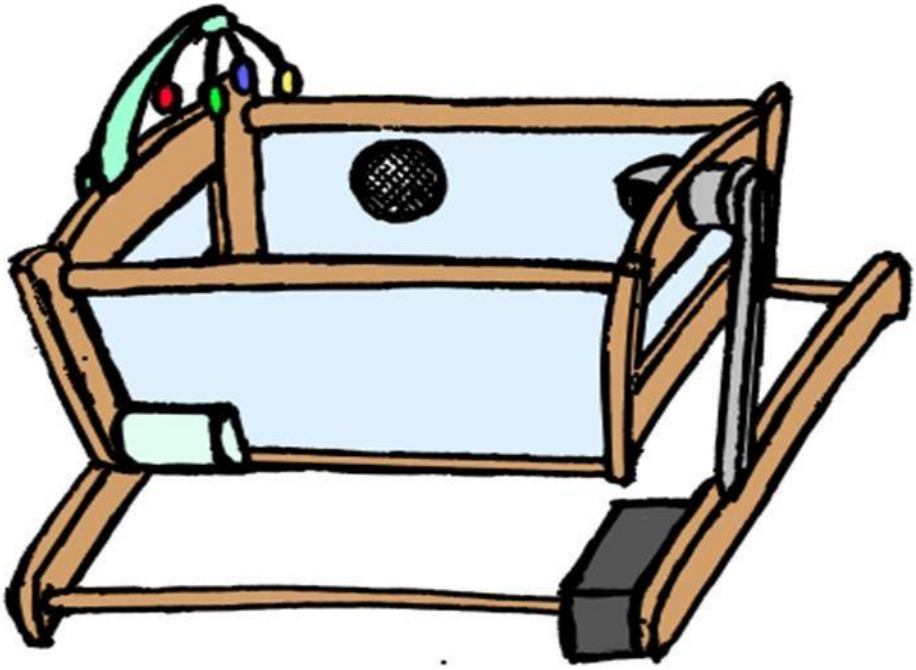
Fanchao Meng

Chief Executive Officer

Baby Rock

Enclosure: Proposal for a Smart Baby Cradle

ISSUED: JANUARY 25, 2016



SMART BABY CRADLE

PROPOSAL, REVERSION NUMBER: 1.0

FANCHAO MENG, YU LIU, XIAOYE LU, KIRU SRI
SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING

Executive Summary

After Jennifer has put her newborn baby to sleep, she decides to take a long shower. She has been working hard all day caring for the baby, and wants to relax. During the shower the baby wakes up and starts crying, unknowingly to Jennifer. After 30 minutes of showering Jennifer hears the baby as she turns off the shower. She rushes to the baby, and it has been crying for a while. Jennifer is upset at herself for taking a long shower...

This is only of the difficulties of having a newborn Jennifer experiences. There are many tasks which all parents have to experience during a time where the child is a newborn. During times like cooking a parent might want to stay to make sure the food is safe to leave before attending a baby. Babies can sense when their parents are stressed leading to negative effects on the babies' emotions.

Many Parents buy a lot of products to help them raise their baby during this time. They buy baby monitors, cribs, cradles, toys, and music player to help calm the baby. These products may end up costing the parent up to $600 depending on what products choose. They are all controlled separately, which may end up being a hassle for the parents. Many of these aren't automated either, it requires the parents to operate the device.

This document proposes a device that will have semi-automated features, as well as manual. The device will combine the features of all the devices mentioned previously, as well as automated to help soothe the baby when the parents are unable to. This will give parents a little more time to do everyday tasks, and reduce the stress on the parent. A happy parent equals a happy baby.

Baby Rock Inc. consists of three systems engineers and one computing engineer. Each one has a variety of experience from mechanical to software development, from the use of SolidWorks to the understanding of materials, as well as coding for Arduino and other microcontrollers.

We plan to finish this project in a 12 week period, and have an extra week if anything deviates from our original plans. This project will require us to research a variety of components usable with a microcontroller, as well as mechanical information which we will use to design and construct the prototype. The project is estimated to cost $400 which is mostly funded by ESSEF and through our own pockets.

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Glossary

FPS/fps: Frames per second, used to measuring how many frames in a moving image or video per second

VDC: Volts of direct current

1. Introduction

We live in a world where technologies is used all around us. The new generation of parents were raised with technology and own smartphones. There are many things these parents will buy to help them care for their baby (Cradle, Crib, Baby Monitor, etc.). We noticed that a lot of the products can be put into one product. BabyRock's Smart Baby Cradle provide parents a simple Android application help these parents monitor and comfort the baby. The Smart Baby Cradle allows them to monitoring their babies, rock the cradle, turn on the mobile toy, play soothing music and even speak to the baby. This is done with a cradle, a micro-controller, a webcam, a mobile toy, a stepper motor, a mic and a speaker (Figure 1).

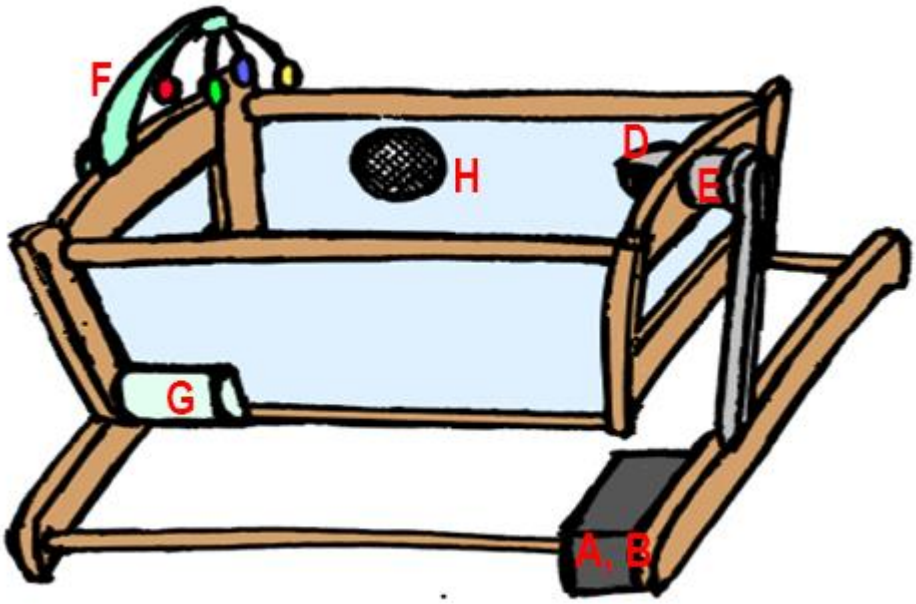


Figure 1: Conception Drawing for Smart Baby Cradle (refer to page 4 for what each part is)

2. Background

With rising costs and relatively busy lifestyles, newborn parents have to sacrifice a lot of time to raise and care for a baby, as well as do day to day task. Parents still have to cook, clean, do laundry, etc. but have to either choose to finish a task or go comfort the baby. Other times maybe the parents are outside gardening or taking a shower, and unable to hear the baby cry. The four of us we realized that we all will be parents in the near future, and we too will face these problems. So we came up with the Smart Baby Cradle, and Baby Rock was formed.

We realized that every single one of our friends had a smartphone, and they all will most likely be parents in the near future as well. After talking to some relatives and friend about what was hard about raising a baby, we decided we wanted to make a Cradle and add features to it. The cradle should be controllable by a smart phone, as well as send data to it, such as video/audio stream. It should have an automatic way to comfort the baby if the parent can't get to the baby right away. After coming up with a couple of features we decided to pursue this idea.

3. Company Detail

Baby Rock Consists of Four Engineers on their final years of study. From our collective skills we decided to make the Smart Baby Cradle.

Xiaoye Eric Lu - Chief Technology Officer (CTO)

I am a fourth year Systems Engineering student at Simon Fraser University with a previous co-op term placement at Shanghai Huabin Investment Ltd. I have skills in both software and hardware. During my co-op experience, I have developed a great skill on quality assurance, creating test case and test plans, and technical writing skills. Through course works and projects, I have experience using Solidworks, Matlab, AutoCAD, etc. I have participated as a key member in these projects and have displayed excellent communication and leadership skills. On top of that, I am also talented in project management, planning and organizing team meetings.

Fanchao Meng - Chief Executive Officer (CEO)

I'm a fourth year Computer Engineering student at Simon Fraser University with up to 2 years industry experience. I am highly interested in software development. Based on my career in SFU and my co-op experience, I am very familiar with software programming, especially C++ and Java languages. As a computer engineering student, I am also familiar with computer architecture and hardware configuration.

Yu (Nick) Liu - Chief Financial Officer (CFO)

I am a fourth-year systems engineering. I have experience with software(C/C++/Matlab) and hardware (VHDL, QNX Neutrino RTOS,68HC12 assemble language) coding. I am also familiar with some software and tools such as SolidWorks, LT-Spice, SQL, LabVIEW, Oscilloscopes, DMMs, Function Generator and SPA. I worked as a quality tester in Airbus, China and also a website developer in Focus Media Inc., Canada.

Kiru Sri - Chief Information Officer (CIO)

I am a fifth year Systems Engineer currently enroll at Simon Fraser University. In my previous two co-ops I worked at a startup called Navigate Surgical Technologies. Over there I had worked with physical hardware and learned

about manufacturing and design. Since I worked closely with the management at Navigate I have also picked up on some managerial skills. I am also familiar with a variety of scrips including C++, Java, Matlab etc.

4. Scope/Benefits/Risks

In this section, we are going to introduce the overview of our project and our solutions for some specific features. In addition, we also show a state diagram that describes the overall performance of our product.

1.1. Scope

The main feature of our product is to create the communication between parents and their babies when they are not together. We want the parents to be able to see their babies by phone and softly rock the cradle to comfort babies when they cry. We also want the parents to be able to turn on some electronic devices attached to the cradle. In order to accomplish those requirements, we bring our desired solutions. We will compare with some alternative solutions to justify our choices.

Webcam

Our proposed solution is going to use a webcam module that can easily be connected with the micro-controller, such as JPEG Color Camera Serial Interface (Figure 2). The advantage of the solution is that the webcam provides open source libraries for any platforms, such as Arduino and Raspberry Pi. Therefore, it can be easily controlled by the micro-controller. It has acceptable revolution with 160*120 outputs. It has very low power consumption without extra power supply.

Figure 2: Arducam Mini Module Camera

An alternative solution for webcam is that we can use an independent camera, such as FoscamFI9821W Wireless IP Camera (Figure 3). It has high revolution standard and it can provide high quality video output. There are many Android Apps that can communicate with this camera, such as tinyCam Monitor Pro.

Figure 3: Foscam FI9821W Wireless IP Camera

Compared with our proposed solution, the Foscam camera can provide higher revolution video. In addition, we can use the applications in Google Play to get the video signal instead of developing our own Android app. However, the disadvantage of this alternative solution is obvious as well. First, the parents have to use two phone applications. One is for monitoring and the other is for cradle devices control. We want the parents to be able to take action immediately once they are notified that the baby is crying. So it is not convenient for parents to monitoring babies and switch to another app to rock the cradle or turn on the toys. Second, in order to make an integrated system, we prefer for the micro-controller to control everything. This can also help people to easily control the system. Therefore, a webcam that can be connected to the micro-controller would be a better choice. Moreover, the webcam is only aim to help parents to identify their babies' state. High revolution is not important and it will increase the cost and the power consumption of the system.

Motor

In order to rock the cradle, we need a motor. Our proposed solution is to use a stepper motor (Figure 4). There are different types of stepper motors that can provide different torque based on requirement. The stepper motor can provide accurate control, such as the degree of rotation and rotation speed. Therefore, the users can choose how softly the cradle moves.

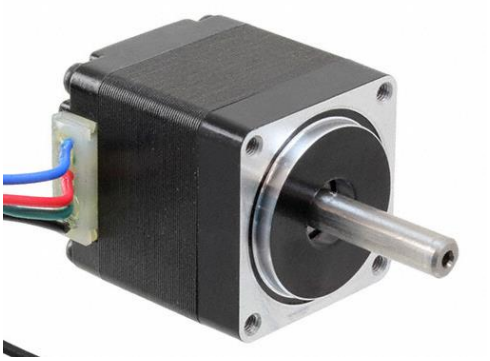


Figure 4: Stepper Motor

We have two alternative motor choices, which are normal DC motor and servo motor. The DC motor is cheaper but needs more additional hardware designs. In order to accurately control the cradle, we need to design the feedback control block and speed reducer which reduces the motor speed to get the required torque. On the

other hand, the servo motor has similar functions with the stepper motor. The shortcoming is that the servo motor is more expensive and it will increase our cost.

Equipment Specification

In Figure 5, we show the key components of our proposed design. The following briefly describe what they are used for.

a. Micro-controller: a mater control that get data from webcam and send control signal to the stepper motor, the speaker and the mobile toy. It also communicates with the Android application to provide remote control.
b. Wi-Fi module shield: allows the micro-controller to deal with the data communication through Wi-Fi network.
c. Router: provides Wi-Fi network environment for the communication between the micro-controller and the phone application.
d. Webcam: monitoring the baby in the cradle and is controlled by micro-controller.
e. Stepper motor: provides required torque to rock the cradle and is controlled by micro-controller.
f. Mobile toy: is used to comfort the baby and is controlled by micro-controller.
g. Mic: collects sound data from the baby to identify if the baby cries and is controlled by micro-controller.
h. Speaker: allows the parent to speak and comfort the baby. It is controlled by the micro-controller.
i. Android application: provides remote control and communicates with the micro-controller.

State diagram

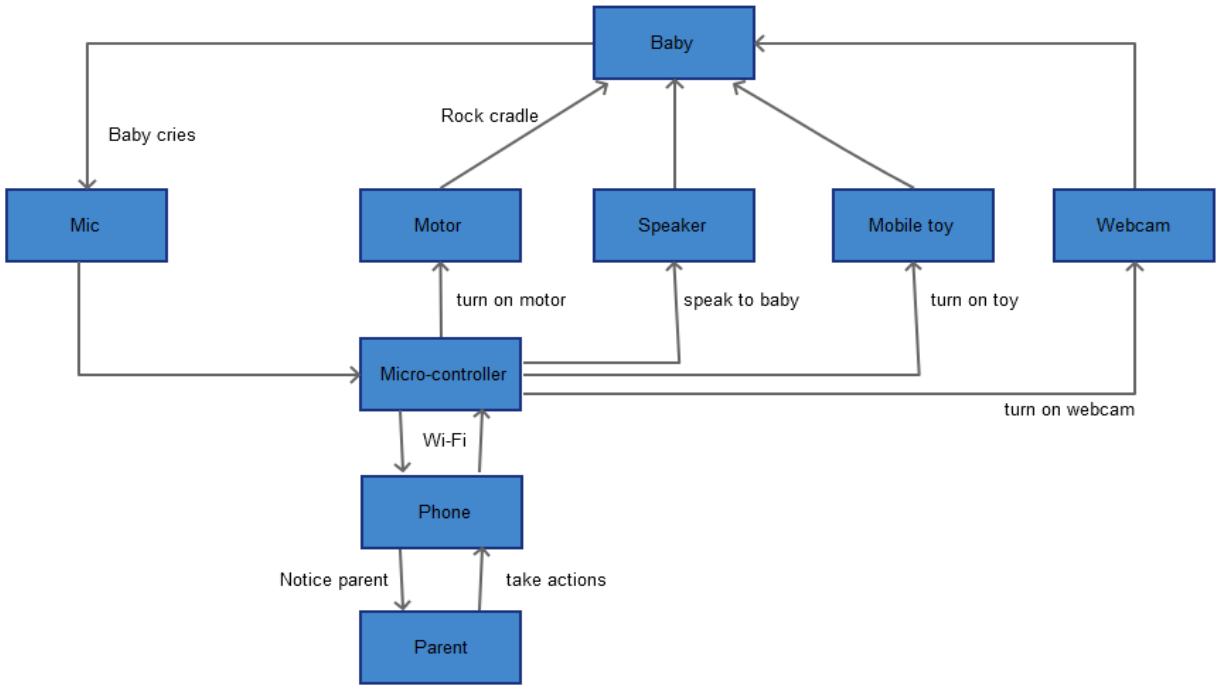


Figure 5: The State Diagram of the System

1.2. Risk

1. Baby's curiousness

   It is nature for babies to feel curious about everything that they can see. Our product contains multiple electronics devices, including the stepper motor, micro-controller and webcam. Each of them contains tiny components. When the system is working, the sounds and LEDs may draw the baby's attention. It is possible that the baby will try to stand and touch the devices. Beside the risk of electrical shock, the components may fall off or be broken by the baby and the baby might even try to bite or eat the parts.

   In addition, the system contains mobile toy which will be turned on by micro-controller. Babies like toys and are willing to play toys by hands. So it is a risk that the baby might stand up and try to touch or pull the toy. It is possible that the baby may fall and get hurt.

2. Parents' worries

   Parents consider the safety issues much more than the features of our produce. Therefore, when we demonstrate our smart baby cradle, we have to make sure our product can not only provide our desired features perfectly but also convince the customers that we have limited safety risks with reliable performance. Otherwise, parents will not accept our design and refuse to purchase it. This is a potential financial risk.

1.3. Benefits

The benefits of our product are listed as three main aspects:

1. Providing valuable free time for new parents.
2. Reducing stress on baby with instant notification and care.
3. User-friendly all-in-one system with android phone app controllable.

The social benefits of this product are enormous. By detecting baby's cry, the system automatically rocks the cradle and sends notification to parents and allows them to monitor the baby's situation right away. This would help parents of new born reduce stress, increase time for other activities without being disconnected from their baby. That valuable free time could be used for stressed parents to cook a proper meal, take a hot bath, or sleep better for the tomorrow's challenges.

The other benefit is related to high efficiency of the system. The baby's stress is also reduced by instant taking care of. By notifying the parents instantly, and calming baby simultaneously, the time of baby being alone and not getting care is definitely reduced. It also reduces the possibility of baby being not heard by parents, and under stress for an extended period of time. With this system, the efficiency of babysitting will greatly increase.

Furthermore, the other benefit of the smart cradle is the all-in-one system design which make this system very convenient to users. Smart phones are always with young people, especially the new generation parents. Hence, an android phone application can control the rocking, music, mobile toy, and camera would greatly improve the user interface and processing. Comparing to the existing baby products on the market, our all-in-one system contains the features of baby cradle, baby music player, baby mobile toy, baby monitoring system, and combined with an android app for an all-in-one control. The system not only eliminate four baby products, but also save large amount of money comparing to existing products.

5. Market/Competition

According to the Statistic Canada, the first time parents' average age is around 29 years old. At this age range, first time parents have a lot of stress on their work. In order to reduce the stress and to have some personal spare time, they are always willing to find solutions to minimize the stress of taking care of the baby. Our product targets the young first time parents who are busy, stressful and technology dependent as our primary customers. In the market, there is no product that has exactly same features as our smart cradle system, but there are some substitute products which have partial features of our products. One of our biggest competitors is the Fisher Price 4 in 1 Smart Connect Cradle'n Swing (Figure 6). This is the latest smart baby cradle produced by Fisher Price who is one of the leading smart baby cradle makers worldwide and it has more the half of the market share.

Figure 6: Fisher Price 4 in 1 Smart Cradle'n Swing

Some of the key features of this produce include:

1. Two choices of swinging motions with 6 speeds adjustment: side-to-side cradle motion or traditional head-to-toe
2. Free Smart Connect app controlling the swing from smart phone or tablet – works anywhere in your home up to 164 ft. away
3. 16 songs, 3 nature sounds and overhead mobile with light-up birdies

By comparing the price on Amazon, eBay, Toys "R" Us etc., the average price of this smart baby cradle is about $200 Canadian dollars.

The other substitute product of our smart cradle system is the Video Baby Monitoring System (Figure 7). There are many kinds of video baby monitors in the market and the average price is about $120 Canadian dollars.

Figure 7: Video Baby Monitoring System

The key features of the video baby monitor include:

1. 2.4GHz FHSS Technology with Two-Way Communication
2. LCD display shows real-time video and sound in your baby's room with up to 25 FPS video playback.
3. Camera with night vision provide bright and clear view during night

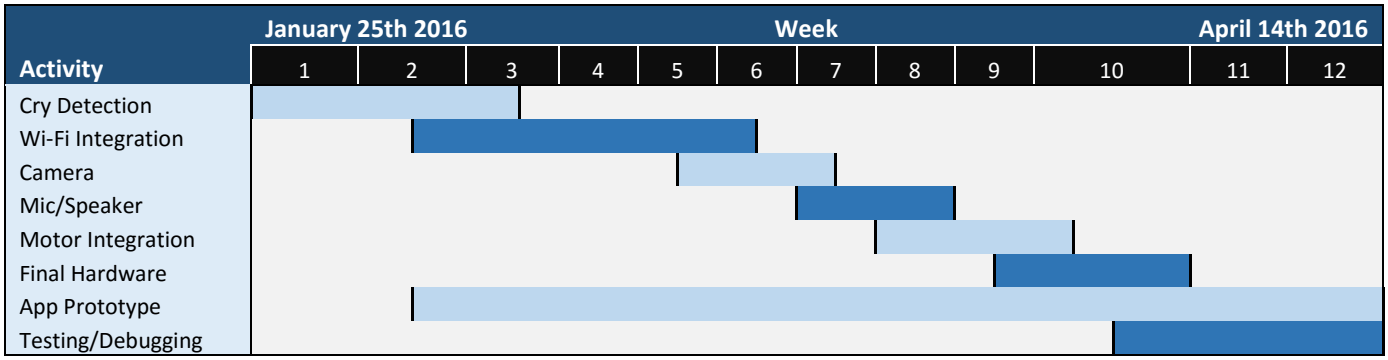
Not only our product combines all the features of our competitors in a single product controlled by a single mobile app, we also add a unique baby crying detection system which aromatically activating the swing/ rock function. The extensive amount of unique features in our product makes it very competitive in the market.

6. Rhetorical Issues

The minimum cost of our product prototype is around $300-400. In the future, if we can mass produce our product in China, India or Southeast Asia, we believe the unit cost of our product can be reduced to $150-200. We can set our sale price to $300 or more so the unit profit is about $125. The price for buying a Fisher Price 4 in 1 Smart Connect Cradle'n Swing and a Video Baby Monitoring System is about $320 in total. Our product offers a more technologically advanced compact smart baby cradle system with a relatively cheaper price. This makes our product more competitive than our potential competitors in the markets. Statistically, the number of new birth in Canada 2015 is 388, 729. [1] If 20% of the new birth use smart baby cradle, the market size for Canada is 77,746. If our product can gain 50% of the market share and the unit profit is $125, we can make revenue of $23.323, 740 and a net profit of $9,718,225.

7. Project Planning

Table 1: Project Gantt chart

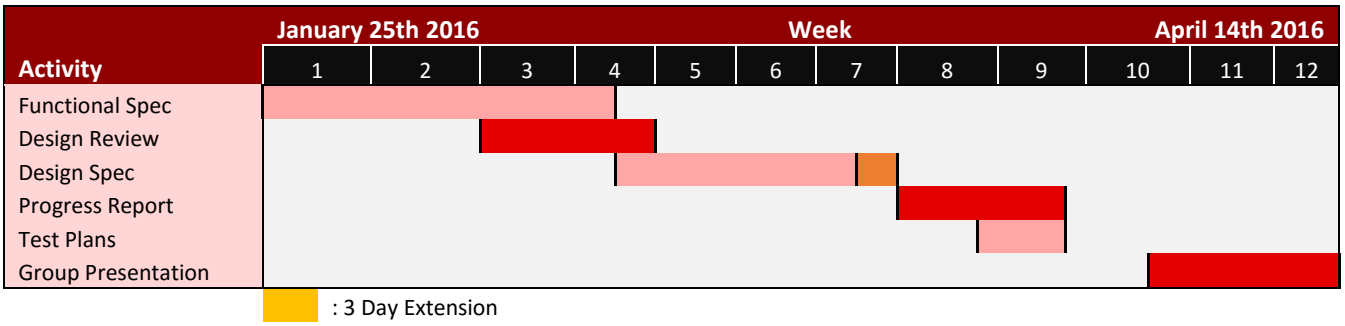


The Gantt chart shown displays our timeline for each component of this project. We have yet to acquire any components for our project so we decided to start with the Cry Detection. The Cry detection can be done on computer than integrated later into the Microcontroller. A database of baby crying noises is used to compare noises going into a mic to determine if the sound matches the database. We plan to be finished the database and detection software by February 10th 2016. We expect to have the microcontroller half way through Week 2, this is where we expect our microcontroller and Wi-Fi module to be here by as well as other components. The team will be split into two. One team will work on the Android App for the project, while the other team will work on integrating the Wi-Fi module with the microcontroller. The other team will work on receiving data through Wi-Fi. This is expected to be done by March 6th 2016, as well as integrating the cry detection database into the microcontroller.

Around the Fifth Week one member from each team will start with camera for the Arduino and the Android App. They will have two weeks to complete this task. The other two will work on the Wi-Fi Module and when they finished they will help integrate the webcam to the Android App. After which during the 7th week these two will start integrating the mic and cry detection software to the Arduino, as well sending a notification to the phone. The estimated date for completion for the camera and mic/speaker features are the middle of 7th weak and end of 8th week respectively.

The team working on the webcam will start working on the integrating the stepper motor and the cradle during the 8th week with the Arduino for both manual features and automatic cry detection features. The team working on mic/speaker feature will help integrate the android app to the motor by sending manual commands, as well as manual overrides for the motor. The two teams will also start working on Final Hardware. Such as adding the mobile toy and motor, and making the cradle baby safe by encasing all the electrical components. We plan to be complete the Hardware sometime during the 10th week. The teams will start finalizing the android app during the 9th week (i.e. UI, putting all functions into 1 app, etc.). After completing final touches the whole system will go through rigorous testing and debugging.

Table 2: Documentation Gantt chart



We decided to keep the three day extension for the Design specifications because it will be the most time consuming part of our documentation as well as require the most research.

8. Cost Considerations

Table 3: Price of each component

Components	Description	Estimate Cost ($)	Sources
Baby Cradle	2nd hand Made with wood With shelf	70-120	http://vancouver.craigslist.ca/bnc/bab/5371649580.html [2]
Stepper Motor	Standard Type Unipolar Torque 36.8- 82.1 (Oz-in) 24VDC	79.6 – 133.36	http://www.digikey.ca/product-detail/en/29SM-K250-99V/P14308-ND/2417032 [3]
Arduino Microcontroller	Part #A000066 REV3 ATmega328 Supply Voltage 7-12V Digital I/O Pins 14 Analog Input Pins 6	34.18	http://www.digikey.ca/product-search/en?keywords=ardunio%20a000066 [4]
Camera Chip	Y201-IR-RS485 Infrared featured Built in light sensor VGA/QVGA/160*120 resolution DC 3.3-5V power supply	31.6	https://item.taobao.com/item.htm?spm=a230r.1.14.44.3ESr0p&id=41246480734&ns=1&abbucket=5#detail [5]
Mic Module	LM386 Frequency 50Hz-20KHz Voltage 3.3-5.3V Size 39.0 X 21.0mm AOUT - MCU.IO DOUT – MCU.IO	18.6	http://world.tmall.com/item/44469685476.htm?spm=a230r.1.14.1.eTjWfc&id=44469685476&cm_id=140105335569ed55e27b&abbucket=5 [6]

Digital Speaker Module	Operating voltage: 2.0 - 5.5V Interface Type: Digital Support Gravity interface	6	http://www.dfrobot.com/index.php?route=product/product&product_id=1401&search=speaker&description=true&category_id=48#.VqR-iPmrSUk [7]
Wi-Fi Module	Bring Wi-Fi connectivity via Serial Host Interface, compatible with Arduino Security Protocol : WEP, WPA/WPA2-PSK, Enterprise, EAP-FAST, EAP-TLS, EAP-TTLS, PEAP Supports the module with chip antenna	76.05	http://www.dfrobot.com/index.php?route=product/product&product_id=548&search=wifi&description=true&category_id=48#.VqR__vmrSUk [8]
Mobile Toy	2nd hand Crib or Cradle Toy Fisher-Price	10	http://vancouver.craigslist.ca/pml/bab/5415919248.html [9]
Casing	Solidworks Design 3D Printed	50-100	SFU Engineering LAB

Total cost range: $376.03-529.79.

9. Conclusion

BABY ROCK Inc. is an innovation company that is dedicated to applying the smart phone technology and electronic devices to caring for babies. We aim to help young parents take care of their babies and enhance the baby's safety as well. With our technology and products, parents can significantly reduce their tension and stress.

Our proposed Smart Baby Cradle would provide an effective way for young parents to comfort their babies remotely. When the baby cries, parents can get notified right away and check the baby's status through the webcam. With our smart phone application, parents can remotely access the electronic devices attached in the cradle to comfort their babies. Compared with the existing similar products, our design and approach are more effective and integrated. We have an integrated product that combines all potential features that parents might need into one convenient app. We also make lots of efforts on the safety issues to enhance its reliability.

We have introduced the overview of our project, the scope of our design, the proposed solutions, the market analysis and cost consideration. We have a clear logic approach and design blueprint that can help us to accomplish our desired goal. Our team have strong knowledge of engineering, software programming and financial analysis. We believe we can complete the project based on our schedule and demonstrate a high quality product in the end.

Reference

[1] Statistics Canada “Births, estimates, by province and territory” http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo04a-eng.htm [22 Jan 2016]

[2]Craigslist, http://vancouver.craigslist.ca/bnc/bab/5371649580.html [22 Jan 2016]

[3] Digi-Key Electronics, http://www.digikey.ca/product-detail/en/29SM-K250-99V/P14308-ND/2417032 [22 Jan 2016]

[4] Digi-Key Electronics, http://www.digikey.ca/product-search/en?keywords=ardunio%20a000066 [22 Jan 2016]

[5] https://item.taobao.com/item.htm?spm=a230r.1.14.44.3ESr0p&id=41246480734&ns=1&abbucket=5#detail [22 Jan 2016]

[6] http://world.tmall.com/item/44469685476.htm?spm=a230r.1.14.1.eTjWfc&id=44469685476&cm_id=140105335569ed55e27b&abbucket=5 [22 Jan 2016]

[7] DFRobot, http://www.dfrobot.com/index.php?route=product/product&product_id=1401&search=speaker&description=true&category_id=48#.VqR-iPmrSUk [22 Jan 2016]

[8] DFRobot, http://www.dfrobot.com/index.php?route=product/product&product_id=548&search=wifi&description=true&category_id=48#.VqR__vmrSUk [22 Jan 2016]

[9]Craigslist, http://vancouver.craigslist.ca/pml/bab/5415919248.html [22 Jan 2016]