**SYSC 4907 Fourth Year Project  
Project Proposal**  
**Project Title:** Building Smart Baby Monitoring System with Internet of Things (IoT) with Web Service and Cloud Computing

**Due Date:** September 30th, 2019

**Supervising Professor**: Professor Chung Horng-Lung

**Group Members:**

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**Objectives**

The goal of this project is to develop an application monitored and controlled by a central system to improve the quality of life for parents and their infants. This system will identify and differentiate babies in need of attention based off information gathered via sensors. The system will then select appropriate approaches toward soothing distressed babies based off tendencies observed over time and automatically employ them. It will, as a last resort, then notify parents with different levels of tolerances depending on parents’ sleep schedules.

**Project Background**

The overall intent of this project is to address remaining and rising challenges pertaining to parent maternal behaviours and their effects on both parent and infant health and wellbeing. This also includes data acquisition for future parent maternal strategies to aid in health and wellbeing for future generations.

The development of infants and newborns is an important responsibility for both parents and healthcare professionals. This is regarded as a very time consuming and difficult task. As such it could benefit from an increase in parenting support through technological and engineering means. The importance of the early stages of infant development are paramount as within the first 9 weeks of infancy babies are already developing facial expressions and facial structure to begin forming the basis of word construction [1]. There are many solutions and approaches to these challenges however, many solutions consist of using medication or providing helpful parental information the former proving to be less effective than the latter [2].

The proposed smart baby monitoring system is a technological approach towards solving many of these prevalent issues in parenting in the modern day. The system would be geared towards improving upon parent’s knowledge of their babies and their ability to service or provide parental and behavioural support to promote healthy infant development and an overall increase in parent health and wellbeing. This system would provide a basis for parents to schedule and maintain infant patterns that would increase positive parent behaviour and time spent with the child as well as increase effective use of parent time and time management skills.

Through technological means, this project will address early infant development and parental obstacles that would benefit parents and infants in today's societies where there is a significant lack of industry products geared towards safely improving infant care and knowledge in an effective manner. There is a growing market in today’s society for a technological solution to the increasing strains on parents and parenting ability as well as infant data and health information. This could be addressed using the proposed smart baby monitoring system that would benefit parents, infants, and the healthcare sector while providing a marketable platform for a technological system that could become widely used and change industry standards.

**Project Description**

As discussed above, parents in this age are having children at later stages in their lives and focusing on their careers more in the earlier stages, this not only means that they have more stress in their already busy lives, but it also means that they have more money to spend on both their children and comfort.

Our new smart baby monitoring system will help parents in multiple ways to solve the issues discussed in the previous section. Parents will have the ability to constantly keep track of their babies from an application on their smartphone. The application will allow parents to set up a camera and microphone to constantly keep an eye on their baby. Whether the baby is sleeping or playing the parents will always have the comfort of being able to see what the baby is doing. The application will allow parents to check the environment in the baby’s room, multiple elements will be analyzed such as the temperature and movement in order to maintain a comfortable area for their child. Parents will be notified when the temperature in the room gets too hot or cold for the baby and alert them to take action (OR, we were thinking of hooking up a fan as an option if the room gets hot and a heater if it gets too cold, If Time Permits). The parents will be able to know if there is movement in the babies room and can turn on an option to be alerted if there is movement in suspicious times (for example if there is a lot of movement on the floor of the babies room in the middle of the night), the application will have options to take pets into consideration (if the user has pets) so that it does not produce unwanted alerts.

Using the features mentioned above, the parent as a user has many features that will use the data collected to help the parents deal with situations where the baby may be agitated. The application will be capable of recognizing the baby’s voice and alert the parents if the baby starts crying. Once this notification is received the parent will have a list of options to help buy them some time. The application will give the parents the option to turn on the crib mobile (toy that hangs above the babies bed, it spins and makes music) to attempt to calm the baby down. The parent also will have the option to turn on some quiet music for the baby, there will be a list of available songs for the parents to pick from. These features can be very useful to buy the parent a few minutes even if they do not fully work to calm down the baby. The application will allow for a certain amount of time (pre-set by the parents) to pass after each option is selected and if it did not work they will be notified again.

What sets this smart baby monitoring system apart from the others is the fact that we are attempting to add some aspects of data analysis and machine learning into the project. The system will constantly collect information in regards to the baby and the many useful ways to use that data. The application will attempt to learn the behaviour of the baby as time progresses, and it will attempt to implement strategies to make the user’s experience better. One way of doing so is to analyze the sleeping patterns of the baby, analyzing what times the baby usually wakes up crying or goes to sleep. The application can take precautions sending warning alerts that the baby usually goes to sleep around that time and that it might be a good idea to see if the baby wants to sleep. Or for example, if the system learns that the baby usually wakes up around 2:30 in the morning, it will take precautions like playing a quiet lullaby for the baby in the background to attempt to put it back to sleep (there are many precautions that can be taken, such as turning on the heater if it gets cold, turn on the fan if it gets hot, and etc.). The application will also take measures to attempt to make the baby go back to sleep before alerting the parents, the application will learn what usually works for each baby (for example the baby usually falls asleep after turning on the mobile, or turning on a certain lullaby). There are many options at play in the system and it can take many factors into account before deciding what the course of action to take will be. The basic flow of logic for the system in this scenario is: the baby wakes up, the system will use a few options from the aforementioned list and if they are not working the parent will be notified (the parent will also be notified of what strategies were used and if they were effective). The application will also learn the usual time that the baby gets hungry, needs to be changed, etc. based on the data it will collect to help prepare for those events and help warn and prepare the parents.

(If Time Permits)The final feature in the system is an analysis (possibly monthly/weekly maybe configurable) for the parents at the end of every (month/week) to help them keep track of information relating to their babies. They can keep track of the babies favourite songs, the best tactics to use when the baby is crying, the average times the baby wakes up/ gets hungry/ gets sleepy/ etc., the babies favourite temperature ,and so on. This will give the parents the opportunity to learn more about their babies and hopefully help them better organize their lives.

**Project-Degree Relationship**

The team consists of two Computer Systems Engineering Students and a Software Engineering student. The project relates to the Computer Systems and Software Engineering degrees as it requires the use of many if not all of the classes taken within the programs. These classes include software engineering and development courses such as SYSC2004 and SYSC2006 as the project will include the development process of various software solutions including design, testing, and implementation using various architectures and development languages.

The project contains hardware configuration requirements and a bridge between hardware and software technologies exhibited in courses taken in computer systems engineering such as ELEC 2501/2507 and SYSC 2310/2320. These courses provide an understanding of both electrical and computer architecture to gain an ability to provide dual hardware-software solutions prevalent with this project via software implementations and architectures interacting with sensors and microcontrollers.

The project will require software database management skills exhibited through many of the specific software engineering courses not offered to the computer systems engineering degree. COMP 3005 provides in-depth database table sorting knowledge to avoid repetitive data in database tables causing resource starvation.

Computer Systems Engineering and Software Engineering students take many of the same classes throughout their four years and we all have a lot of experience in the aforementioned fields.

**Method**

The technical approach intended for the system involves a variety of software and hardware components. For the software aspect of the system, the back-end logic, the plan is to write the higher-level code in Java. The Java code will be responsible for controlling the communication between the system and the android application. It will also control the database, general logic in the back end (ex. when to alert the parents that the baby is awake), data management and analysis (and learning), and voice recognition. The embedded code, written in C, will be used to control the Arduino and in turn control the sensor (all the sensors included in Project Requirements) inputs and outputs. The C code will transfer this data to the database through the Java code (where it will be analyzed) using a library ( JSSC -2.6.0- Release, <https://code.google.com/archive/p/java-simple-serial-connector/downloads>) that transfers C code to Java. The Database will most likely be MySQL (and use Spring Boot/REST Java API to control Queries), hosted on (either AZURE or AWS) cloud services.

**Timetable**

The Diagram below describes the milestones and dates for the following year:

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| --- | --- | --- | --- |
| **Task** | **Description** | **Due Date** | **Personal**  **Goal** |
| Project Proposal (Final) | Final submission of Project Proposal | Sept. 30, 2019 | Sept. 24. 2019 |
| Begin technical system design | Design all diagrams and use cases for the system (DB Schema, Use Case, Sequence) | Oct. 7, 2019 | Oct. 5, 2019 |
| Buy All Required Equipment and Sensors | Buy required sensors, and order any required items for project | Oct 9, 2019 | Oct 7, 2019 |
| Begin Programming the System | Once all the design is done for the system, we will begin programming the Pis and Arduinos. | Oct. 15, 2019 | Oct. 14, 2019 |
| Personal Milestone #1 | * Connect Main Hardware Components (Motion Sensors/Camera, Temperature Sensors) with Arduino * Connect Arduino with Raspberry Pi and Java Code * Develop and connect the Database | Nov. 10, 2019 | Nov. 7, 2019 |
| Oral Presentation Form Submission | Oral Presentation form submission online | Dec. 6, 2019 | Dec. 3, 2019 |
| Progress Report | Finish writing up the Progress Report | Dec. 6 2019, noon | Dec. 3, 2019 |
| Personal Milestone #2 | * All Hardware and Software communicating and integrated, from Sensors -> C -> Ras Pi Java -> DB -> Android App * Most of the Logic behind the system is done (Baby voice recognition and alerts, strategies for parents implemented (probably not controlled by the app yet)) * Simple Android App set up (basic, bare bones) | Jan. 1, 2020 | Dec. 26, 2020 |
| Oral Presentation Changes | Any changes to the Oral presentation submission form are due on this day. | Jan. 6, 2020 | Jan. 3, 2020 |
| Oral Presentation | Present the project to a group of engineers | Jan. 27, 2020 - Jan. 31, 2020 | Jan. 25, 2020 |
| Poster Fair Demo Form | Submission of Poster Fair Demo Form due online | Jan. 6, 2020 - Feb. 21, 2020 | Jan. 6, 2020 |
| Project Scope Finalization | Finalize our Decision on whether or not we will include the following:   * Heater/Fan for temperature control * The weekly/monthly report for parents * The extent of machine learning to use (we will attempt to learn as many of the babies patterns as possible). | Feb. 10, 2020 | Feb. 10, 2020 |
| Special Request for HW and SW at the Fair | Special request forms for hardware and software required at the fair due. | Feb. 28, 2020 | Feb. 26, 2020 |
| Personal Milestone #3 | * System fully functional (In terms of the main use cases) | Mar. 1, 2020 | Feb. 29, 2020 |
| Draft of Final Report | The draft of the final project report is due for submission. | Mar. 9, 2020 | Mar. 6, 2020 |
| Poster Fair | Tentative start day for the poster fair. | Mar. 20, 2020 |  |
| Final Report Due | Submission of Final Project Report due online | Apr. 7, 2020 | Apr. 3, 2020 |

**Project Requirements**

In terms of technical components needed for this project a list is provided below:

* Raspberry Pis
* Arduinos
* Microphones
* Speakers
* Camera/Motion Sensors
* Temperature Sensors
* Build a small baby crib for testing
* Motor to turn on the mobile (baby toy above bed) (and maybe for turning on the heater/fan)
* Mobile (and maybe fan and heater)

A Raspberry Pi will be used as the central hub of the baby monitoring system, it is a computer that will be used to store the code and transfer data collected to the database. The Arduino will be used to transfer the sensor data needed to the Raspberry Pi. The sensors needed for the project are: temperature sensors, microphones, speakers, camera (or motion sensor), and motor(s). The sensors will be used to achieve the functionality described in the previous parts. We will also need to build a small baby crib for demonstrations (or buy a toy one), as well as a mobile (toy hanging above a babies bed). (IF we decide to add fan/heater) We also need a fan and a heater in order to control the room temperature.

**Bibliography**

[1] L. Murray et al. “The functional architecture of mother-infant communication, and the development of infant social expressiveness in the first two months,” *Scientific Reports*, vol. 6, no. 1, Dec. 2016. [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5155249/>. [Accessed: 23- Sept- 2019].

[2] J. A. Mindell et al. “Behavioral Treatment of Bedtime Problems and Night Wakings in Infants and Young Children,” *Sleep*, vol. 29, no. 10, pp. 1263–1276, Oct. 2006. [Online]. Available: <https://academic.oup.com/sleep/article/29/10/1263/2709180>. [Accessed: 23- Sept- 2019].