

Adaptive Baby Monitoring System

Project Proposal

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1.0 Introduction

1.1 Statement of Purpose

A baby's cry is an important signal that they are in need of care. For deaf or elderly parents or caretakers, it is sometimes hard for them to tell when a baby is crying. Our product will aid them and let them know when their baby is crying immediately so that they will know immediately and be able to provide assistance to the baby.

1.2 Objectives

1.2.1 Goals & Benefits:

- Ensure that parents are always aware of whenever the baby is crying and in need of care promptly.
- Optimize adaptability by providing immediate solution to alleviate stress from the baby.

1.2.2 Functions & Features:

- Cry detector which will be trained using machine learning to adapt to a baby's individual cry.
- Notify parents or caretakers whenever the baby starts to cry through mobile app.
- Upon detection of cry, playback device will play music.
- Allow users to control playback device through mobile app.
- Playback device, which is powered through a wall plug, will contain a power supply that powers all the different components of the playback device.

2.0 Design

2.1 Block Diagrams

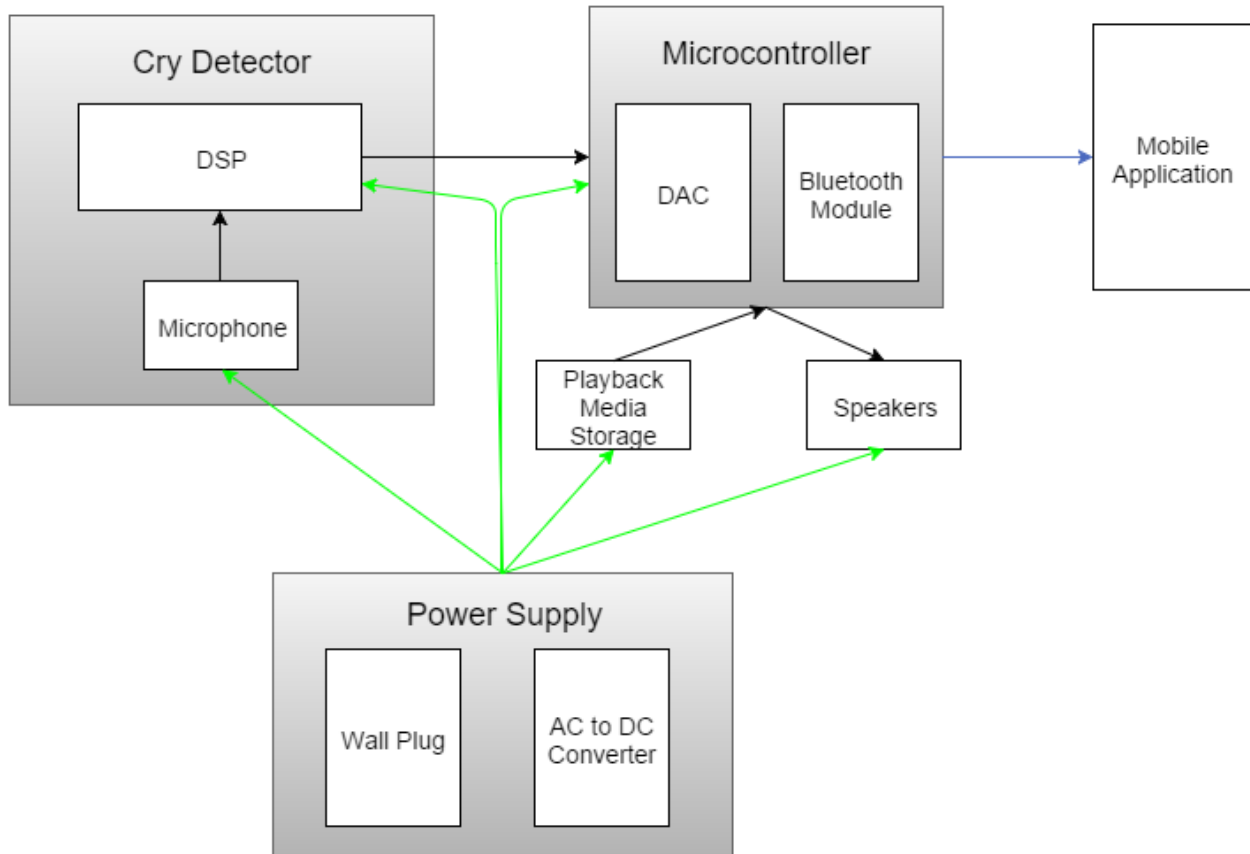


Figure 1. Block Diagram where black indicates signals or input, blue indicates bluetooth, and green indicates power

2.2 Block Descriptions

2.2.1 Digital Signal Processor for Cry Detector

The DSP will be programmed with a pattern recognition algorithm for cry detection. We will train a Support Vector Machine (SVM) classifier in MATLAB, and then we will store that in the DSP. The DSP itself will obtain some frequency information from the sounds captured by the microphone to use as feature vectors for the SVM classifier. This data is then fed into the SVM classifier, which gives a result of cry or no cry. Whenever a cry is detected, it will send a signal to the microcontroller.

2.2.2 Microphone

The microphone records real time sounds in the room, which will be sent to the DSP as an input to the cry detection algorithm. It will have a sampling rate of at least 44.1 kHz so that it can record audible range without aliasing.

2.2.3 Playback Media Storage

The playback media will be stored on a 16GB SD card. It contains all the tracks in .wav format. This will be used as an input into the microcontroller.

2.2.4 Microcontroller

The microcontroller allows interface between the DSP to the Bluetooth module and the playback media storage to the speakers. It will read the output from DSP which tells whether there is a cry or not. According to that, the microcontroller will interface with the bluetooth module to send out the notification. It will also read the stored music file from storage and output to the DAC where the audio can be fed to the speaker.

2.2.5 Speakers

This will play the sounds in the media playback storage. The two main components of the speakers are the amplifier and analog audio output. The analog output from the DAC built in the microcontroller will be amplified by the amplifier and playback by the speaker.

2.2.6 Mobile Application

Once a cry is detected, the application will receive a notification. This is done by interfacing with a Bluetooth module and the microcontroller. The mobile application also has a user interface to play/pause, change the track, and adjust the volume of the music playback device.

2.2.7 Power Supply

The power supply will have the voltage from wall converted to lower voltage by a transformer. Then it will be converted to 12V DC voltage and input to the system. It will also need to be converted down to appropriate voltage to drive each component in the music player.

3.0 Requirements and Verification

3.1 Requirements

Requirement	Verification	Points
1. Cry detector a. SVM classifier must successfully classify testing tracks at at least 90% accuracy. b. The microphone must have a sampling rate of at least 44.1 kHz to ensure proper quality of recorded sound.	1. Digital Signal Processor : a. Compare classification result (cry/no cry) to ground truth. Across hundreds of samples taken from microphone, at least 90% of them must be classified correctly. b. Verify specs of microphone in data sheet to ensure that sampling rate is at least 44.1 kHz.	30
2. Microcontroller must be able to do the following upon detection of a cry: a. read signal from DSP b. send notification to mobile application	2. Microcontroller: a. Place Digital Multimeter in parallel with microcontroller. Whenever cry is detected, voltage should be around 5V. Otherwise, it should be around 0V. b. The mobile application must receive a notification within 30 seconds of a detected cry.	25
3. Music is played on speakers upon detection of cry	3. Speakers: Speakers must play the music from the playback media storage within 30 seconds of a detected cry.	10
4. Mobile application must be able to control playback media device	4. Mobile Application: The mobile application should be able to control volume, on/off status, and the track played. The playback device should respond accordingly.	10
5. Power Supply Supply 12V +/-0.25V with current up to 5A	5. Power Routing System: a. Place Digital Multimeter in parallel with power source. Measure the voltage difference across the power source.The	15

	voltage should read 12V +/- 0.25V b. Place Digital Multimeter in series with the power supply and measure the current drawn. With up to 5A load, the power supply should be able to operate continuously without breaking down.	
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3.2 Tolerance Analysis

In order for the cry detector to work properly, it is important to ensure that only crying sounds are detected and that other human sounds like talking are not misclassified as crying. In order to accomplish this, we need to make sure that the training set contains at least 100 .wav files with sounds classified as crying and 100 .wav files with sounds not classified as crying. Each .wav file should be between 1 - 10 seconds. This ensures a robust and accurate SVM classifier. Otherwise, the SVM classifier may not be able to reach the desired accuracy of 90%.

In order for the DSP to run the classification algorithm through the SVM kernel efficiently, we need to make sure that the SVM kernel can be stored in the processor's RAM. Therefore, we have decided to limit the storage size of this SVM kernel to be 2MB.

We also want to ensure that the quality of the sound captured from the microphone is adequate. Therefore, we have set a minimum sampling frequency of 44.1 kHz on our microphone.

As one of our goals is to notify deaf or elderly parents when their baby cries swiftly, it is important that the mobile application and playback device respond promptly upon detection of a cry. As the SVM classifier should operate in linear time on the test data, the classification should only take a few seconds. Therefore, before 30 seconds have elapsed since the detection of a cry, the mobile application must have received a notification, and the music player must have started playing music.

4.0 COST AND SCHEDULE

4.1 Cost Analysis

4.1.1 Labor

Name	Hourly Rate	Total Hours Invested	Total = Hourly Rate x 2.5 x Total Hours Invested
Michael Qiu	\$30	240	\$18,000
Luis Ramirez	\$30	240	\$18,000
Yueyang Lin	\$30	240	\$18,000
Total Labor Cost			\$54,000

4.1.2 Parts

Item	Quantity	Cost/Unit	Total Cost
Microcontroller	1	\$5	\$5
DSP	1	\$100	\$100
Full-range speaker	2	\$20	\$40
Bluetooth module	1	\$30	\$30
SD cards (16GB)	2	\$5	\$10
Microphone	1	\$10	\$10
AC to DC converter	1	\$5	\$5
Total			\$200

4.1.2 Grand Total

Section	Total
Labor	\$54,000
Parts	\$200
Grand Total	\$54,200

4.2 Schedule

Week	Task	Responsibility
February 8	Finalize proposal	Michael Qiu
	Prepare mock design review	Luis Ramirez
	Begin design review prep	Yueyang Lin
February 15	Construct flow chart of cry detection algorithm	Michael Qiu
	Come up with detailed schematic of intermodule interfacing	Luis Ramirez
	Research on power supply and routing system and develop the fundamental schematic	Yueyang Lin
February 22	Finalize Design Review	Michael Qiu
	Finalize Design Review Order parts	Luis Ramirez
	Finalize circuit schematics	Yueyang Lin
February 29	Prototype cry detection algorithm on MATLAB	Michael Qiu
	Set up connections between storage devices, DSP, and microcontroller	Luis Ramirez
	Begin building power routing system and amplifier for system	Yueyang Lin
March 7	Implement cry detection algorithm on MATLAB	Michael Qiu
	Implement connections between storage devices, DSP and microcontroller	Luis Ramirez
	Continue building power routing system and amplifier for system	Yueyang Lin
March 14	Export SVM kernel onto DSP and begin testing	Michael Qiu
	Solder any necessary connections between storage devices, DSP and microcontroller	Luis Ramirez
	Finish building power routing system and amplifier for system	Yueyang Lin
March 21	Spring Break	Michael Qiu
		Luis Ramirez
		Yueyang Lin
March 28	Test cry detection algorithm and evaluate accuracy	Michael Qiu

	Set up Android Development Environment and begin work on user interface	Luis Ramirez
	Revise power routing system to meet with the final design schematic	Yueyang Lin
April 4	Finish developing user interface of Android application	Michael Qiu
	Implement controls for playback device on Android application	Luis Ramirez
	Finalize revisions to power routing system	Yueyang Lin
April 11	Test system and make sure that all components work together as intended	Michael Qiu
	Solder components and package them	Luis Ramirez
	Make the PCB	Yueyang Lin
April 18	Start planning for presentation	Michael Qiu
	Start planning for demonstration	Luis Ramirez
	Prepare for final paper	Yueyang Lin
April 25	Finalize presentation	Michael Qiu
	Finalize demonstration	Luis Ramirez
	Prepare for final paper	Yueyang Lin
May 2	Finalize presentation	Michael Qiu
	Finalize final paper Lab checkout	Luis Ramirez
	Finalize final paper	Yueyang Lin