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Baby Care System

ICOM 5047
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Group name: *Guarding Angels*

Abstract

This document presents a proposal to design the Baby Care System. It exposes all the design elements needed for the construction of the system, including budget plans, design strategies, hardware and software specifications, and so forth. Baby Care System is a complete system which aims to aid in the care of a baby to hearing impaired parents and the prevention of SIDS. It includes ambient humidity and temperature sensors, besides a crying detector and a device to detect if the baby is sleeping on his abdomen. The parents will be provided with a remote device, which will alarm them if something unusual is happening to the infant, while a soothing system will be activated at the crib. Moreover, Baby Care System will let them record each time their baby is asleep, fed, changed or has taken medicine.

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Execute summary

Project overview

Baby Care System will allow hearing impaired parents to monitor their baby while at the crib. It will include sensors to determine if the room's temperature and humidity are adequate, and it will detect if the baby is sleeping on his abdomen, since this is one of the main causes of Sudden Infant Death Syndrome (SIDS). Moreover, this system will determine if the baby is crying and possible reasons, by having a register of the last time he received a meal, medicine or his diaper was changed. Thus, if the baby cries, the parents will be notified via a vibrating alarm, while a soft sound and lights will be played to soothe the baby while they arrive.

Deliverables

1. Prototypes
   a. Parent's unit
   b. Crib device
2. Written reports
   a. Proposal
   b. Progress report
   c. Final report
3. Plans
   a. Budget/capital plan
   b. Risk management plan
   c. Project plan
   d. Testing plan
4. Test results
   a. Modules testing
   b. Unit testing
   c. Integration testing
5. Technical drawings
   a. Schematics
   b. Block diagram

Milestones

- Design a device that monitors the room's humidity and temperature and display them on the system screen. The device will use temperature and humidity sensors in order to acquire the data.
- Design a registry to store information about the last time the infant received a meal, had a diaper change, was administered medicine or was asleep. The registry will be updated by the users, using the options provided on the screen. The system will then proceed to store the data in a removable data storage device.
- Design an alarm system to warn users that the infant requires attention. This alarm, which contains a vibrating motor and LEDs, will be triggered if the infant is crying, turned on his abdomen or the room has an inadequate temperature or humidity.
- Design a system which will detect when the infant turns on his abdomen in the crib. This detector, consisting of RFID readers and tag, will be triggered when the tag is detected by one of the RFID readers.
- Design a mechanism to soothe the infant. This mechanism will be activated in junction with the alarm, turning on soothing sounds and lights.

Justification and economical aspects

Baby Care System will be a product designed to aid in the care of an infant for hearing impaired parents. It will provide them tools to keep track of everyday care of the baby, such as feeding and diaper change, besides monitoring the baby's sleeping position to prevent SIDS. Other products in the market provide some of the functionalities that Baby Care System provides, but not all of them. To obtain all the functionalities Baby Care System provides, the cost could go around $400, for a combination of products, which monitors the baby's movement, crying, humidity and temperature of the room, but does not keep a record of the baby's care. Moreover, some of these products are not aimed for hearing impaired people. On the other hand, Baby Care System prototype's cost is around $360, which will decrease once it goes into mass production. Furthermore, this product aims to supply a market that is currently in its infancy.

Introduction

The amount of people with hearing disabilities have grown considerably during the past decades. In 1980, the amount of deaf people in Puerto Rico was approximately 97,000[1]; in 1990 this number increased to 126,793[2] and a recent study shows that this number increased to 140,000 in 2003[3]. On the other hand, SIDS was one of the first ten causes of post-neonatal deaths in Puerto Rico in 2005[4] and one of the first nineteen leading causes of death in 2000[5]. Moreover, SIDS is the third cause of deaths in children of Puerto Rican mothers living in the United States according to a study made in 2002[6]. In the United States there are more than 4 million infants born each year[7], of which 2,162 died by SIDS, in 2003 alone [8].

The reasons for SIDS are not well known, but there are some risk factors that increase the possibility of a death by this syndrome, such as overheating and sleeping on the abdomen instead of the back. Baby Care System's mission is to help hearing impaired parents in the care and safety of their baby. Also, it will be able to determine if the infant flips his position and measure the temperature and humidity of the room. Moreover, it will notify parents, using a portable alarm device that will vibrate and emit lights, if the infant is in danger by one of these causes; thus, reducing the possibility of infant deaths by SIDS.

Besides the prevention of SIDS, Baby Care System will keep a registry of the last time a basic daily need was satisfied. Some examples are: the time at which the infant was fed, the time in which the diaper was changed, and so forth. The information will be displayed and stored in a removable memory device. This feature will help hearing impaired parents when leaving their child in the care of a third person, or to communicate with each other in an effortless manner.

The main scope of this project is to give the stakeholders (FDA, developers, and people with hearing disabilities with infants, in the newborn stage to one year stage) a tool to minimize the possibility of suffering from SIDS and to keep a record of daily care activities. Moreover, it will let parents know when the baby is crying with the vibrating alarm aforementioned.

Problem statement and variables

People with severe hearing disabilities often cannot hear their infant crying. The system will address this situation by alerting the parents via a remote vibrating alarm. Another concern is the risk of SIDS. This will be addressed by monitoring the infant's position, and the room's humidity and temperature; the system will alert the parents when the temperature or humidity are inadequate or when the infant has turned and is sleeping on his abdomen. Lastly, since these parents often lack fluidity in communications skills, a registry system will be provided to record the daily activities associated with the care of an infant. These activities are: the time of each meal and medication, change of diaper, and the sleep time.

Project antecedents

Market Overview

- Potential Costumers
  - Hearing impaired parents with a newborn infant in the family
  - Interviewed client: Yarett Piñeiro. See appendix I for more information.

Products and market competitors[1]

- **Bambino 2 Baby Alarm[9]**
  - Features:
    - Bambino 2 Baby Alarm has a small microphone placed in the baby's bedroom. This microphone is hard wired through into the parent's room. In contrast, Baby Care System has a microphone in a main console that communicates wirelessly to a remote alarm device. Furthermore, BCS contains temperature and humidity sensors, and a graphic LCD display.

[1] *For products related to infant care for parents with no hearing disabilities see appendix IV*

- Since Bambino is hard wired, users have a restriction of ten meters of cable; with Baby Care System the range will be determined by the XBee® devices, which could be up to 70 meters.
- Bambino 2 Baby Alarm has a pillow vibrator that will be activated when the infant cries, while BCS's alarm will be a portable device; thus parents do not have to be in bed to notice that an alarm was triggered.

- **Silent Call Vibrating Alert System [10]**
  - Features:
    - Silent Call Vibrating Alert System (SCVAS) is aimed to people with different disabilities such as blindness, deafness and hard of hearing. In contrast, Baby Care System focuses its market to hearing impaired parents and caregivers.
    - SCVAS has a pillow vibrator that will be activated when a sound is detected, while the filter in BCS will try to detect only the baby's cries. Moreover, the alarm will be in a portable device; thus parents do not have to be in bed to notice that an alarm was triggered.
    - SCVAS provides different receiver's options (flashing light, bed vibrator), while BCS's remote device will have all the offered options included.

Competitive advantage of Baby Care System

- Baby Care System is aimed to hearing impaired parents and caregivers.
- Baby Care System provides most of the main functionalities of the other products in a single module.
- Unlike other products, this system will keep track and history of every meal, medicine, and diaper change in a removable storage device. This feature will allow parents to share this information with doctors or any other person that could be in contact with the infant.
- According to the feedback received from clients, the system provides ease of use; with a touch screen display the parent could store the last time an action was performed.

Economical analysis

Corporations in the hearing impaired market have competitive revenue, as can be observed with Accessolutions Company. According to information in their website, their revenues in 2006 were $1,477,341,000. This information provides Guarding Angels a projection of the market in which they aim their product Baby Care System.

On the other hand, infant care products such as AngelCare® and WhyCry® are solutions aimed for parents which not necessarily have hearing disabilities. Baby Care System have incorporated most of the competitive products' features in the baby care area in a single device focused on the hearing impaired population. Considering the cost of infant care products in the market, the advantages in terms of functionalities, and the cost of the products aimed to deaf people we can argue that our product will have a good reception in the market.

Standards

- *ASTM F1169 – 09 Standard specifications for full size baby crib.*
  - This standard specifies all the aspects to take into consideration to ensure the safety of an infant when in the crib. Among these standards, it stipulates that the mattress must be the same size of the crib's frame, without leaving any gaps; this is to ensure that the infant will not get trapped between the frame and the mattress. Furthermore, the mattress must be firm enough to provide adequate support to the infant and to avoid suffocation.

- *Consumer Product Safety Commission (CPSC) Regulations*
  - States that all electrical components must be entirely enclosed and cannot be accessed by common tools other than screwdrivers or other specific tools. This enclosure must be strong enough to avoid accidental exposure of wires or other components and must be also heat resistant to avoid morphing or deformation due to heat. Moreover, if the electrical component is exposed to water, it must be

completely sealed and isolated from the water, preventing the user from getting an electrical shock or damaging the equipment.

Proposed system objectives

- Minimize the risk of SIDS cases
- Create a tool for hearing impaired parents to help them with their infant's care
- Offer a device to alert parents when the infant requires attention
- Provide a mechanism to soothe the baby while his caregivers arrive
- Present a device that shows the room's temperature and humidity

Social, legal and environmental impact

Baby Care System's social impact is to provide a tool which will assist people with hearing disabilities to be able to communicate more effectively with third parties, in the care of their infants, as stated by Yarett Piñeiro, our main client. As an environmental impact, this product can be reused if the parents decide to have more children, thus reducing waste. Moreover, the log that Baby Care System keeps is only displayed electronically being environmentally friendly, thus reducing paper usage.

On the other hand, Guarding Angels could be involved in legal problems if the baby's safety is at risk. A potential risk that could harm the baby is assembling problems; such as small pieces misplaced, unprotected cables, and so forth. This could be a problem in the prototype model, but it should not be found if the product is developed by a manufacturing company, since extensive system testing should be performed before going into mass production.

Product specifications

System overview

Baby Care System consists of two main devices; one is the main console and the other is a remote device. The main console will have the following components: a temperature and humidity sensor, a microphone, a touch screen GLCD, a soothing system (composed of a sound player and colored LEDs) and an XBee® module for the wireless communication with the remote device. Additionally, the main console will contain a dedicated microcontroller which will be in charge of the baby position detection module, composed of two RFID readers and an RFID tag. On the other hand, the remote device will work as an alarm system. It consists of a vibration motor, a buzzer and a LED. Their relationships can be observed in the system block diagram (Figure 1).

Hardware specifications[2]

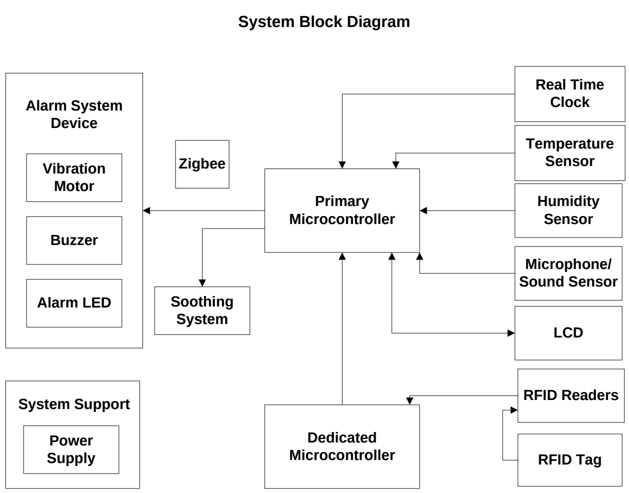

Figure 1: Block diagram for the system

[2] *For a preliminary list of components, see table 5 in the budget section.*

Hardware considerations

This product must run on batteries, thus, chosen components should be low power. For example, the MSP430 considered for implementation is a low power microcontroller, with power dissipation of 616μW in active mode and 4μW in stand-by mode [11]. On the other hand, the XBee® model dissipates 1mW when transmitting [12].

Software specifications

Software diagram

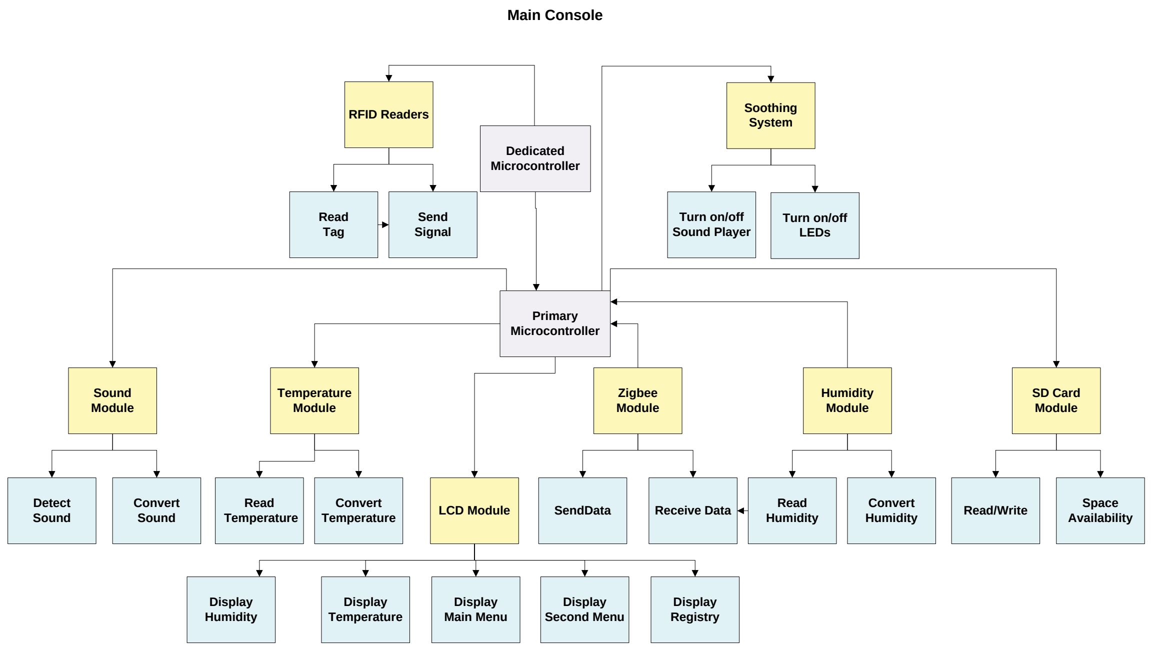

Figure 2: Software diagram of main console

The software diagram exemplifies the main software modules to be programmed and their relationships.

Monitoring system specification and alarm triggers

- Cry detection alarm
  - This alarm will be activated when:
    - A sound in the frequency 900 Hz- 1200 Hz is detected, which corresponds to the infant cries in hyperphonation[3] mode
  - False alarms could happen when:
    - An external sound with the same frequency is detected
    - A vibration in the abovementioned frequency is detected
    - Sensor is damaged
- Room temperature and humidity alarm
  - This alarm will be activated when:
    - The temperature is higher than 35°C (95°F) or lower than 20°C (68°F)
    - The humidity is higher than 70% or lower than 40%
  - False alarms could happen if:
    - Sensors are damaged
- Position detection alarm

[3] Hyperphonation: production sound by means of vocal cord vibrations with a high frequency, around 1KHz

The position detection system will have two RFID readers and a single tag. The tag will be on the infant's abdomen inside a belt or in the clothing. The RFID readers will be positioned around five inches away from each other at the center of the mattress. When the infant flips upside down the tag will be picked up by the readers and the alarm will be activated.

- This alarm will be activated when:
  - The RFID reader detects the tag
- False alarms could happen if:
  - The belt attached to infant's abdomen is moved to another position
- The system could fail in the detection if:
  - The baby is too far from the RFID reader detection's range

System state diagram

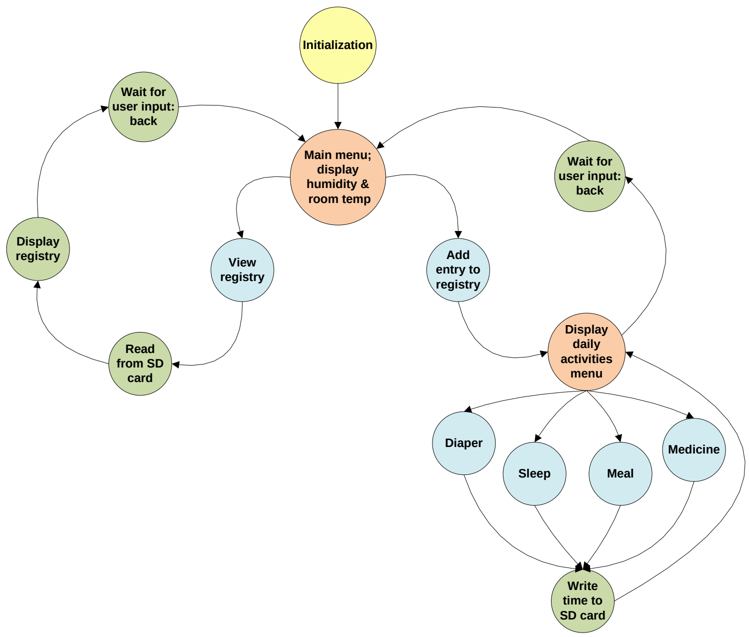

Figure 3: System state diagram

The software system will work as shown in figure 3. The system will initialize when turned on. Afterwards, it will read the room's humidity and temperature constantly in the background and display them on the screen, besides monitoring the infant's cry and position. Meanwhile, the main menu will be displayed with the options: *view registry* and *add a new entry*. The *view registry* option will read the log from the SD card and display it on the screen. After receiving the user's input it will go back to the main menu. The *add entry* option will display a second menu which will contain the following options: *diaper*, *sleep*, *meal*, and *medicine*. The system will record in the SD card the time when one of these options was selected. The secondary menu will have a *back* option to return to the main menu.

Software considerations

The software design will follow a phase's model, specifically incremental development. This type of development avoids the famous "big bang" at the end of the implementation [13]. The reason behind the choosing of this model is based on that all requirements are known up-front. This method also benefits users and stakeholders who will see working functionalities early in the lifecycle.

Timing

An RTC will be used to obtain the current time which will be utilized each time the registry is updated. This registry will be stored in the SD Card. XBees® work at a frequency of 32K Hz[12]; as a result, an external 32K Hz crystal oscillator or similar system will be needed. The basic clock module of the microcontrollers examined for the application support this type of oscillator.

Testing

Module	Type of test	To be tested	Test steps	Expected result
Temperature	Software (20%)	MCU takes a reading every 30 seconds	Develop sample code to take reading and verify it with an actual clock	Accurate measurement of room temperature
		Convert the signal and verify if the value obtained corresponds to a valid temperature measurement	Write sample code to get temperature reading and to display on LCD; compare obtained value with an actual thermometer	
		Determine if the temperature value obtained could be dangerous; if it is, send signal to alarm system device	Create a sample code to compare actual measured value with dangerous temperature range; to trigger the alarm, use a fixed value to verify that the alarm system is turned on	
	Hardware (10%)	Temperature sensor installation	Measure sensor's output voltage	
		Amplifier sensor installation	Verify that the temperature value obtained is a multiple of the amplification factor	
Humidity	Software (20%)	MCU takes a reading every 30 seconds	Develop sample code to take reading and verify it with an actual clock	Accurate measurement of room humidity
		Convert the signal and verify if the value obtained corresponds to a valid humidity measurement	Write sample code to get the actual humidity reading and display it on LCD; compare obtained value with an actual humidity meter	
		Determine if the humidity value obtained could be dangerous; if it is, send signal to alarm device	Create a sample code to compare actual measured value with dangerous humidity range; to trigger the alarm, use a fixed value to verify that alarm system is turned on	
	Hardware (10%)	Humidity sensor installation	Measure sensor's output voltage	
		Amplifier installation	Verify if humidity percentage obtained is a multiple of the amplification factor	
Sound/ Microphone	Software (15%)	MCU takes a reading every 5 seconds	Develop sample code to take reading and verify with an actual clock	Infant's cry is detected and alert signal is sent to remote device
		Convert and filter the signal; verify if it is a valid value	Write sample code to covert signal and to compare the value obtained with normal frequency values	
		Determine if the frequency value obtained could be baby's cry; if it is, send signal to alarm device	Create a sample code to compare the frequency value obtained with baby's cry frequency range; to trigger the alarm, reproduce baby's cry sound to verify that alarm system is turned on	
	Hardware (15%)	Sound sensor installation	Measure sound sensor/microphone output voltage	
		Filter installation	Test sound sensor by reproducing a sound with frequency known and comparing it with the value obtained	
LCD, SD card and RTC	Software (20%)	Initialization successful and displays main menu	Write code to initialize LCD, set time in RTC, load menu, take temperature and humidity readings and display them	Temperature and humidity are displayed on main menu; main options are displayed; time is stored on SD when an activity is selected; log is displayed in main console
		Displays daily activities menu	Develop code to load menu and write on memory card the time when an option is selected; read SD card to verify that the information was successfully written	
		Displays registry	Test after writing on SD card several activities and verify if the information is successfully displayed on LCD	
	Hardware (10%)	LCD installation	Verify by turning LCD on and adjusting screen brightness	
		SD card installation	Develop sample code to write on SD card; verify on a computer if the data was written	
		RTC installation	Develop sample code to store actual time on SD card; verify value in a computer	
Zigbee	Software (15%)	Communication between both XBees® successful; send signal to turn on/off the alarm system components	Write code to turn on alarm system components via Zigbee® communication	Send signal with main console's XBee® unit and receive it with remote device's XBee® unit
	Hardware (15%)	XBee® installation on main console and on remote device	Develop code for XBee® communication; test by sending a signal to remote device to turn on LED; verify if it worked correctly	
Baby position detector	Software (15%)	Tag programming and RFID tag detection; send signal to remote device when tag is detected	Test by passing RFID tag around the RFID reader; if detected, corroborate if the RFID reader sends a signal to remote device	Detects when the infant turns on his abdomen
	Hardware	RFID readers and tag installations	Pass RFID tag around the RFID reader to verify if it is	

	(15%)	and enclosures	detected	
Alarm system	Software (10%)	MCU turns on/off LED, buzzer and vibration motor	Write code to turn on/off alarm system components	Turns on/off the components when signal from MCU is received
	Hardware (20%)	LED installation	Verify if LED works by applying a source voltage	
		Buzzer installation	Corroborate if buzzer works by applying a source voltage	
		Vibration motor installation	Test vibration motor by verifying if it works properly when applying a source voltage	
Soothing system	Software (10%)	MCU turns on/off the soothing system	Develop code to turn on/off all the alarm system components	Turns on/off components when signal from MCU is received
	Hardware (20%)	LEDs installation	Verify if LEDs works by applying a source voltage	
		Sound player	Corroborate if sound player works by applying a source voltage	
Integration	Software (50%)	All modules are working as intended; both units communicate properly	Write code to test each functionality of both units and to test their interaction	All modules are working properly and both units communicate as intended
	Hardware (50%)	Main console unit and remote alarm system are fully assembled	Verify that all components are properly connected by measuring their output voltage or by applying any of the previous tests	

Table 1: Testing plan

Restrictions and Scope

Baby Care System will:

- Determine if the infant flips positions in his crib
- Determine and alert caregivers if the infant needs attention
- Keep registry of the time in which a basic need was covered
- Displays room temperature and humidity
- Sooth baby playing soft sounds and lights

Baby Care System will *not*:

- Determine if the baby is breathing
- Determine the reasons why the baby is crying or required action
- Control the room temperature and humidity

Project management

Organization breakdown structure

Figure 4: Organization breakdown structure

Project Skills and Resources Assigned

Team Leader: The team leader is the person who will respond for the specific task and has the responsibility to inform the progress to the Project Manager and other team members.

Supporting Member: The supporting member is the person who will work side by side with the team leader and is responsible for the task if the team leader has an emergency or could not be present.

Skill required for the project	**Vimaliz Montes**	**Marinés Chaparro**	**Michelle Almodóvar**
Data acquisitions:			
▪ Temperature		Team Leader	Supporting Member
▪ Humidity	Supporting Member		Team Leader
▪ Sound	Team Leader	Supporting Member	
Zigbee® Communication		Team Leader	Supporting Member
LCD programming		Supporting Member	Team Leader
Microcontroller programming	Supporting Member	Supporting Member	Supporting Member
Baby Position Detector	Team Leader	Supporting Member	Supporting Member

Budget planning	Supporting Member	Supporting Member	Supporting Member
Soft Skills	Supporting Member	Supporting Member	Supporting Member

Table 2: Human resources

Personnel training:

- Microcontroller self teaching
  - Possible Solutions:
    - Book acquired: MSP430 Microcontroller Basics by John H. Davies and other books
    - Web tutorials
    - Consult experts
      - Manuel Jimenez (PhD)
      - Rogelio Palomera (PhD)
- Zigbee® Communication
  - Possible Solutions:
    - Read papers and tutorials
    - Consult experts
      - Kejie Lu (PhD)
      - Hector Lugo (MS)

Resources

Biographies of team members

Refer to Appendix II.

Technical resources

Some of the technical resources that will be needed are the spare equipment from the laboratory and tools such as multi-meter, TTL cable, screwdrivers, breakouts, among others. Moreover, the soldering station and computers available at the laboratory will also be utilized.

Work breakdown structure

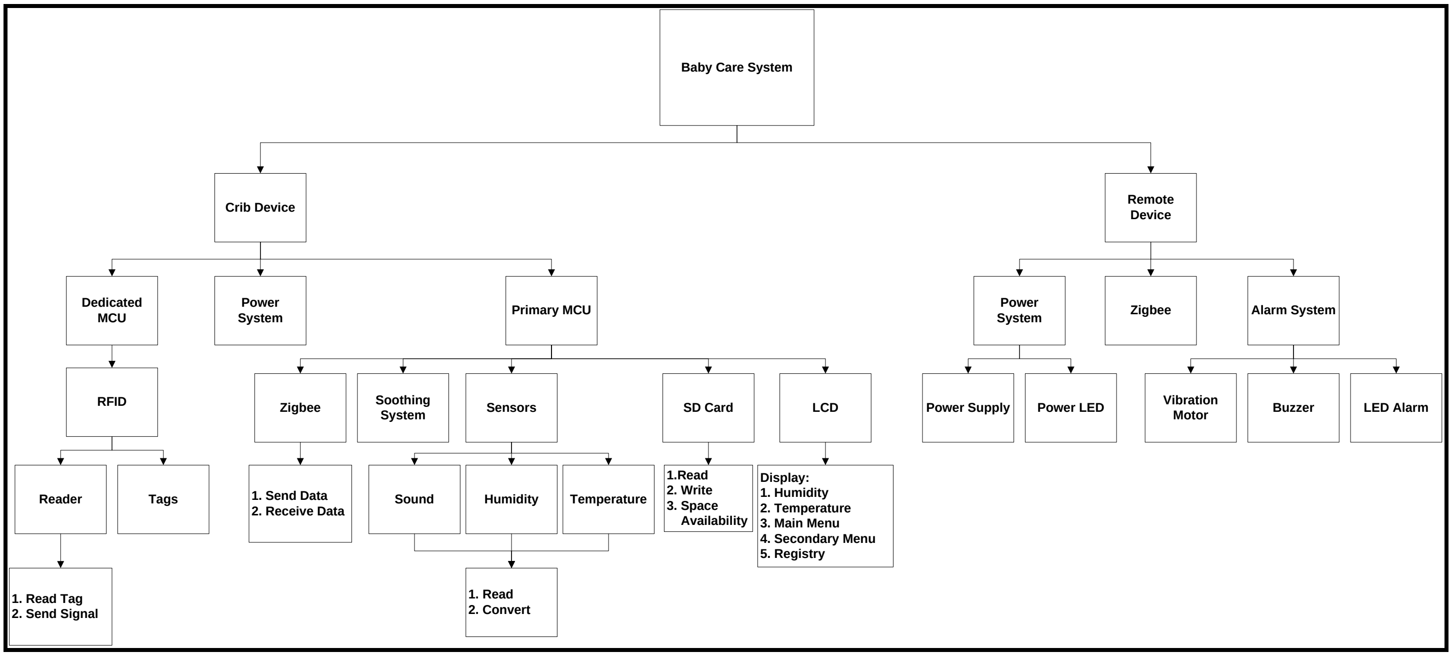

Figure 5: Work breakdown structure

Gantt chart

The detailed Gantt chart with critical path can be found at appendix V and attached to the proposal email.

		Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**⊟ System Support**	**7 days**	**Wed 2/10/10**	**Thu 2/18/10**		
2		Design	3 days	Wed 2/10/10	Fri 2/12/10		Vimaliz Montes[90%],Marinés Chaparro[50%]
3		Get components	3 days	Wed 2/10/10	Fri 2/12/10		Vimaliz Montes[10%]
4		Hardware implementation	3 days	Mon 2/15/10	Wed 2/17/10	3	Vimaliz Montes[25%],Michelle Almodóvar[25%]
5		Testing	1 day	Thu 2/18/10	Thu 2/18/10	4	Vimaliz Montes[25%],Michelle Almodóvar[25%]
6		**⊟ LCD Module**	**28 days**	**Wed 2/10/10**	**Fri 3/19/10**		
7		Design	3 days	Wed 2/10/10	Sun 2/14/10		Michelle Almodóvar,Marinés Chaparro[50%]
8		Order components	1 day	Fri 2/19/10	Fri 2/19/10	7SS	Michelle Almodóvar[1%]
9		Software implementation	2 days	Mon 3/15/10	Tue 3/16/10		Marinés Chaparro,Michelle Almodóvar,Vimaliz Montes
10		Hardware implementation	1 day	Wed 3/17/10	Wed 3/17/10		Marinés Chaparro,Michelle Almodóvar,Vimaliz Montes
11		Testing	2 days	Thu 3/18/10	Fri 3/19/10		Marinés Chaparro,Michelle Almodóvar,Vimaliz Montes
12		**⊟ Temperature Module**	**32 days**	**Mon 2/15/10**	**Tue 3/30/10**		
13		Design	4 days	Mon 2/15/10	Thu 2/18/10		Marinés Chaparro[60%],Michelle Almodóvar[15%]
14		Order components	1 day	Fri 2/19/10	Fri 2/19/10	13SS	Marinés Chaparro[1%]
15		Software implementation	3 days	Mon 3/22/10	Wed 3/24/10		Marinés Chaparro[60%],Michelle Almodóvar[40%]
16		Hardware implementation	1 day	Thu 3/25/10	Thu 3/25/10		Marinés Chaparro[60%],Michelle Almodóvar[40%]
17		Testing	3 days	Fri 3/26/10	Tue 3/30/10		Marinés Chaparro[60%],Michelle Almodóvar[40%]
18		**⊟ Humidity Module**	**32 days**	**Mon 2/15/10**	**Tue 3/30/10**		
19		Design	4 days	Mon 2/15/10	Thu 2/18/10		Michelle Almodóvar[60%],Vimaliz Montes[15%]
20		Order components	1 day	Fri 2/19/10	Fri 2/19/10	19SS	Michelle Almodóvar[1%]
21		Software implementation	3 days	Mon 3/22/10	Wed 3/24/10		Michelle Almodóvar[60%],Vimaliz Montes[40%]
22		Hardware implementation	1 day	Thu 3/25/10	Thu 3/25/10		Michelle Almodóvar[60%],Vimaliz Montes[40%]
23		Testing	3 days	Fri 3/26/10	Tue 3/30/10		Vimaliz Montes[40%],Michelle Almodóvar[60%]
24		**⊟ Sound Module**	**32 days**	**Mon 2/15/10**	**Tue 3/30/10**		
25		Design	4 days	Mon 2/15/10	Thu 2/18/10		Vimaliz Montes[60%],Marinés Chaparro[40%]
26		Order components	1 day	Fri 2/19/10	Fri 2/19/10	25SS	Vimaliz Montes[1%]
27		Software implementation	3 days	Mon 3/22/10	Wed 3/24/10		Vimaliz Montes[60%],Marinés Chaparro[40%]
28		Hardware implementation	1 day	Thu 3/25/10	Thu 3/25/10		Vimaliz Montes[60%],Marinés Chaparro[40%]
29		Testing	3 days	Fri 3/26/10	Tue 3/30/10		Vimaliz Montes[60%],Marinés Chaparro[40%]
30		**⊟ Baby Position Detector Module**	**36 days**	**Fri 2/19/10**	**Fri 4/9/10**		
31		Design	11 days	Fri 2/19/10	Fri 3/5/10		Vimaliz Montes,Michelle Almodóvar[50%]
32		Order components	1 day	Fri 2/19/10	Fri 2/19/10	31SS	Vimaliz Montes[1%]
33		Software implementation	2 days	Mon 4/5/10	Tue 4/6/10		Vimaliz Montes,Michelle Almodóvar[50%]
34		Hardware implementation	1 day	Wed 4/7/10	Wed 4/7/10		Vimaliz Montes,Michelle Almodóvar[50%]
35		Testing	2 days	Thu 4/8/10	Fri 4/9/10		Vimaliz Montes,Michelle Almodóvar[50%]
36		**⊟ Alarm/Remote device and Zigbee (**	**36 days**	**Fri 2/19/10**	**Fri 4/9/10**		
37		Design	11 days	Fri 2/19/10	Fri 3/5/10		Marinés Chaparro,Michelle Almodóvar[50%]
38		Order components	1 day	Fri 2/19/10	Fri 2/19/10	37SS	Marinés Chaparro[1%]
39		Software implementation	2 days	Mon 4/5/10	Tue 4/6/10		Marinés Chaparro,Michelle Almodóvar[50%]
40		Hardware implementation	1 day	Wed 4/7/10	Wed 4/7/10		Marinés Chaparro,Michelle Almodóvar[50%]
41		Testing	2 days	Thu 4/8/10	Fri 4/9/10		Marinés Chaparro,Michelle Almodóvar[50%]
42		**⊟ Prototype integration**	**12 days**	**Thu 4/15/10**	**Fri 4/30/10**	**36,30,24,18,12,**	
43		Full system testing	12 days	Thu 4/15/10	Fri 4/30/10		Vimaliz Montes,Marinés Chaparro,Michelle Almodóvar
44		**⊟ Reports and demonstrations**	**61 days**	**Wed 2/17/10**	**Wed 5/12/10**		
45		Proposal presentation	1 day	Wed 2/17/10	Wed 2/17/10		Vimaliz Montes[10%],Marinés Chaparro[10%],Michelle Al
46		Demonstration I - Design	5 days	Mon 3/8/10	Fri 3/12/10		Vimaliz Montes,Marinés Chaparro,Michelle Almodóvar
47		Progress report	1 day	Wed 3/24/10	Wed 3/24/10		Vimaliz Montes[50%],Michelle Almodóvar[10%],Marinés C
48		Demonstration II - Individual compor	3 days	Mon 4/12/10	Wed 4/14/10		Michelle Almodóvar,Marinés Chaparro,Vimaliz Montes
49		Demonstration III - Integration	3 days	Mon 5/3/10	Wed 5/5/10		Marinés Chaparro,Michelle Almodóvar,Vimaliz Montes
50		**⊟ Closing**	**5 days**	**Thu 5/6/10**	**Wed 5/12/10**		
51		Final report	2 days	Tue 5/11/10	Wed 5/12/10		Vimaliz Montes,Michelle Almodóvar,Marinés Chaparro
52		Final presentation	3 days	Thu 5/6/10	Mon 5/10/10		Marinés Chaparro,Michelle Almodóvar,Vimaliz Montes

Figure 6: Gantt chart

Managerial approach

Meetings and work hours:

The team will have meetings three times a week, and work hours every day, whenever possible. This meetings will be held every Monday, Wednesday and Friday at 3:00pm and have a duration of one hour. After the meeting the group will work on their assigned tasks from 4:00pm to 6:00pm. In addition, the group will also work on Tuesdays and Thursdays from 3:30pm to 6:30pm.

Team management:

The team will work on pairs, following an extreme programming methodology. This approach ensures that all work is immediately revised by a team member, besides avoiding the lost of knowledge since not one person will work alone and exclusively on one task. All of the project's major decisions will be put up to a vote, ensuring that the majority will agree to any decision.

Progress evaluation plan

A percentage method was developed to evaluate the status of each task. These metrics are as follows:

Case	Module	Test data	Steps	Expected Results

1	Temperature	Room temperature measure	*Design*, 20%
			- Sensor and amplifier schematic, 10%
			- Code flowchart, 10%
			Software, 30%
			- Write code to:
			  ○ Read data, 5%
			    • MCU will take a reading every 30 seconds
			  ○ Convert data, 10%
			    • Convert the analog signal to digital with MCU ADC port
			  ○ Analyze data, 15%
			    • Compare valid temperature measurement, complying with ±2˚C of accuracy; 10mv corresponds to 1˚C
			    • Send signal to alarm system device when measurement obtained is outside range (from 20˚C to 35˚C)
			Hardware, 20%
			- Temperature sensor installation, 10%
			- Amplifier installation, 10%
			Testing, 30%
			- Detailed division on table1
				Accurate measurement of room temperature

2	Humidity	Room humidity measure	*Design*, 20%
			- Sensor and amplifier schematic, 10%
			- Code flowchart, 10%
			Software, 30%
			- Write code to:
			  ○ Read data, 5%
			    • MCU will take a reading every 30 seconds
			  ○ Convert data, 10%
			    • Convert the analog signal to digital with MCU ADC port
			  ○ Analyze data, 15%
			    • Compare valid humidity percentage, complying with ± 3% of accuracy
			    • Send signal to alarm system device when measurement obtained is outside range (from 40% to 70%)
			Hardware, 20%
			○ Humidity sensor installation
			○ Amplifier installation
			Testing, 30%
			○ Detailed division on table1
				Accurate measurement of room humidity

3	Sound/ Microphone	Baby's cry detection	*Design*, 25%
			- Sensor and filter schematic, 15%
			- Code flowchart, 10%
			Software, 25%
			- Write code to:
			  o Read data, 5%
			    • MCU will take a reading every 5 seconds
			  o Convert data, 10%
			    • Filter sound
			    • Convert to digital
			  o Analyze data, 10%
			    • Verify if it is a valid baby's cry frequency
			    • If it is send signal to alarm system device and to the soothe system
			    • Sound sensor error margin fluctuates between ± 5%
			Hardware, 20%
			  o Microphone installation, 10%
			  o Filter installation, 10%
			Testing, 30%
			- Detailed division on table1
				Baby's cry is detected and alert signal is send to remote device

4	LCD, SD card and RTC	Main menu, activities options and registry	*Design*, 20%
			- Components schematic, 10%
			- Code flowchart, 10%
			Software, 35%
			- Write code to:
			  o Initialization, 3%
			    • Set time
			  o Display main menu, 12%
			    • Read and display keywords
			    • Display humidity
			    • Display temperature
			  o Display activities menu, 10%
			    • Read and display keywords
			    • Write the time when the activity was selected on SD card
			  o Display registry, 10%
			    • Read log from SD card
			    • Display log on LCD
			Hardware, 15%
			- LCD installation, 8%
			- SD card installation, 4%
			- RTC installation, 3%
			Testing, 30%
			- Detailed division on table1
				Temperature and humidity is display on main menu; main options are display; time is stored on SD card file when an activity is selected; log is display in main console

5	Zigbee	Zigbee communication	*Design*, 20%
			- XBee® schematic, 10%
			- Code flowchart, 10%
			Software, 30%
			- Write code to:
			  o Establish connection between them, 15%
			  o Send signal to turn on the alarm system components, 15%
			Hardware, 20%
			- XBee installation on main console, 10%
			- XBee installation on remote device, 10%
			Testing, 30%
			- Detailed division on table1
				Send signal with main console's XBee unit and receive the signal with remote device's XBee unit

6	Baby position detector	Baby position detection	*Design*, 20%
			- Schematic, 8%
			- Code flowchart, 12%
			Software, 25%
			- Write code to:
			  o RFID tag programming and detection, 20%
			  o Send alarm signal to remote device, 5%
				Detects when the baby turns on his stomach

			Hardware, 25% ◆ RFID readers installation, 5% ◆ RFID tag installation, 5% ◆ RFID tag enclosure, 7.5% ◆ RFID readers enclosure, 7.5% *Testing*, 30% ◆ Detailed division on table1	
7	Alarm system	Alarm system	*Design*, 20% ◆ Components schematic, 10% ◆ Code flowchart, 10% *Software*, 25% ◆ Write code to: ○ LED, 9% • Turns on/off ○ Buzzer, 8% • Turns on/off ○ Vibration motor, 8% • Turns on/off *Hardware* 25% ◆ LED installation, 9% ◆ Buzzer installation, 8% ◆ Vibration motor installation, 8% *Testing*, 30% ◆ Detailed division on table1	Turns on/off the components when signal from MCU is received
8	Soothing system	Soothing system	*Design*, 20% ◆ Schematic, 10% ◆ Code flowchart, 10% *Software*, 20% ◆ Write code to: ○ Turn on/off LED, 10% ○ Turn on/off sound player, 10% *Hardware*, 30% ◆ LEDs installation, 10% ◆ Sound player installation, 10% ◆ LEDs enclosure, 10% *Testing*, 30% ◆ Detailed division on table1	Turns on/off components when signal from MCU is received

Table 3: Metrics

Risk plan

No.	Risk	Probability	Impact	Priority	Mitigation Plan
1	Changes in design due to clients requests and needs	High	High	1	Possible requested changes (a survey will be performed on Saturday, February 13, 2010 to a hearing impaired sector in Mayagüez, PR in order to collect data of their mayor necessities of this matter) • LCD display ○ Use of icons in the menu display instead of keywords • Alarm system ○ Use a color coded LED to indicate which alarm was triggered • Soothing system ○ Use colored LEDs instead of sounds
2	Integration Problems	High	High	1	• Maintain a backup of the last time the product worked correctly • Avoid the sub modules dependency, whenever possible • Test thoroughly each module • Maintain open communication with other developers and their design decisions
3	Errors with baby position detection: Tag is not detected	High	High	1	• Use other component with less chance to fail reading ○ Proximity sensor ▪ Place it on top of the crib ▪ Detect when the baby moved away from the center of the crib ○ Button activation ▪ Use a belt with a IR LED or sound button to detect when the baby turns on his abdomen

					○ Accelerometer ▪ Place it on top of the crib or inside the mattress ▪ It will detect the position of the infant at all times ▪ Combine the accelerometer with an specific sound which will be detected by the microphone, to determine the infant's position
4	Errors filtering sound	High	High	1	• Find a more accurate microphone • Use another appropriate filter • Get MCU with an integrated DSP • Diminish the frequency range
5	Problems reading SD card and displaying on LCD	High	High	1	• Problem displaying icons in menus ○ Draw icons one to one per address line ○ Use keywords instead of icons • If problem is with registry ○ Open one SD card file at a time, displaying more than one registry window (one for food, one for diaper change, etc) ○ Store data in a different format
6	Problems with the device's communication and timing	High	High	1	• Spend time in trainings and learning about timing or other necessary topics • Change internal clock if components clock frequency do not match or other problems arise • Verify and adjust components range; acquire a wider range XBee®
7	Budget issues	High	High	1	• Ask professors or students for spare components • Ask for sample pieces from different companies or professors • Get loans from family members, friends or agencies, if necessary
8	Supplies do not arrive in a timely manner	High	High	1	• Work on tasks that do not require the missing components • Ask professors or students for spare components • Buy component from another supplier with second day shipping
9	Damage or theft of components	High	High	1	• Have spares components, if possible • Ask professors or students for spare components • Buy lost components and work on tasks that are independent of it
10	Excess of work with other courses	High	Low	2	• Make Important phases as soon as possible • Make frequent meeting to discuss the progress of each member and determine if redistribution is required. • Redistribution workload to team members with less academic load
11	Requirements Change	Low	High	2	• Define a process to manage each change. • Divide the project in independent modules, in which one module does not affect the others • Redesign Gantt Chart and adjust timeline
12	Partial or total withdrawals from a team member	Low	High	2	• Assign two people to work together in the same task • Make rotations so everyone could have experience in every area • Maintain good communication with other team members • Redistribute tasks to the remaining team members
13	Lost of information	Low	High	2	• Use a repository to store and keep track of everyone's progress • Assign two people per tasks • Actualize the repository frequently
14	Strikes or university closed down because of power or water lost, among other causes	High	Low	2	• Reschedule task to work on the ones that do not require lab equipment • Try to contact advisors to get equipment loans and work from remote locations • Update Gantt Chart and reschedule to reflect the lost of workable days, if necessary
15	Sickness of one or more team members	High	Low	2	• Assign two people to work together in the same task • Use a repository to store and keep track of everyone's progress • Work remotely, if possible
16	Family emergency or personal situation	Low	High	2	• Assign two people to work together in the same task • Use a repository to store and keep track of everyone's progress • Redistribute tasks to compensate for the temporary loss of a team member

17	Adverse weather conditions or catastrophes	Low	High	2	• Work remotely, if possible • Work on tasks that do not require lab equipment • Try to contact advisors to get equipment loans and work from remote locations • Update Gantt Chart and reschedule to reflect the lost of workable days, if necessary
18	Problems temperature module	Low	High	2	• If the sensor model is not appropriate or does not work correctly ○ Change sensor model • If the amplifier model is not appropriate for the application or does not produce the expected result ○ Change amplifier model
19	Problems humidity module	Low	High	2	• If the sensor model is not appropriate or does not work correctly ○ Change sensor model • If the amplifier model is not appropriate for the application or does not produce the expected result (see testing table) • Change amplifier model
20	Unexpected travels of a team member	Low	Low	3	• Assign two people to work together in the same task • Use a repository to store and keep track of everyone's progress • Work remotely, if possible • Redistribute tasks to compensate for the temporary loss of a team member

Table 4: Risk plan

Budget

The cost of the Baby Care System prototype will be approximately of $360. This cost includes the R&D resources and budget of single components. If the system is produced a hundred times the cost per unit will be approximately of $316 (Please see Appendix III for calculations of mass production and personnel salary) [14].

Preliminary list of components:	**Unit Price**	**Quantity**	**Cost**
LM35 temperature sensor	$1.71	1	$1.71
ECM-60p microphone/sound sensor	$0.95	1	$0.95
HS1101 humidity sensor	$6.95	1	$6.95
UA78m33, 3.3V voltage regulator	$0.60	2	$1.20
UA7805, 5V voltage regulator	$0.80	2	$1.60
LCD touch screen display	$39.95	1	$39.95
Red LED	$0.35	1	$0.35
Power switch	$3.99	2	$7.98
Vibrator motor	$3.99	1	$3.99
XBee ®	$22.95	2	$45.90
XBee ® breakout board	$2.95	2	$5.90
MSP430, dsPIC30 or dsPIC33 Microcontrollers	$5.25	2	$10.50
SD card slot reader	$17.95	1	$17.95
SD card 2G	$14.99	1	$14.99
Buzzer	$5.10	1	$5.10
Sound player	$6.99	1	$6.99
RFID reader	$29.95	2	$59.90
RFID reader breakout	$0.95	2	$1.90
RFID tag	$1.95	1	$1.95
Batteries	$3.24	1	$3.24
Battery holder	$2.69	1	$2.69
Transistors amplifiers	$0.17	2	$0.34
Resistors	$0.25	3	$0.75
Capacitors	$0.45	4	$1.80

Diode	$2.79	2	$5.58
BQ4845 RTC	$6.25	1	$6.25
		Subtotal	$256.41
		Shipping	$62.64
		Personnel	$41.00
		Total	$360.05

Table 5: Product cost

Overhead

Hours per year	Weeks per year	Weeks per month	Hours per week	Hours per month	Hours per 5 months
2080	50	4.166666667	20	83.33333333	416.6666667

Hours spend in	per week	per month	per 5 months	per team	
Reunions	3	12	60	180	
Training	4	16	80	240	
Writing Reports	2	8	40	120	
Class Hours	5	20	100	300	
Workshops			7	21	
Presentations			3	9	
Oral Exams			3	9	
Buying Components/In road			12	12	
			Total	891	**Non billable hours**
				1250	**Billable hours**
			Overhead	71.28	%

Table 6: Overhead cost

Estimated project cost

Employees	Position	Annual Salary	Working hours per year	Salary per hour	Project hours	Payment per contract
Vimaliz Montes	Project Manager	42000	2000	21	434	9114
Michelle Almodóvar	Computer Engineer	40000	2000	20	434	8680
Marinés Chaparro	Computer Engineer	40000	2000	20	434	8680
					Employee Total Cost	26474
Hours per week	**Weeks per year**	**Hours per year**			**71.28% Overhead**	18870.6672
40	50	2000			**Project Total Cost**	45344.6672

Table 7: Project cost

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Appendix I

Client feedback

Client:

Yarett E. Piñeiro Rodríguez

Client Interview (*Translation*)

"The usage of images instead of words is a great idea and I am going to explain why. Deaf people are very visual. For some reason, some of them do not learn how to read, so they take actions based on pictures. That's their way of communication. A clear example of this is the sign language, which allows us to obtain a description of what we see. The color coded lights are a great idea, they will let the mother know what is happening with her baby and take appropriate actions."

(Are you worried about SIDS?)

"That's one of my biggest concerns, being unable to hear when the baby crying. I am worried of finding my son dead because of something that could be avoided if I had the ability of hearing him (the baby). I don't think that the fact that a person have deafness increments the possibility of death by SIDS. When a person is unable to hear they are more concerned with their baby than a person who has all their sensory faculties. I also understand that there is an almost magical communication between baby and mother and she will feel when the baby is at risk. Hearing-impaired mothers have this instinct more developed."

Appendix II

Biographies of Team Members

Vimaliz Montes Méndez

Vimaliz Montes Méndez was born in Manatí, Puerto Rico in March 12, 1985. She is a senior student at the University of Puerto Rico, Mayagüez Campus, currently pursuing a bachelor's degree in Computer Engineering, with emphasis in software. Her skills include knowledge in high level programming languages such as C#, C, Java, Visual Basic 6.0, VB Script, JavaScript, among others. She also has experience developing Graphical User Interfaces to be used at different levels of expertise by the client side. Moreover, she took a public speaking course which helped her to develop her soft skills.

Her experience includes a coop internship with Medtronic, Inc. in 2008, were she developed a software station for the production area, using C#, XML and the company's proprietary software. This software station included a GUI for the employees in the company. She has also worked in projects for the courses Operating Systems, Computer Architecture, Operating System and Network Administration and Security, and Analog Integrated Circuit Design. Furthermore, she has taken seminars on Project Management in views to take the CAPM (Certified Associate Project Manager) certification in the near future.

Michelle Almodóvar Vélez

Michelle Almodóvar Vélez was born in San Juan, Puerto Rico in September 7, 1986. She is a Computer Engineering bachelor's degree student. She took several courses such as Software Engineering, Analog Integrated Circuit Design, Programming Languages, Advance Programming, Microprocessors and Economical Analysis for Engineers. She has experience with programming languages such as C and Java. As part of some of these courses' projects, Michelle has acquired some experience with other languages and tools such as C#, Perl, Python, JavaScript and VBScript.

In 2008, she worked as a coop student at Hamilton Sundstrand Company at Santa Isabel, PR. She was in charge of a project related to finding improvements to certain manufacturing processes in the plant. As one of many solutions found to improve these processes, Almodóvar developed a Microsoft® Access database in order to make one of the processes electronic, reducing certain factors such as time and walking distance. Therefore, she had some experience with Visual Basic and SQL. Moreover, she worked as a web developer for the Dean's Office and the Governmental Ethic's Committee. At this job, Almodóvar acquired experience with html and flash. In her future plans she will complete a Master Degree in Industrial Engineering in order to complement her knowledge in the Computer Engineering area and process improvement.

Marinés Chaparro Acevedo

Marinés Chaparro Acevedo was born in Aguadilla, Puerto Rico in February 11, 1986. She is pursuing a bachelor's degree in Computer Engineering, with specialization in software, at the University of Puerto Rico in Mayagüez. Some relevant courses that she has taken include Software Engineering, Analog Integrated Circuit Design, Programming Languages, Advance Programming, besides participating in undergraduate researches. These courses helped her to develop her abilities as an engineer. Her major technical skills include: knowledge in high level programming languages such as Java and C#; scripting languages such as VBScript, Perl and JavaScript; as well as basic knowledge in circuit design and analysis.

Since the summer of 2007, she has been working with Travelers Insurance Company. Her main responsibilities and projects in the company were: streamline processes, using scripting and shell command languages, such as Bash; developing next year's budget and research about new Wireless-N technology. The gained experiences in this company and in the university helped her improve her research proficiency, herself learning ability, soft skills and many others. As part of her future vision, she wants to obtain a PhD to teach in the University of Puerto Rico.

Appendix III

Cost of manufacturing 100 systems:

Preliminary list of components:	Unit Price	Quantity	Cost	Unit Price in Bulk (min. 100)	Quantity	Cost
LM35 temperature sensor	$1.71	1	$1.71	$0.94	1	$0.94
ECM-60p microphone/sound sensor	$0.95	1	$0.95	$0.75	1	$0.75
HS1101 humidity sensor	$6.95	1	$6.95	$6.25	1	$6.25
UA78m33, 3.3V voltage regulator	$0.60	2	$1.20	$0.40	2	$0.80
UA7805, 5V voltage regulator	$0.80	2	$1.60	$0.54	2	$1.08
LCD touch screen display	$39.95	1	$39.95	$31.96	1	$31.96
Red LED	$0.35	1	$0.35	$0.28	1	$0.28
Power switch	$3.99	2	$7.98	$3.99	2	$7.98
Vibrator motor	$3.99	1	$3.99	$3.99	1	$3.99
XBee®	$22.95	2	$45.90	$18.36	2	$36.72
XBee® breakout board	$2.95	2	$5.90	$2.36	2	$4.72
MSP430, dsPIC30 or dsPIC33 Microcontrollers	$5.25	2	$10.50	$5.25	2	$10.50
SD card slot reader	$17.95	1	$17.95	$14.36	1	$14.36
SD card 2G	$14.99	1	$14.99	$14.99	1	$14.99
Buzzer	$5.10	1	$5.10	$5.10	1	$5.10
Sound player	$6.99	1	$6.99	$6.99	1	$6.99
RFID reader	$29.95	2	$59.90	$23.96	2	$47.92
RFID reader breakout	$0.95	2	$1.90	$0.76	2	$1.52
RFID tag	$1.95	1	$1.95	$1.56	1	$1.56
Batteries	$3.24	1	$3.24	$3.24	1	$3.24
Battery holder	$2.69	1	$2.69	$2.69	1	$2.69
Transistors amplifiers	$0.17	2	$0.34	$0.17	2	$0.34
Resistors	$0.25	3	$0.75	$0.25	3	$0.75
Capacitors	$0.45	4	$1.80	$0.45	4	$1.80
Diode	$2.79	2	$5.58	$2.79	2	$5.58

BQ4845 RTC	$6.25	1	$6.25	$4.63	1	$4.63
		Subtotal	$256.41		**Subtotal**	$212.81
		Shipping	$62.64		**Shipping**	$62.64
		Personnel	$41.00		**Personnel**	$41.00
		Total	$360.05		**Total**	$316.45

Personnel cost per hour:

Hours per week	Weeks per year	Hours per year
40	50	2000

Average Annual Salary	Hour per year	Cost per Hour
41000	2000	20.5

Assuming that one system can be assembled in 2 hours, then the personnel's cost will be: $41.00

Appendix IV

Similar products in the market related to baby care

Angelcare® Baby Monitor

- Features:
  - In Angelcare® the alarm system is sound based, while Baby Care System will use lights and vibration.
  - Movement detection(Angelcare®) vs. RFID Tags reader (Baby Care System)
  - Angelcare® constantly transmit the sounds in the room, Baby care will just alarm parents if the baby is crying or flip his position
  - Angelcare® displays room temperature, while Baby Care displays room's temperature and humidity

Major problems with other products and proposed solution of Baby Care System

Angelcare® Baby Monitor[15]	***Baby care system***
You may get false alarms if your baby is in a very deep sleep	Since Baby Care does not measure breathing or movement, a false alarm if the baby is sleeping deeply is less likely
Alarm will not sound if a device that can cause vibration (fan, music, motorcycles, among others) is present	Vibration will not be a problem in our system, since the alarm will be activatedwhen the RFID reader detect a tag (the baby is face down). People who live in a tropical place cannot let the babies without a fan.

Snuza™ Halo Baby Movement Monitor

- Features:
  - In Snuza the alarm system is sound based, while Baby Care System will use lights and vibration.
  - Battery operated
  - Movement(Snuza™) vs. RFID Tags reader
  - Snuza™ Halo is clipped on baby's diaper, while Baby Care System is on a separate piece of cloth
  - Baby Care displays room's temperature and humidity
  - Snuza™ Halo is more portable than Baby Care System

Major problems with other products and proposed solution of Baby Care System

Snuza™ Halo Baby Movement Sensor[16]	***Baby care system***
Loud alarm (greater than 85dB) is attached to baby's diaper	The alarm will be in a portable device that the parents will have. The alarm will have lights and a vibrating alert.
Complete device will be stick to baby's diaper with a clip (must be always in contact with baby's skin)	Baby care will provide an adjustable belt avoiding the direct contact with the baby's skin.

Whycry®

- Features:
  - In Whycry® the alarm is sound based, while Baby Care System uses lights and vibration
  - Displays room's temperature and humidity
  - Whycry® does not determine possible causes of SIDS

- Whycry® make conjectures of the possible reasons of why the baby is crying, while Baby Care notifies the parents if the baby is crying and let them see if the reason is a basic need.

Major problems with other products and proposed solution of Baby Care System

WhyCry® [17]	***Baby care system***
Does not detect SIDS and is not aimed to hearing impaired people	The main focus of Baby Care System is the minimization of deaths by SIDS on infants living with people with hearing disabilities
Guesses the reason of crying	Has a registry with information of basic needs that could be potential crying reasons.

Appendix V

Detail Gantt chart