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FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING AND INFORMATICS.

FINAL YEAR PROJECT REPORT

TITLE: DESIGN AND IMPLEMENTATION OF A SMART ASSISTANT BABY SITTER

BY

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A final year project Submitted to the Department of Computer Engineering in Partial Fulfillment of the Requirements for the Award of a Bachelor's Degree in Computer Engineering of Busitema University

September, 2023

DECLARATION

I **AHIMBISIBWE PATRICIA** BU/UG/2019/0111, hereby declare that this project report is my original work except where explicit citation has been made and has never been published and/or submitted for any other degree award to any other university or institution of higher learning for any academic award.

Sign: ....

Date: …………………………..

APPROVAL

The final year project under the title “DESIGN AND IMPLEMENTATION OF A SMART ASSISTANT BABY SITTER” has been done under my guidance and is now ready for examination.

Signature …………………………………………………...

Date ……………………………………………………………….

Dr. OCEN GILBERT

Department of Computer Engineering.

DEDICATION

I dedicate this report to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this project and on His wings only have I soared.

I also dedicate this report to my parents, Mr. John Beyongyera and Mrs. Hope Orishaba who have encouraged me all the way and whose encouragements have made sure that I give it all it takes to finish that which I have started. God bless you.

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I convey my sincere gratitude to my Supervisor, **Prof. Gilbert Ocen** and the Department of Computer Engineering for the guidance and insight into concepts of research and project management as well as technical knowledge applicable to the design of the system.

I am thankful to all my friends **Ssemambo Christopher, Faruku Toah, Kabanda Simon, Rosemary Nalwanga,** and **Ojok Rogers** who have been always helping and encouraging me throughout this project. I have no valuable words to express my thanks, but my heart is still full of the favours received from every person.

ABSTRACT

Today's lifestyle is fast paced, parents in the present world are very busy in their professional life, hence they don’t get sufficient time to take care of their new born babies. It is inconveniencing for parents to constantly watch over their new born babies while doing their work or chores, hence need of a system which helps parents to remotely monitor their babies.

In this project a smart assistant baby sitter is designed which will assist parents to remotely monitor the baby. In this system, the microphone module is to capture the baby cry sound, the temperature sensor is to detect and measure the baby’s coldness or hotness, moisture sensor is to determine the moisture condition, that is urine detection and MP3 player for playing for the baby soothing sound when it cries.

The system can send sms notification to the parent/baby’s care taker’s device when; baby cries, baby’s diapers are wet, and baby’s temperature is abnormal.

LIST OF ACRONYMS

GSM	Global System for Mobile communications
SIM	Subscriber Identity Module
ECG	Electro-cardiogram
LCD	Liquid Crystal Display

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CHAPTER ONE: INTRODUCTION

1.1 Background

Infant crying is a critical evolutionary signal that allows infants to communicate hunger, discomfort and pain. Crying is also a known stressor that can decrease caregiving quality and increase risks for infant development and caregiver mental health[1].

Crying is the most salient vocal signal of distress. The cries of a newborn infant alert adult listeners and often elicit caregiving behavior. For the parent, rapid responding to an infant in distress is an adaptive behavior, functioning to ensure offspring survival.

Crying, at least in early life, is thought to be largely reflexive, often occurring in response to pain, hunger, or separation from a caregiver. Much like the solicitation signals of other species, an infant's distress cry ultimately serves to promote proximity between infant and caregiver.

The sound of a human infant cry is characterized by a high and highly variable pitch, an overall “falling” or “rising–falling” melody, typically with some degree of tremor (or “vibrato”), and often includes abrupt changes in harmonic structure[2].

These acoustic features are thought to be largely attributable to infants' short vocal chords and limited muscular control over the vocal tract

Observational studies have shown that across cultures, infant crying provokes selective orienting of attention toward the infant and a desire to intervene, typically to provide care[3].

Adults often report the sound of a crying infant as annoying, distressing, aversive, and likely to promote a desire to perform a caregiving response.

There is evidence suggesting that hearing infant cries can initiate a broad range of physiological reactions in adult listeners[4].

Parental responses to infant cries in particular have received much attention as a foundation of attachment relationships[5].

Newly born infants have distinctive skin structure, physiology so that the skin easily breaks, hence skin cleansing is essential to maintain good skin integrity of the newborn.

Pamper diapers have been popular with parents for a past few decades for protecting babies/children from urine when they urinate. Parents/caretakers of babies will surely use pamper on them.[6]

Babies have sensitive and soft skin, so that in wet conditions and in contact with harsh diaper material will be able to cause baby’s skin wounds and irritation**.**

All these harsh chemicals will easily damage the sensitive skin of the baby, so that it will experience allergies.[6]

1.2 Problem Statement

Today's lifestyle is fast paced, parents in the present world are very busy in their professional life, hence they don’t get sufficient time to take care of their new born babies. It is inconveniencing for parents to constantly watch over their new born babies while doing their work or chores, hence need of a system which helps parents to remotely monitor their babies.

Thus there was a need to design a smart assistant baby sitter which will assist parents to remotely monitor the baby.

1.3 Objectives

Main objective

To design and implement a smart assistant baby sitter.

Specific objectives

To review literature related to the existing assistant babysitter systems.

To identify and analyze the requirements for designing and developing the system.

To develop the prototype for the proposed system.

To test and validate the system.

1.4 Significance

1.4.1 Value proposition

The system helps parents to monitor their baby remotely as they do other home activities.

1.4.2 Impact

The system helps parents save time, as they can monitor the baby while doing other house chores.

1.5 Scope

1.5.1 Geographical scope

The system is to be used in homes with young babies.

The parent or baby care taker can receive a notification about the baby’s state.

1.5.2 Technical scope

The system can help a parent or baby’s care taker to monitor the baby along side other home chores, by sending sms notification to the parent’s device, that is about the state of the baby. It can also play soothing sound(baby music) for the baby when it cries.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter summarizes the literature relating to baby monitoring systems.

The main purpose is to gain knowledge and ideas based on the previous establishments and get to know about their strengths and weaknesses to further improve and upgrade the integration. It particularly focuses on the design of a baby monitoring system.

2.2 Related Systems

1. Sensory baby vest

The sensory baby vest includes fully integrated sensors for the parameters respiration, heart rate, temperature and humidity, eg. By sweating for the continuous monitoring of infants under home conditions. It allows the early alert for potential life-threatening events as well as the recognition of the development or progression of diseases at an early stage. Health protection or even life -saving will be enabled in time. A variety of principles for the measurement of the parameters is assessed for the integration into the garment . The garment is produced by weaving, knitting, sewing, printing and coating technologies common in textile and clothing industry[7].

2. Wireless-crib monitor

This involves a wireless technology-based sensor that detects the up-and-down movements of the baby's chest while sleeping. Wireless-crib monitor uses Breath-optics technology to focus on the respiratory system of the body and accordingly sends alerts[8]. If the infant stops breathing or gulps for air, the device emits a warning signal, notifying the parents that something is wrong.

3. The smart jacket technology

In the smart jacket project, a comfortable wearable monitor system for prematurely born babies is designed, which can be worn inside the incubator, as well as outside the incubator, while in the parent's arms (Kangaroo mother care). Survival rates for prematurely born babies have increased in the last decades due to improved neonatal care. The smart jacket aims for providing reliable health monitoring as well as comfortable clinical environment for neonatal care and parent-child interaction. The jacket is expandable with new wearable technologies and has aesthetics that appeal to parents and medical staff. An iterative design process in close contact with the users and experts lead to a balanced integration of technology, user focus and aesthetics. When critically ill or premature neonates are admitted to the NICU they are monitored and treated in an incubator. These neonates are extremely tiny and vulnerable. Round-the -clock health monitoring is crucial for early detection of medical problems (eg. Apnea, arrhythmias and hypoxema) and potential complications (eg. convulsions). The monitored vital signs include body temperature, electro-cardiogram (ECG), respiration and the degree of blood oxygen saturation(S02)[9].

4. Microcontroller based baby incubator using sensors

The system consists of temperature sensor, humidity sensor and respiration sensor. Temperature sensor is sensing the data from the incubator. Humidity sensor is sensing the data from the incubator. Respiration sensor is sensing data from the baby. The single chip microcontroller reads and frames the surrounding temperature, humidity, respiration along with the sensor. All the values are displayed on the LCD. The single chip microcontroller can analyze all the three sensor data and an alert sent to parents automatically in case of any variations[10].

5. Health Gear

Health Gear is a real-time wearable system for monitoring, visualizing and analyzing physiological signals. Health Gear consists of a set of non-invasive physiological sensors wirelessly connected via Bluetooth to a cell phone which stores, transmits and analyses t physiological data, and presents it to the user in an intelligible way. Health Gear uses a blood oximeter to monitor the user’s blood oxygen level and pulse while sleeping. One exemplary applications of Health Gear is for monitoring users in their sleep in order to detect sleep opnea events[11].

6. E-baby cradle

Goyal and Kumar [12] designed a low-cost e-baby cradle that is capable to swing only when a baby cry is detected. The user can change the speed of the swinging cradle. It also has a buzzer alarm that alerts the user that the baby's mattress is wet and when the baby's cry is detected for a certain time. A GSM network-based smart system was suggested in [13].

2.2.1 Existing system Comparison table

Identified system	**System strengths**	**System drawbacks**
Sensory baby vest[7]	It allows the early alert for potential life-threatening events.	It involves a cable connector which may cause discomfort to the baby.
Wireless crib monitor[8]	It monitors respiratory rate and notifies the parents in case the infant stops breathing or gulps for air.	Focuses on respiratory system of the body.
The smart jacket technology[9]	It monitors the vital parameter that is temperature, heartbeat rate and respiratory rate.	Limited for clinical usages therefore there is no remote monitoring.
Microcontroller based baby incubator using sensors[10]	It monitors pressure as well as controlling humidity	Limited to hospitals It majorly focusses on monitoring temperature.

Health Gear[11]	Used to monitor the user's blood oxygen level and pulse while sleeping	Limited to the Bluetooth range to get information There is no remote monitoring
E-baby cradle[12]	It is capable of swinging the cradle automatically when the baby cries. The user can change the speed of the swinging cradle	The system can't be controlled remotely as GSM network is not involved.

Figure 1 Showing Existing systems Comparison Table

2.3 System

The idea behind this project is to monitor baby remotely by parent or care giver. The microphone module is to capture the baby cry sound, the temperature sensor is to detect and measure the baby's coldness or hotness, moisture sensor is to determine the moisture condition, that is urine detection and MP3 player for playing for the baby soothing sound when it cries.

The system can send sms notification to the parent/baby's care taker's device when; baby cries, baby's diapers are wet, and baby's temperature is abnormal.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter focuses on the various approaches and methods used to achieve the specific objectives of the above system.

3.2 Requirements Elicitation

This process determines what the system needs to achieve and what needs to be created to make that happen.

Data collection involved gathering information about the system and the existing related systems and understanding the infants and system requirements from the gathered information. Different research mechanisms are utilized to collect the data necessary to accomplish the system as well as realize the above-stated objectives, some of the methods include;

3.2.1 Literature Review

This included reading journals, scientific books and magazines mainly from the internet and also from other research sites such as Google Scholars, Research Gate and many others. The data obtained from gathering and reviewing literature aided in identifying the requirements of the system.

3.2.2 Interviews

Since the system directly impacts parents, a number of them were approached and asked about what they think about the proposed system. Many of them gave positive feedback and some of their expectations as one of the main users of the system.

3.2.3 Consultations

Consultations were made to acquire and seek more knowledge from experienced people and experts in this field. Some of these consultants included Lecturers, parents, house maids and fellow students with knowledge in their respective fields.

3.3 System Design

The system consists of the following components; power supply, microphone module, temperature sensor, moisture sensor, MP3 player, GSM module and an arduino microcontroller which are connected to create the system's design as shown below.

Bock Diagram

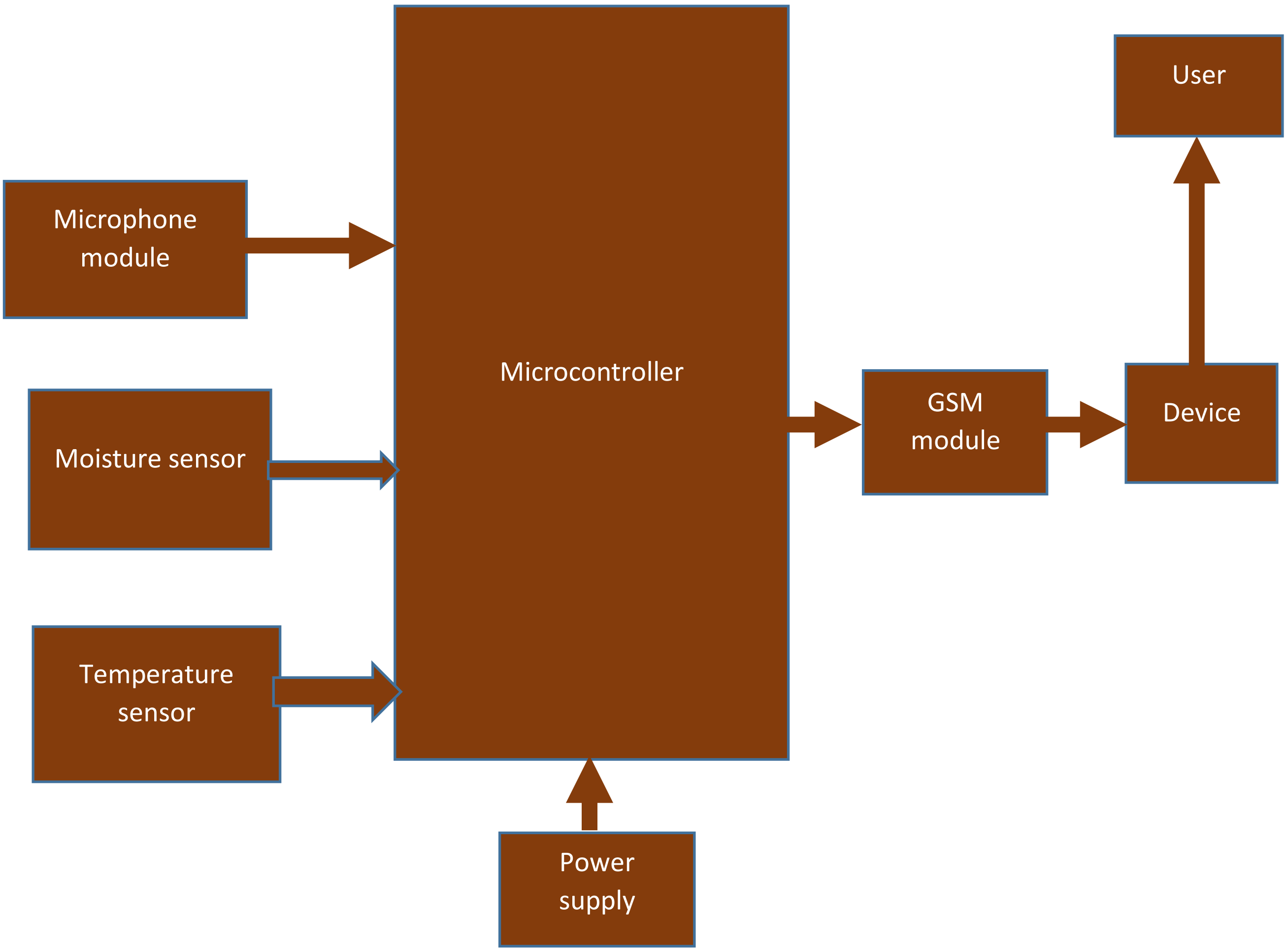

Figure 2 Showing System Block diagram

3.3.1 Description of the components.

1. Arduino Nano Microcontroller; It is used as a microcontroller of the system to receive inputs and correspondingly control the outputs. It sends control signals to other modules such as the GSM.

2. Microphone Module; It used for detecting the baby cry sound.

3. SIM900GSM module; Used for sending messages to mobile phone of the user.

4. Temperature sensor; It used for detecting and measuring hotness and coolness of the infant.

5. Moisture Detection sensor; Used to determine the moisture condition, that is urine detection.

6. MP3 player; Used for playing audio files (that is, soothing baby music) stored on a microSD card.

3.3.2 Software Tools.

1. Proteus simulation software for system simulation and analysis.
2. Arduino IDE for writing code that will run on the microcontroller.
3. Microsoft Visio for construction of system design diagrams.

CHAPTER FOUR: SYSTEM ANALYSIS AND DESIGN

4.1 Introduction.

This chapter describes the functional analysis, requirement analysis and system design aimed to achieve the main objective of this project. It also shows the interfaces which are used to operate the project.

4.2 Functional Analysis.

The system has undergone analysis and verification to ensure its functionality. It is capable of sending SMS alerts to parents or caregivers when the baby cries, while simultaneously playing a soothing sound for the baby. Additionally, the system can send an SMS alert in the event of wet diapers or an abnormal baby temperature.

4.3 Requirements Analysis.

Requirements analysis is the method used to determine the needs and expectations of a new or modified product. The requirements were categorized into functional and non-functional requirements.

4.3.1 Functional Requirements.

These describe product features or functions that must be implemented in the system to enable users to accomplish their tasks. Generally, functional requirements describe system behavior under specific conditions.

Functional aspects of this project include the following;

1. The system utilizes SMS as a means of communication with parents or caregivers.
2. The system's ability to promptly send SMS alerts ensures that parents or caregivers are informed in real-time, enabling them to provide timely care and attention to the baby.
3. The system is capable of managing multiple alerts concurrently. That is, it can send both a cry alert and a wet diaper alert simultaneously, allowing parents or caregivers to address multiple needs at once.
4. Simultaneously with the SMS alert, the system plays a soothing sound for the baby.
5. By providing alerts and soothing sounds, the system assists caregivers in promptly addressing the baby's needs and maintaining a conducive environment for the baby's well-being.

4.3.2 Non-Functional Requirements

Non-functional requirements describe the system’s operational capabilities and constraints and attempt to its functionality.

The non-functional requirements include:

1. System reliability; the system is reliable and works efficiently.
2. Usability; The system is easy to use.
3. Convenient; the system does not require much learning time to be used.
4. Extensibility; it is easy to add new features to the system or modify its functionality.
5. System availability; the system can run and is always on 24/7.

4.4 System Design

4.4.1 Logical Design

Logical design pertains to an abstract representation of the data flow, inputs, and outputs of the system. It describes the inputs (sources), outputs (destinations), data processing units (decision-making), and procedures (data flows) all in a format that meets the system user requirements.

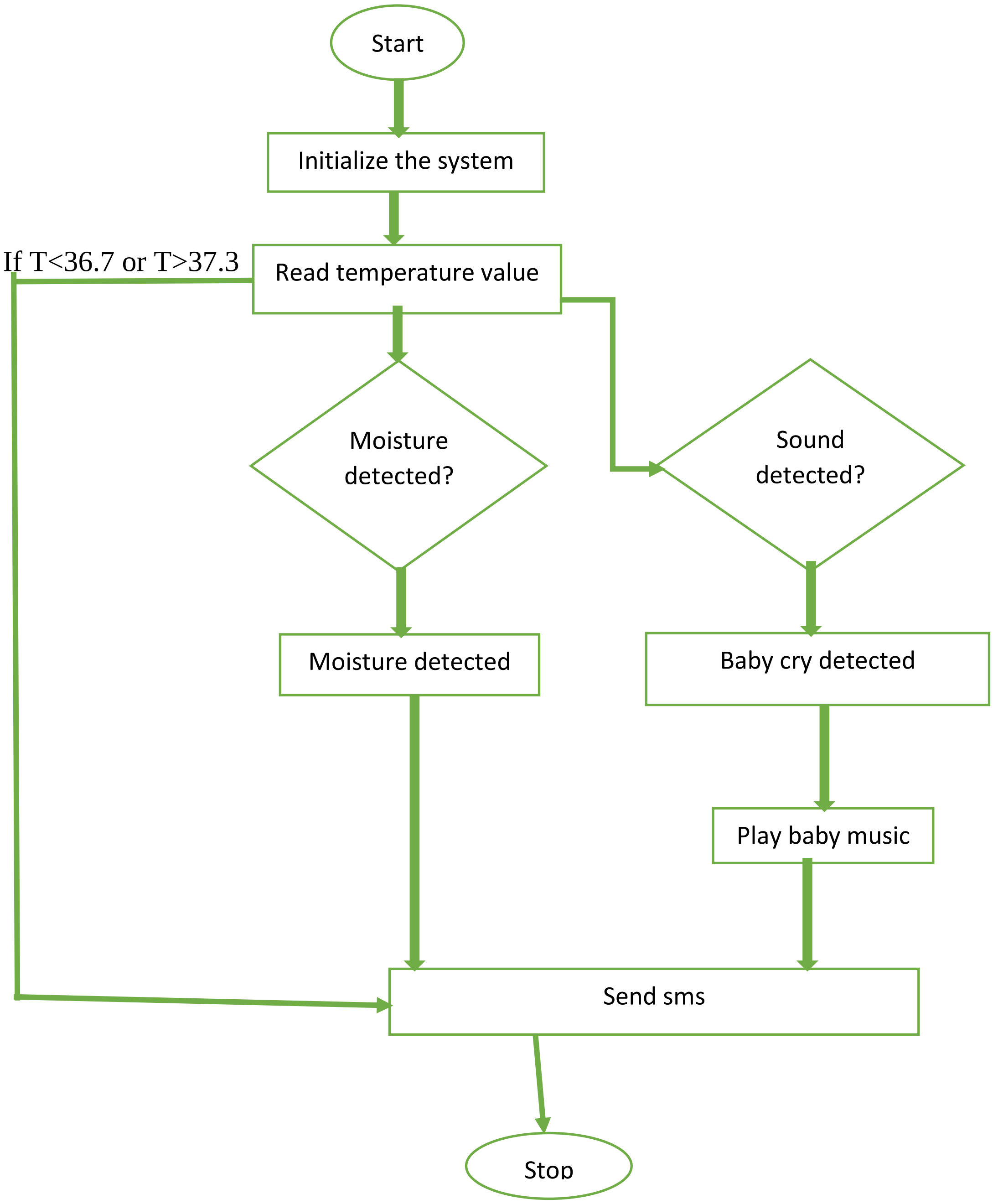

Figure 3 Logic diagram

4.4.2 Physical Design

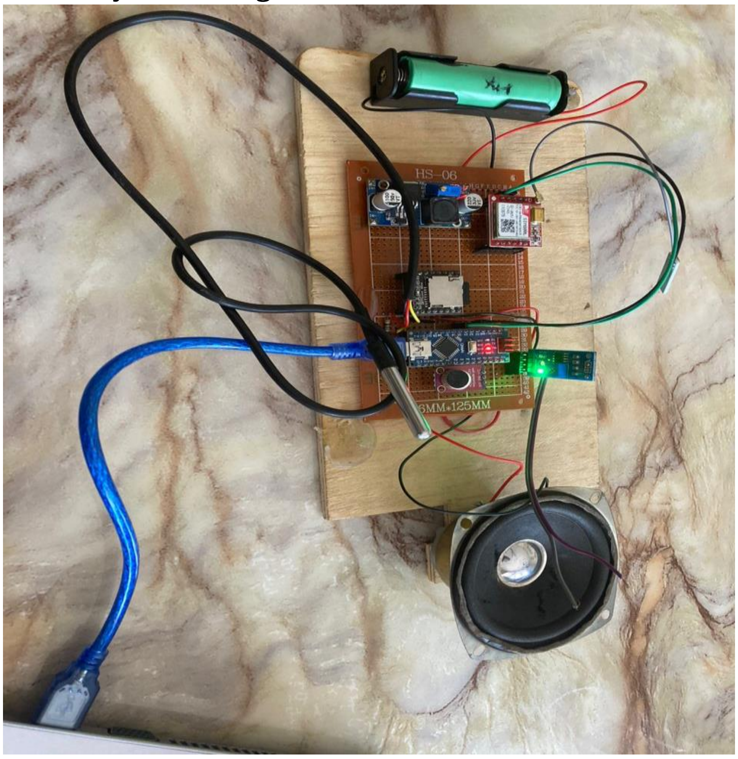

Figure 4 Physical Diagram

CHAPTER FIVE: IMPLEMENTATION AND TESTING

5.1 Introduction

This chapter describes the development of the design and results of the system. The development was a series of steps that included the; development platforms, code designs, system testing, verification and validation.

5.2 Development platforms

5.2.1 Arduino

Arduino is an open-source platform that uses hardware and software. Arduino consists of both a physical programmable circuit board (a microcontroller) and a piece of software, IDE (Integrated Development Environment) that runs on a computer, these were used to write and upload hardware code to the microcontroller through the Arduino UNO physical board.

5.2.2 Proteus Design Suite

Proteus design suite is a simulation and design software use for lab center Electronic for electrical and electronic design circuits. Proteus is the best simulation software for various with microcontroller. It is mainly common software because of availability of almost all microcontrollers in it. It was used for simulation of the designs of the system.

5.3 Code Designs

The system and program were written in the Arduino Platform. The design codes are attached in the Appendix.

5.4 Testing

The different components of the system were against the requirements and then integrated to make sure that they achieve the goal of the system. It was done at the unit level and integrated level.

5.4.1 Unit Testing

This involved testing individual components to determine whether they are fit for use.

5.4.2 Integration Testing.

Different parts of the system and code were brought together to analyze how well they work once they are integrated. This helped to know whether the combined units of the system work.

5.4.3 System Testing.

This was carried out to ensure that the system is in line with the specified requirements. It took place on the overall integrated system.

5.4.4 System Verification

This involved examining all predetermined system specifications such as documents, code, design and program to ensure that the system is meeting the specified functional and nonfunctional requirements. System verification was done at every stage of development before any feature is implemented.

5.4.5 System Validation

System validation occurred after the system has been completely built. Its main intent was to ensure that the modules of the system are performing to yield the desired and expected goals.

CHAPTER SIX: DISCUSSIONS AND RECOMMENDATIONS

6.1 Introduction.

This chapter describes the summary of work done, critical analysis /appraisal of the work, recommendations for future work and conclusion.

6.2 Summary of work done.

The main objective of this project was to design and implement a system that helps parents to monitor the baby remotely alongside other home activities.

6.3 Critical Analysis / Appraisal of the work.

The smart assistant baby sitter was successfully designed as it was stated in the main objective.

I did face some challenges such as limited funds, high transport costs, expertise and a shortage of components on market.

My objectives were successful and I hope the system will help parents in homes to remotely monitor their babies alongside other home chores.

6.4 Recommendations.

I recommend future improvements on the system by any researcher but keeping in mind the core and major objectives and aims of what the system was developed for.

The following are the future recommendations and proposals for this research to be a perfect success.

1. Adding some additional features like camera monitoring for the parent to watch the baby remotely using an application on their phones.
2. Using Microprocessor as a controller for the system, since it has some components built in it already, this helps reduce on the bulkiness of the system.
3. Use of Artificial intelligence technology, to help successfully differentiate the baby cry sound from other types of sounds, and also different the types of baby cry.

6.5 Conclusion.

There are many smart assistant baby sitter systems developed on different platforms. These systems require either complex hardware or software applications to monitor the baby. Many of them are costly and time-consuming.

Moreover, these systems need adequate prior knowledge to operate those complex systems. So, in this work, an attempt has been made to implement a system which is economical and easily accessible.

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APPENDICES
Appendix A

```
#include <SoftwareSerial.h>



//Create software serial object to communicate with SIM800L

SoftwareSerial mySerial1(3, 2); //SIM800L Tx & Rx is connected to Arduino #3 & #2

 //<<<<<<<<<<<<<<<<<<<<<<<<<<<

 #include <OneWire.h>

#include <DallasTemperature.h>



// Data wire is plugged into digital pin 2 on the Arduino

#define ONE_WIRE_BUS 12



// Setup a oneWire instance to communicate with any OneWire device

OneWire oneWire(ONE_WIRE_BUS);



// Pass oneWire reference to DallasTemperature library

DallasTemperature sensors(&oneWire);
```

```
int deviceCount = 0;

float tempC;

//>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

#include "SoftwareSerial.h"

SoftwareSerial mySerial(10, 11);

# define Start_Byte 0x7E

# define Version_Byte 0xFF

# define Command_Length 0x06

# define End_Byte 0xEF

# define Acknowledge 0x00 //Returns info with command 0x41 [0x01: info, 0x00: no info]

# define ACTIVATED LOW


boolean isPlaying = false;

void setup () {

 sensors.begin();  // Start up the library

  Serial.begin(9600);

    //Begin serial communication with Arduino and SIM800L

  mySerial1.begin(9600);


  Serial.println("Initializing...");
```

```
  // locate devices on the bus

  Serial.print("Locating devices...");

  Serial.print("Found ");

  deviceCount = sensors.getDeviceCount();

  Serial.print(deviceCount, DEC);

  Serial.println(" devices.");

  Serial.println("");

//>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
>>

mySerial.begin (9600);

delay(1000);


isPlaying = true;

}

void loop () {

  //sms();

  int mo= analogRead(A2);

  int so= analogRead(A0);

  Serial.print("Moisture: ");

  Serial.println(mo);
```

```
  Serial.print("Sound: ");
 Serial.println(so);


 temp();
 if(mo==0)
 {
  sms();
//play();
//playFirst();
 }
 if(tempC>30){
  smst();


  }
  if(so>517){
    smsC();
  play();
  playFirst();
  delay(5000);
    }
```

```
  else{
    Serial.print("--------------------------");
    pause();
    //delay(5000);


    }


}
void smsC()
{
    mySerial1.println("AT"); //Once the handshake test is successful, it will back to OK
  updateSerial();


  mySerial1.println("AT+CMGF=1"); // Configuring TEXT mode
  updateSerial();
 mySerial1.println("AT+CMGS=\"+256785075679\"");//change ZZ with country code and xxxxxxxxxxx with phone number to sms
  updateSerial();
  Serial.println("........................sms.............");
  mySerial1.print("CRING----------------------"); //text content
  updateSerial();
```

```
  mySerial1.write(26);

}

void smst()

{

    mySerial1.println("AT"); //Once the handshake test is successful, it will back to OK

  updateSerial();

  mySerial1.println("AT+CMGF=1"); // Configuring TEXT mode

  updateSerial();

 mySerial1.println("AT+CMGS=\"+256785075679\"");//change ZZ with country code and xxxxxxxxxxx with phone number to sms

  updateSerial();

  Serial.println("........................sms.............");

  mySerial1.print("Temperature is abnormal"); //text content

  updateSerial();

  mySerial1.write(26);

}
```

```
void sms()

{

   mySerial1.println("AT"); //Once the handshake test is successful, it will back to OK

  updateSerial();



  mySerial1.println("AT+CMGF=1"); // Configuring TEXT mode

  updateSerial();

 mySerial1.println("AT+CMGS=\"+256785075679\"");//change ZZ with country code and xxxxxxxxxxx with phone number to sms

  updateSerial();

  Serial.println("........................sms.............");

  mySerial1.print("Baby needs urgent attention"); //text content

  updateSerial();

  mySerial1.write(26);

}

void updateSerial()

{

  delay(500);

  while (Serial.available())

  {

    mySerial1.write(Serial.read());//Forward what Serial received to Software Serial Port
```

```
  }
  while(mySerial1.available())
  {
    Serial.write(mySerial1.read());//Forward what Software Serial received to Serial Port
  }
}
void temp()
{
  // Send command to all the sensors for temperature conversion
  sensors.requestTemperatures();

  // Display temperature from each sensor
  for (int i = 0;  i < deviceCount;  i++)
  {
    Serial.print("Sensor ");
    Serial.print(i+1);
    Serial.print(" : ");
    tempC = sensors.getTempCByIndex(i);
    Serial.print(tempC);
    Serial.print((char)176);//shows degrees character
```

```
    Serial.print("C  |  ");
    Serial.print(DallasTemperature::toFahrenheit(tempC));
    Serial.print((char)176);//shows degrees character
    Serial.println("F");
  }

  Serial.println("");
  delay(1000);
}
void playFirst()
{
execute_CMD(0x3F, 0, 0);
delay(500);
setVolume(20);
delay(500);
execute_CMD(0x11,0,1);
delay(500);
}
void pause()
{
```

```
execute_CMD(0x0E,0,0);

delay(500);

}

void play()

{

execute_CMD(0x0D,0,1);

delay(500);

}

void playNext()

{

execute_CMD(0x01,0,1);

delay(500);

}

void playPrevious()

{

execute_CMD(0x02,0,1);

delay(500);

}

void setVolume(int volume)

{
```

```
execute_CMD(0x06, 0, volume); // Set the volume (0x00~0x30)

delay(2000);

}

void execute_CMD(byte CMD, byte Par1, byte Par2)

// Excecute the command and parameters

{

// Calculate the checksum (2 bytes)

word checksum = -(Version_Byte + Command_Length + CMD + Acknowledge + Par1 + Par2);

// Build the command line

byte Command_line[10] = { Start_Byte, Version_Byte, Command_Length, CMD, Acknowledge,

Par1, Par2, highByte(checksum), lowByte(checksum), End_Byte};

//Send the command line to the module

for (byte k=0; k<10; k++)

{

mySerial.write( Command_line[k]);

}

}
```

Appendix B