**CONSTRUCTION OF A BABY MONITOR FOR A DEAF MOTHER**

**Chapter One**

**1.0 Introduction**

**1.1 Background**

Technology advancement has covered an impressive milestone over the years. The most notable developments are those that have contributed to people’s relationship with society and their environments (Fullerton,2019). Such developments are key, especially to physically challenged individuals. One of the most common types of disability is deafness. About 5% of the world’s population are deaf, which accounts for three hundred and ninety million people of the entire world’s population ((Fullerton,2019). Out of this 5%, those found in sub-Saharan Africa find it difficult to interact in society and have independent lives. It is often difficult for a deaf parent to relate to their babies without getting most of their help from other people. Newborn babies cannot walk or call out to their parents; therefore, they often rely on their cries to get their parent’s attention. If the deaf parents are poor, they cannot afford the very few and expensive options on the market. Finding a cheap option has been the challenge for many years now. Only very few researches exist in this area. Hence, this project seeks to research and develop a cheap solution to this problem. This device will bridge the gap of emotional trauma that hearing babies and deaf parents face in the first few years of the baby’s life. This system will enable the parents to attend to their babies with little help from other people, thereby giving them control over their baby. (Vaughn, 2019)

**1.2 Problem Definition**

This project focuses on developing a device that helps poor deaf parents recognize that their baby is crying. This development will be beneficial, especially when the parents are not close to their baby or the parent(s) are sleeping. This device will serve to strengthen the bond between a deaf parent and their baby by giving the parents a sense of independence. With this device, the parents will be able to take care of their babies with little help from other people, such as family members and friends. (Singer,2018)

Surveys show that physically challenged deaf parents, feel the most helpless when they cannot take care of their babies without help from friends (Liow, 2019). A device that bridges this gap will strengthen the bond between the parents and their babies. Certain ailments that would have otherwise occurred because the baby cries too much could be avoided. The babies will spend less time crying because their parents can find out easily. Hence, there is a great need to embark on this project.

**1.3 Aim and Project Objectives**

The aim of this project is to construct a baby monitor for a deaf mother. The following are the objectives of the project;

* A cheap and portable baby monitor for an average income deaf parent(s).
* A baby monitor that works over a minimum distance of 50m.
* A baby monitor with very low power consumption.
* A baby monitor that is easy to use.

So the final product must satisfy all the following:

* The device should be light enough to be worn by a baby of 3 months to 3 years old.
* The device should last a year without changing the battery.
* The device should operate for at least 50m.

**1.4 The Motivation for the Baby Monitor Project**

Living in one of the most underdeveloped parts of the world has many limitations and complications, even for a person with no physical challenge. Thinking of the social, economic, and emotional issues poor deaf parents faces in countries like Ghana, it seems almost impossible to believe. Meanwhile, this problem could be solved using electrical and electronic engineering. 3

**1.5 Scope of work**

This project is limited to the construction of a crying baby detector using a microphone, amplifier and LEDs only.

**CHAPTER TWO**

**2.0 Literature Review**

This chapter presents the different work on same or similar topic by other authors in the past, it also gives the theoretical framework for the topic with a view to determining the necessity or importance for this work, it also brings out the importance of the work together with the unique difference between this work and those by other authors.

**2.1 Related Work**

Families of deaf parents and hearing children are not exceptional. It is estimated that 6 people out of 1,000 are not able to hear speech unaided, and the prevalence rate could rise to 86 per 1,000 persons if including those with some degree of hearing loss (Haruna, 2019). Endogamous marriage rate of deaf people is very high; approximately 85-95% of deaf adults marry each other (John, 2019). Over 90% of deaf couples give birth to normally hearing babies (Hussa, 2020). Mismatched hearing status is in fact a normative pattern for a family formed by deaf adults and their children. Meadow-Orlans’ study showed that mismatched hearing status casts negative impact on building parent-infant relationship (Pulse, 2019). The quality of interactions between a deaf mother and a hearing infant was rated significantly lower than dyads of both parties are hearing or even both are deaf.

Deaf parents may not be confident of their childrearing abilities, nor gain as much social support as special services or programs targeting at deaf children (Pulse, 2019). Some deaf parents even give up their parental rights, as they “felt that their disability would place their children at a disadvantage in society if they raised the kids themselves” (Liow, 2019). We realized that designers could do much more for the deaf than simply compensate their hearing impairment.

Research has shown that the development of the bond between parents and their children is dependent on the parent’s ability to be responsive and sensitive to their child’s physical and emotional needs (Liow, 2019). This project explores a different approach to solving the problem of deaf parents being unable to know when their baby is crying. The implementation of this project makes use of the rate at which the heartbeat of the baby changes from a rest state to a crying state. The very few competitions out there make use of the voice of the child as an input. As stated earlier, this project will use the beat per minute (BPM) of babies between the ages of three months to thirty-six-months and use their crying range as an input to the system. Studies showed that the heart rate of an infant increases considerably from pre-crying and peak at crying. As indicated in Table 2.1, the input to this system will be 145BPM (Pulse, 2019).

Table 2.1: Relationship between the heart rate of a baby and cry.

|  |  |
| --- | --- |
| The Time Before Crying (S) | Heart Rate (BPM) |
| 10 | 135 |
| 6 | 137 |
| 2 | 140 |
| Cry | 145 |

Table 2.2: Relationship between the age of a baby and their resting heartbeat.

|  |  |
| --- | --- |
| Age | Resting Heartbeat per Minute |
| 0-3month old | 100-150 |
| 3-6 months old | 90-120 |
| 6-12months old | 80-120 |
| 1-10years | 70-130 |

**2.2 Overview of the Crying Baby Detection System**

**2.2.1 Method 1: A Baby Monitor Using an Algorithm/App.**

According to Dyan et al et al. (2020), the use of algorithms such as an app could help one know when a baby cry. The cries of over 2000 babies were sampled and used to build an app that can categorize the cry of a baby into pain, fussiness, and hunger. They achieved this by looking at the different frequencies in the cries and different patterns of cries and silence. The duration of silence while the baby cries was used to analyse the possible reasons why the baby might be crying. The app was used on iPhone and Android devices. The app works such that five seconds of the baby’s cry is recorded and uploaded to a database. The cry properties such as frequency are compared with other rates to determine why the baby is crying. The result is displayed in the bar-graphical form (Singer, 2018). A major setback of this design is that the deaf parents must be aware of their baby crying before they could use the app to tell why the baby is crying. Another setback is that sophisticated phones and knowledge about graphs are needed to operate the system. A financially challenged or illiterate deaf parent cannot be able to use the app because of its complexity.

**2.2.2 Method 2: A Wireless Baby Monitor with The Use of a Voice Recorder.**

This system was embedded in a toy. It is used to monitor whether the baby is crying or not. The cry detector consists of a voice recorder, an XBee module for communication, and an Arduino. When in operation, a notification from the toy module is sent to a watch module that the parent wears. The watch module consists of a screen that displays the data of the time the baby is at rest, and when he/she is crying. It also includes a vibrating motor that vibrates when the baby is crying (Liow, 2019).

**CHAPTER THREE**

**3.0 System Construction**

This chapter presents the block diagram of the conceived system, the analysis of the circuit leading to the component value determination and selection.

**3.1 Functional; Block diagram**

The block diagram of the system is given below

Microphone

Amplifier

Light Output

li

9V DC power Source

*Figure 3.1: Block diagram*

# **3.2 System Sections**

**3.2.1 Power supply**

The power consumption of the system is estimated from the total of the maximum consumption of the individual components, thus:

Maximum controller consumption = 0.29W (from datasheet)

Maximum Sensor consumption = 0.045W (estimated from datasheet at 5.5V, 9mA max)

Maximum display consumption = 0.75W (estimated from datasheet at 5.0V, 150mA)

The total maximum power consumption = 1.085W

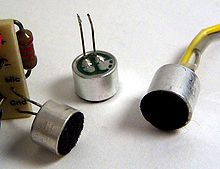
Since the power supply is a 9.0V battery, the current consumption = 1.085/9

IMAX = 1.21A

**3.2.2 The Sensor**

An electret microphone is a type of electrostatic capacitor-based microphone, which eliminates the need for a polarizing power supply by using a permanently charged material.

An electret is a stable dielectric material with a permanently embedded static electric dipole moment (which, due to the high resistance and chemical stability of the material, will not decay for hundreds of years). The name comes from electrostatic and magnet; drawing analogy to the formation of a magnet by alignment of magnetic domains in a piece of iron. Electrets are commonly made by first melting a suitable dielectric material such as a plastic or wax that contains polar molecules, and then allowing it to re-solidify in a powerful electrostatic field. The polar molecules of the dielectric align themselves to the direction of the electrostatic field, producing a permanent electrostatic "bias". Modern electret microphones use PTFE plastic, either in film or solute form, to form the electret. (Pawar, 2020)

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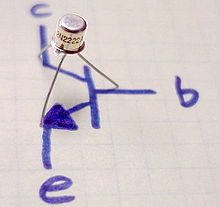
*Figure 3.2: Electret microphone*

**3.2.3 The Transistors**

The 2N2222 is a common NPN bipolar junction transistor (BJT) used for general purpose low-power amplifying or switching applications. It is designed for low to medium current, low power, medium voltage, and can operate at moderately high speeds. It was originally made in the TO-18 metal can as shown in the picture.

The 2N2222 is considered a very common transistor, and is used as an exemplar of an NPN transistor. It is frequently used as a small-signal transistor, and it remains a small general-purpose transistor [6] of enduring popularity.

The 2N2222 was part of a family of devices described by Motorola at a 1962 IRE convention. Since then, it has been made by many semiconductor companies, for example, Texas Instruments.



*Figure 3.3:2N2222 transistor*

**3.2.4 Resistors**

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity. (Tiwari, 2018)



*Figure 3.4: Resistors*

3.2.5 Capacitors

A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals.

The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser or compensator. This name and its cognates are still widely used in many languages, but rarely in English, one notable exception being condenser microphones, also called capacitor microphones. (Silver, 2018)



*Figure 3.5: Capacitors*

**3.2.6 Variable Resistors**

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.

The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.

Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load.



*Figure 3.6: Variable resistor*

**3.3 Complete Circuit Diagram**

The baby monitor for a deaf mother is represented by the complete circuit diagram of the circuit given in figure 3.4



*Figure 3.7: Complete circuit diagram*

**3.4 System Construction**

**3.4.1 Component List**

The following are the proposed components of the system to be designed and constructed

Table 3.1 List of components

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Components | Description | Function |
| 1 | BC547, BC547 | NPN small signal transistor | Amplification |
| 2 | 100kVr | Variable resistor | Distance sensing |
| 3 | Battery | 9V PP3 | Power supply |
| 4 | Switch | Power control | Power Control |
| 5 | LED | Red LED | Output |
| 6 | 4k7,47k,39,220 | Resistors | Biasing |
| 7 | Microphone | Electret | Sound detection |
| 8 | 1uf,1uf,100uf,220uf | Electrolytic capacitors | capacitance |

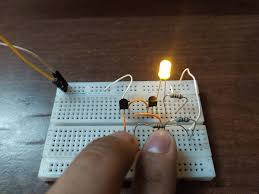
**3.4.2 Component Layout**

A breadboard is a rectangular plastic board with a bunch of tiny holes in it. These holes let you easily insert electronic components to prototype (meaning to build and test an early version of) an electronic circuit. The connections are not permanent, so it is easy to *remove* a component if you make a mistake, or just start over and do a new project. Technically, these breadboards are called solderless breadboards because they do not require soldering to make connections. Soldering (pronounced SAW-der-in).

Breadboarding is a method where electronic components are joined together by melting a special type of metal called solder to give the two components an electrical connection.

Once inserted that component will be electrically connected to anything else placed in that row. This is because the metal rows are conductive and allow current to flow from any point in that strip.

The components are laid on the breadboard following the schematic diagram of the project as shown in figure 3.7



*Figure 3.8: Component Layout*

**3.4.3 Soldering**

Soldering is a joining process used to join different types of metals together by melting solder. Solder is a metal alloy usually made of tin and lead which is melted using a hot iron. The iron is heated to temperatures above 600 degrees Fahrenheit which then cools to create a strong electrical bond. Solder is melted by using heat from an iron connected to a temperature controller. It is heated up to temperatures beyond its melting point at around 600 degrees Fahrenheit which then causes it to melt, which then cools creating the soldered joint, as well as creating strong electrical joints solder can also be removed using a de-soldering tool. A solder is a metal alloy used to create strong permanent bonds; such as copper joining in circuit boards and copper pipe joints. It can also be supplied in two different types and diameters, lead and lead free and also can be between .032” and .062”. Inside the solder core is the flux, a material used to strengthen and improve its mechanical properties.

The type of soldering employed is soft soldering (90 °C - 450 °C) - This process has the lowest filler metal melting point of all the soldering types at less than around 400°C these filler metals are usually alloys, often containing lead with liquidus temperatures under 350°C. Because of the low temperatures used in soft soldering it thermally stresses components the least but does not make strong joints and is then therefore unsuitable for mechanical load-bearing applications. It is also not suited for high temperature use as this type of solder loses strength and melts.

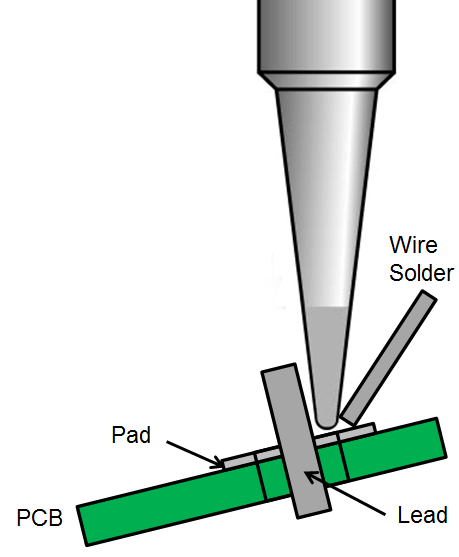
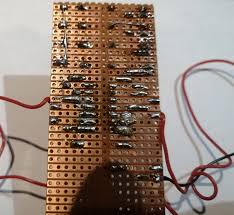


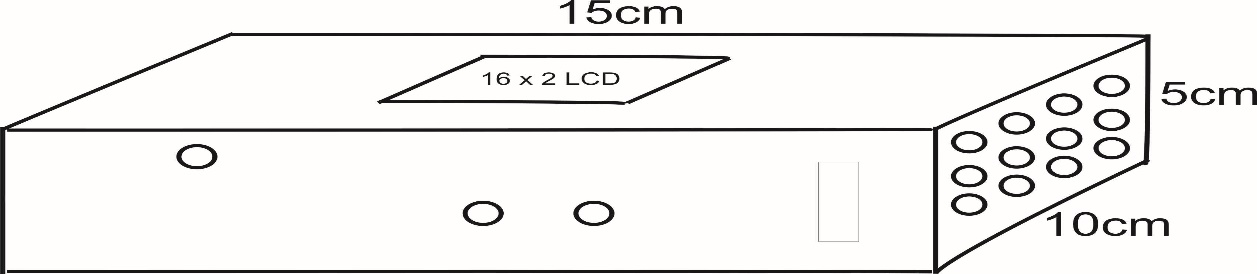
Figure 3.9: Soldering



*Figure 3.10: the soldered circuit*

**3.4.4 Casing**

The case was made out of transparent acrylic material cut to size 15cm by 10cm by 5cm as shown in figure 4.4. Holes were cut for switch, led and LCD Provision was also made for probe wire. Ventilation source were also provided as shown



*Fig. 3.11: Casing/Packaging*

**3.5 Principle of Operation**

When the input AC signal is applied to the input of the first stage, it is amplified by BJT Q1 and appears across the collector load RC. This signal is applied to the input of the second stage through a capacitor CC. The second stage further amplifies this signal. In this way, the cascaded stages amplify the AC signal and the overall gain is equal to the product of the individual stage’s gains.

Since the output signal appears at the collector of the second transistor, a parallel connected LED is connected to light up whenever signal is picked, the light shows the blind woman that baby is crying.

**CHAPTER FOUR**

**4.0 Testing, Results and Discussion**

**4.1 Testing and Result**

**4.1.1 Sectional Circuit Testing**

Test on sections of the constructed circuit was done with a meter and functional Visual tests were done as to check if all connections are done correctly and if there are any short or open circuits on the board, this is done without applying power to the circuit.

The second test is done after powering the circuit, a digital meter is set at continuity and then voltage range to check for polarity of supply, correct voltage levels across and between components.

**4.1.2 Complete Prototype Testing**

The last tests were done on the functional circuit to establish if it can sense and determine the distance between the sensor and the persons height. The completed circuit was powered ON and a person was brought under the sensor. Reading on the display was observed.

* + 1. **Results**

After testing results obtained are documented and tabulated in table 4.1 and 4.2.

Table 4.1 Result of circuit tests

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Test point | Test Type | Result |
| 1 | Battery terminals | Voltage measurement | 9.0V |
| 2 | Vcc pin on Arduino | Voltage measurement | 9.0v |
| 3  4 | Switch Terminals  Transistor Base | Continuity  Voltage | Continuous when closed  0.9V |

Table 4.2 Function test result

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Input Status | Output LED Status | Comment |
| 1 | No Noise | OFF | No sound picked up |
| 2 | Slight Noise | Dim | Slight sound picked up |
| 3 | High Noise Level | Bright | Loud sound picked up |

**4.2 Discussion**

The results tabulated in table 4.1 show that the necessary test points are at the right potential and that the switch is functional. The results in table 4.2 also show that the projects main objectively has been achieved, the circuit was capable of measuring the heights of six persons who volunteered for the test, the result show that a tolerance of +/- 5 to +/\_10% was determined. The overall outcome is that the device is quite capable of determining the height of a person digitally with the convenience of displayed result.

**4.3 Cost Estimate**

To further document this project, its cost estimate is created as shown in table 4.12

Table 4.3: Table of Cost Estimate

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/N | Components | Unit Cost (#) | Quantity | Amount (#) |
| 1 | BC547, BC547 | 300 | 2 | 600 |
| 2 | 100kVr | 200 | 1 | 200 |
| 3 | Battery | 300 | 1 | 300 |
| 4 | Switch | 200 | 1 | 200 |
| 5 | LED | 100 | 3 | 300 |
| 6 | 4k7,47k,39,220 | 100 | 4 | 400 |
| 7 | Microphone | 300 | 1 | 300 |
| 8 | 1uf,1uf,100uf,220uf | 100 | 4 | 400 |
| Total = 2,700 | | | | |

**CHAPTER FIVE**

**5.0 Summaruy, Conclusion and Recommendations**

This chapter contains a brief summary of the work together with conclusion and recommendations for further improvement on the work.

**5.1 Summary**

Technological developments are key, especially to physically challenged individuals. One of the most common types of disability is deafness. About 5% of the world’s population are deaf, which accounts for three hundred and ninety million people of the entire world’s population. Out of this 5%, those found in sub-Saharan Africa find it difficult to interact in society and have independent lives. It is often difficult for a deaf parent to relate to their babies without getting most of their help from other people. Newborn babies cannot walk or call out to their parents; therefore, they often rely on their cries to get their parent’s attention. If the deaf parents are poor, they cannot afford the very few and expensive options on the market. There is a need to develop a cheap and effective baby monitor for a deaf mother.

**5.2 Conclusion**

This project focuses on implementing a baby monitor for financially challenged deaf parents. Implementation includes using a microphone, two stage transistor amplifier and LED outputs. This device consists of cheap parts that are also reasonable to run; hence it can be afforded by even low-income families. The benefits of this device include 1. An effective way for deaf parents to monitor their babies. 2. A means for deaf parents to feel more connected to their babies, and the same applies to the babies as well. 3. To give the deaf parents an option to be able to live with their baby without another person’s supervision. 4. To prevent a problematic situation were a baby gets hurt and cries out for their parents, but they did not attend to the baby on time because they could not hear. Hence this device seeks to curb some if not all the problems deaf parents face when raising a young child between ages 3-30 months old.

**5.3 Recommendations**

This device could be made more efficient with video monitoring. Video monitoring would mean a bigger, more massive, and more complex device, but it will serve the purpose of monitoring a baby more efficiently. Using a rechargeable battery will also result in the lower running costs of the device, therefore adding this feature will be beneficial for future upgrades. Also, introducing a sock version of the device worn by a baby can be another alternative design for this invention. The parents will have an option between the bracelet and ring model and the sock model. Although the sock model will be preferable for night times to prevent it from damaging due to the baby standing on it.

To further improve upon this work it is highly recommended that a vibration output be included together with the LED.

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