American Journal of Applied Sciences and Engineering | *ISSN 2766-7596*
Published by ACADEMIC INK REVIEW | *https://airjournal.org/ajase*
12011 WestBrae Pkwy, Houston, TX 77031, United States
airjournals@gmail.com; enquiry@airjournal.org

Development of Digital Ambu-Respiratory Guided Device

[1]Nwobodo-Nzeribe, Nnenna Harmony; [2]Adejumo, Oluwadamilola Hajarat
[1]Dept. of Computer Engineering, Enugu State University of Science & Technology, Enugu, Nigeria
[2]Department of Electrical and Electronic Engineering, University of Ibadan, Oyo State, Nigeria

Publication Process	***Date***
Received	***September 6th, 2021***
Accepted	***September 26th, 2021***
Published	***September 30th, 2021***

ABSTRACT

Patients suffering from protracted heart failure often find it challenging to respire healthily and so need to be monitored for an emergency. In addition, analysis has proven that deep breathing is a cradle of non-pharmacological treatment of high blood pressure. High blood pressure often leads to protracted heart failure and other cardiovascular diseases. Urgent attention and innovation to this need brought about the development of this technology for African Transformation. Hence, this research work titled "Development of Digital Ambu-Respiratory Guided Device" is aimed to develop a system that will support and monitor the breathing condition of a patient in the hospital or at home. The system constantly gives out the sound signal of breath through the microphone as well as monitors the breathing condition of the patient and displays the breathing output through an LCD. This was implemented with an Arduino Uno microcontroller programmed with an embedded-C. The system was first designed and simulated using Proteus software and then, the prototype was fabricated. The developed system was tested satisfactorily and it was observed that it can be used by everyone to monitor breathing conditions. In conclusion, a device to monitor breathing conditions to be used by everyone including healthcare professionals is developed.

Keywords: *Breathing Monitor; Blood-Pressure; Sound Signal; Digital Ambu-Respiratory Guided Device*

1. Introduction

Due to the high prevalence of most ubiquitous diseases like hypertension, coronary heart disease, persistent heart failure, etc. in this aging society, it has become the leading cause of morbidity and mortality. Patients that suffer from this protracted heart failure find it difficult to breathe properly and subsequently need to be promptly observed (Kawecka, Kloch, & Wojciechowska, 2011; Han, Makoto, Elsa & Dagfinn, 2020).
Past studies have proven that breathing exercises have played a successful role in the treatment of high blood pressure even during pregnancy (Nwobodo-Nzeribe & Ani, 2017). However, this has contradicted the side effects and cost of antihypertensive drugs and paved the way for deep breathing exercise as an effective non-pharmacologic treatment of high blood pressure (Nwobodo-Nzeribe & Ani, 2017). Deep breathing exercise has been helpful to both the systematic and microvascular levels of the cardiovascular system (Nwobodo, Eneh &, Ilo, 2017).
RESPeRATE has been recognized by the American Heart Association as a potentially useful non-pharmacologic approach for lowering blood pressure (Sheldon & Sheps, 2020) RESPeRATE is a breathing guided device developed for slow breathing drill to potentially facilitate patients in the difficult task of maintaining a constant number of breaths (Sharma, Frishman, Gandhi, 2011). This device guides the breathing exercise through the acoustic feedback (Brook, Appel, Melvyn, Ogedegbe, Bisognano, Elliott, Fuchs, Hughes, Lackland, Staffileno, Townsend, Rajagopalan, 2013; Chen-Hsu, Hui-Wen, Han-Luen, & Men-Tzung, 2021) but lacked in the visual display of the breathing rate. The imperative care and modernization in this area brought about the development of Digital Ambu-Respiratory Guided Device for African Transformation. The development of the Digital Ambu-Respiratory Guided Device is aimed to develop a system that will support and monitor the breathing condition of a patient in the hospital or at home. During usage, the system constantly produces a sound signal of breath via the microphone and also monitors and displays the breathing rhythm of the patient through a Liquid crystal display (LCD).

2. Methodology

This work was achieved through design and simulating the model using Proteus 8, software, implementing the design in the breadboard, and the final development of the prototype.
The hardware materials used to achieve this include a breathing inhalation/exhalation sensor, a preamplifier, an earpiece, an LCD display, and an Arduino Uno microcontroller. The software used was Proteus 8 and an embedded-C which served as the systems software for the microcontroller. The preamplifiers, the LCD display, and alarm systems are connected to the microcontroller. The microcontroller is the control unit that analyzes the breathing (inhalation/exhalation) and displays the status as a bar on the LCD. The earpiece is for individual listening of the breathing pattern.

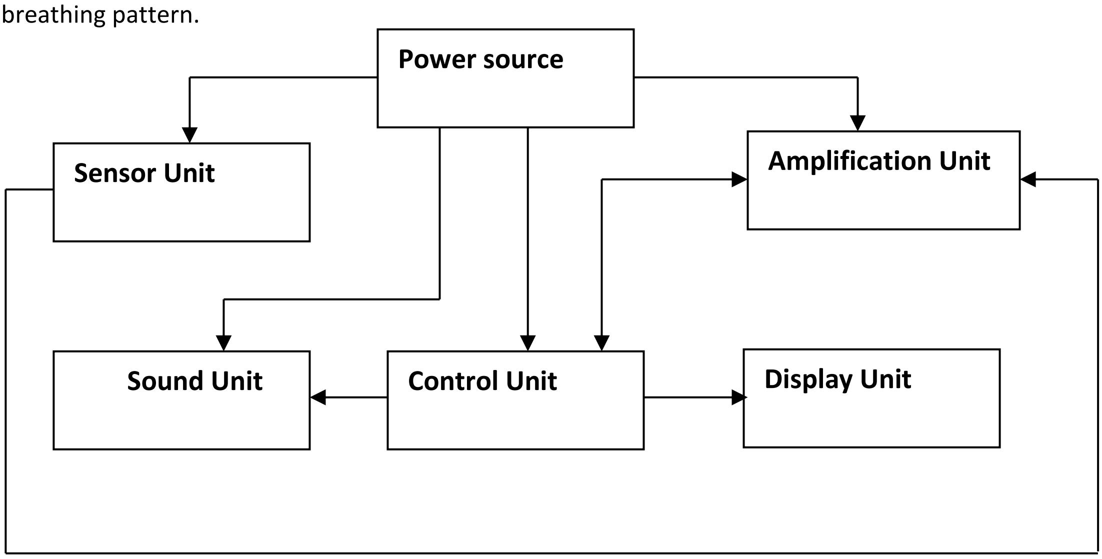

Figure 1: Block diagram of Digital Ambu-Respiratory Guided Device

The block diagram contains the power supply, sensor, amplification, control, sound block, and display units. The power supply unit of the system supplies the electrical signal to the entire unit. The sensor picks the inhalation/exhalation signal from the nostril, and it is converted into an electrical signal. This is then amplified and sends to the control unit. The control unit takes the amplified signal and used it to analyze the breathing system as normal, good, or bad and as well, displays the analyzed status of the breath on the LCD.

3. Implementation

The circuit diagram was designed and simulated using Proteus 8 is as shown in figure 2 while figure 4 displays the system connection in the breadboard.

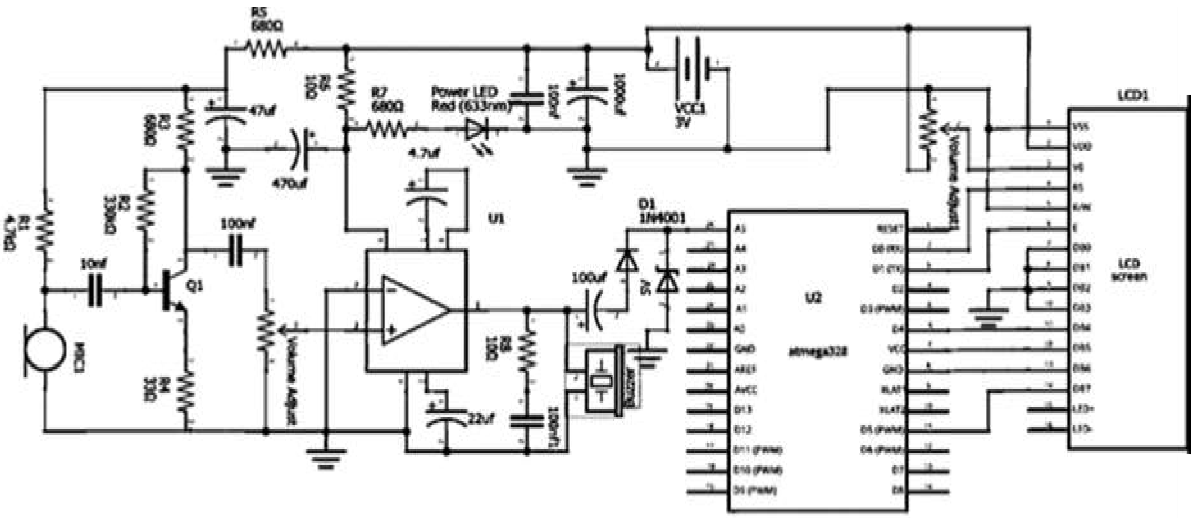

Figure 2: Circuit diagram of Digital Ambu-Respiratory Guided Device

Figure 3 shows the flowchart of the program while the pseudo code is as stated below:

- Start Program
- Read from the sensor
- Analyze value
- Display status
- Make a sound report
- End

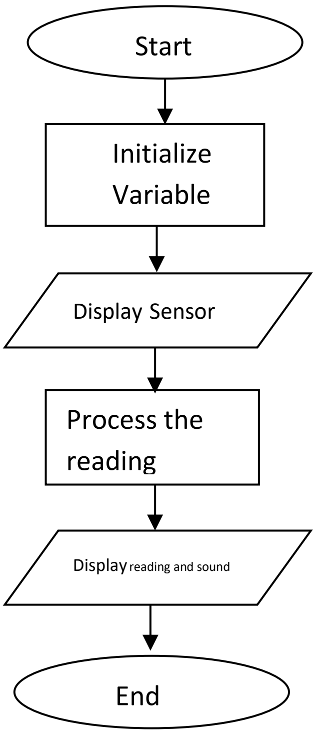

Figure 3: Flowchart of the program

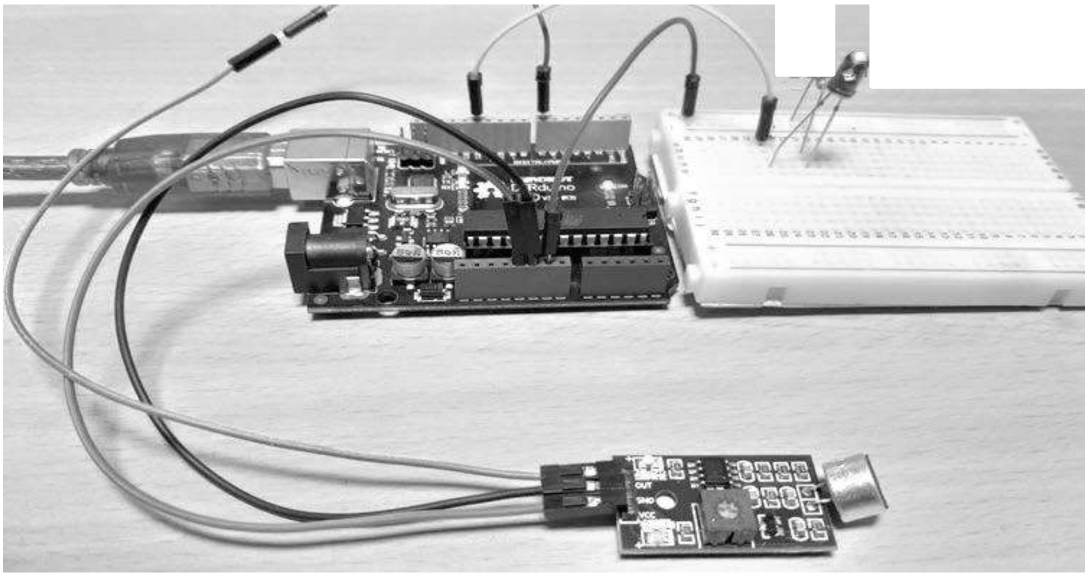

Figure 4: System connection in breadboard

The above connection shows the breadboard arrangement of the system. The connection shows the LED and the sound detection module with the Arduino board. This connection is done to ensure that the system responds well. The sound sensor module has three (3) wires. (the VCC, GND, and OUT). The VCC is the positive supply pin, the GND is the negative supply pin and the OUT pin is the detected signal output pin. The Vcc of the sensor connects to the positive rail of the supply and Arduino board. The GND connects to the negative supply rail of the breadboard. The OUT pin of the sensor module is connected to the ADC pin 5 (A5) of the Arduino UNO board. And the LED was connected to the digital pin 2 for indication of the detected signal. Now, when the sensor senses a sound, it sends the detected signal to the Arduino board which now triggers the LED. When the sound of detected withdraws, the triggering signal is withdrawn from the LED and it turns "off". Note that LED was used in its implementation in the breadboard but Liquid Crystal Display (LCD) activated using light dependent resistors (LDR) was used in Vero board for building the prototype as shown in figure 5 below.

4. Result and Discussion

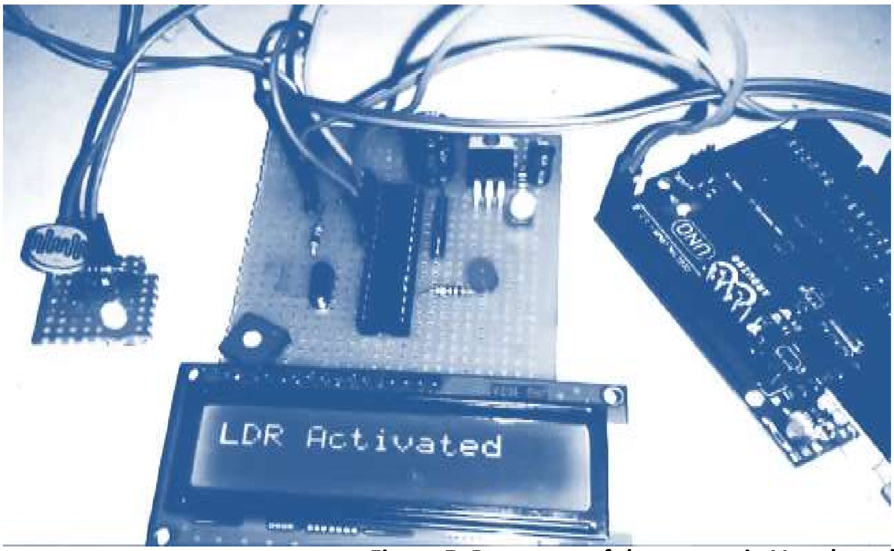

Figure 5: Prototype of the system in Vero board

The result in figure 5 shows that the LDR has been activated the LCD module to display the respiratory rate (RR) during operation.

The result of the implementation process shows that the system responds positively to the expected operation. When the system was powered, the LED begins to glow as an indication of the sound detection. When the LCD was connected as shown in the figure above, the text displayed showing that the sensor activates properly. During the operation on humans, the breathing rate was captured accurately and the value obtained was displayed as on the LCD.

5. Conclusion

In conclusion, a digital Ambu-respiratory guided device to be used in hospitals for monitoring the breathing system of a patient was developed. The system will also assist healthcare personnel to know when a patient needs special attention. Cautious utilization of the device with a normal breathing rate can help in reducing blood pressure.

References

Brook, R.D., Appel, L.J., Melvyn, R., Ogedegbe, G., Bisognano, J. D., Elliott, W. J., Fuchs, F.D., Hughes, J.W., Lackland,D.T., Staffileno, B.A., Townsend, R.R., Rajagopalan, S. (2013). Beyond medications and diet: alternative approaches to lowering blood pressure: scientific statement from American Heart Association Professional Education Committee of Council for High Blood Pressure Research; 61: 1360-1383.

Chen-Hsu, W., Hui-Wen, Y., Han-Luen, H. & Men-Tzung, L. (2021). Long-Term Effect of Device-Guided Slow Breathing on Blood Pressure Regulation and Chronic Inflammation in Patients with Essential Hypertension Using a Wearable ECG DeviceActa Cardiologica Sinica, March, 2021. http://www.ceps.com.tw/ec/ecJnlIntro.aspx?Jnliid=758

Gavish, B. (2010). Device -guided breathing in the home setting: technology, performance and clinical outcomes. Biol Psychol. 2010; 84: 150-156.

Han, P., Makoto, H., Elsa, K. & Dagfinn, A., (2020). Blood pressure, hypertension and the risk of sudden cardiac death: a systematic review and meta-analysis of cohort studies European Journal of Epidemiology (May 2020) published by springer 35(5) 443–454 https://doi.org/10.1007/s10654-019-00593-4.

Kawecka, J. K., Kloch, B.M., & Wojciechowska, W. (2011) Hypertension as a risk factor for heart failure. Arterial Hypertens. 2011; 15: 275-282.

Nwobodo-Nzeribe H.N and Ani A.O. (2017). "The Impact of Slow and Deep Breathing on Clinical Blood Pressure (BP) of Pregnant Subjects Using Automated Technique" Explomartics Journal of Innovative Engineering and Technology, Faculty of Engineering, ESUT. Volume 1, Issue 5, September, 2017pp. 48-57.

Nwobodo, N.H., Eneh, P. C. & Ilo, F.U. (2017). "Concurrence of Manual Auscultatory and Automatic Oscillometric Techniques on Influence of Deep Breathing on Mean Arterial Pressure (MAP)" International Journal in Physical and Applied Sciences. Volume 4, Issue 11, November, 2017, pp. 1-11.

Sharma, M., Frishman, W., Gandhi, K., (2011). RESPeRATE: Nonpharmacological treatment of hypertension, Pubmed, 19 (2) pp (47-51) 0.1097/CRD.0b013e3181fc1ae6

Sheldon, G, Sheps, M.D. (2020). What can you tell me about Resperate? Does it really help lower blood pressure? (expert opinion). Mayo Clinic. Feb. 3, 2020. https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/expert-answers/resperate/faq-20057998