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Use Chest Vibrator to Prevent Pulmonary Infection in Patients with COPD

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Abstract: Chest infection is an infection that affects your lungs, either in the major respiratory tract (bronchitis) or in small air sacs (pneumonia). There is an accumulation of pus and liquid (mucus), and the respiratory tract becomes swollen, making breathing difficult. Chronic obstructive pulmonary disease (COPD) is a serious cause of death globally. This disease is characterized by episodes of acute exacerbations or aggravation that are superimposed upon a gradual decrease in pulmonary function. The study developed a device for vibratory techniques in chest physiotherapy. Vibration is a pressure applied to the chest during exhalation to move the secret into the large respiratory tract. Measurements of the mechanical impedance of the respiratory system in frequencies from about 5 Hz to about 70 Hz in the higher frequency range should be evaluated on the basis of the lung model. In this device, using frequencies that are often used in the field: 30, 40, 50 Hz and a timer of 3 to 5 minutes. This device uses a 12V DC motor as a vibration medium that will be connected to the engine inside the paddle. It uses IC NE 555 as an important component of the conductor circuit. This module uses an LCD screen of 16x2 characters as screen. The result was found that by using IC NE 555 as an important driver in showing acceptable system accuracy, only a minimum error value of ± 0.008% and a maximum error value of ± 0.02%. The advantage of this module is that it is equipped with a 3-5 minutes timer so that it can provide efficient therapy according to the time needed and is equipped with an LCD display to make it easier to observe the time.
Key words*: chest vibrator, COPD patient, infection*

I. INTRODUCTION

Chest vibrator is a vibrational action applied across the chest wall using a mechanical vibrator. As a non-pharmacological therapy to help eliminate secretion from the respiratory tract. It has proven effective in the maintenance of lung function and the prevention or reduction of respiratory complications in patients with chronic respiratory diseases. A thoracic infection is an infection that affects your lungs, either in the main airway (bronchitis) or in small air bags (pneumonia). There is an accumulation of pus and fluid (mucus), and the airways become swollen, making respiration difficult. Chronic obstructive pulmonary disease (COPD) is an important cause of mortality throughout the world.1 The disease is characterized by episodes of acute exacerbation or worsening superimposed on a gradual deterioration in lung function.

More recent studies including the use of new techniques of respiratory physiotherapy have shown positive effects in relieving secretions, reducing clinical scores, and respiratory discomfort with short-term improvement of respiratory signs and symptoms. Previous studies have used mechanical vibrators with a rate of 1 to 60 for 1 minute in patients with severe COPD. However, there are no studies using a thoracic vibrator with a 3-5 minutes timer and in patients with light to moderate COPD. A commercial chest vibrator is applied during treatment to assist patients with COPD to release mucus from their airways. Chest Vibrator combines vertical movement with uneven rotating movement that increases massage effects. This device has 2 interchangeable heads smooth all areas of the body and vibration massage. The feature has been integrated infrared thermotherapy and Specification: Voltage Supply: 200-240V Commonly: 50-60Hz Weighs: 1.3 kg, Dimensions: 35x11.5x15. 5 cm. [1] Another device is a vibrator that combines a vertical movement with an irregular rotary movement that lifts the massage effects. A massage with warmth on is more efficient for treating rigidity and fatigue. The unit is also equipped with a complete heating cross-section temperature up to 55°F to enhance blood circulation will be promoted immediately and vibration relives muscle from fatigue. [2]

In this study, the researchers manufactured modules using frequencies often used in the field: 30, 40, 50 Hz and a timer of 3 to 5 minutes. Previously this module has never been made. This module uses a 12 VDC motor as a vibrating medium that connects to the mechanisms within the paddle. This module uses IC NE 555 as a major component in the driver circuitry. The module uses a 16x2 LCD screen as a display

II. MATERIALS AND METHODS

A. Research Design

This research was conducted using a 12V DC motor mounted on the paddle as a therapeutic medium. Data collection on respondents has been carried out 3 measurements at each frequency. The use of IC NE555 is an important component in the driver. The minimum system using arduino nano (version 3.0) is used as system programming, timer, and display on the LCD. Using a character LCD with 16x2 specifications. A digital storage oscilloscope (Textronic, DPO2012, Taiwan) was used to test the output of the module.

Fig.1. Chest vibrator

Power Supply reverts the incoming AC voltage into DC output. Supply is useful for supplying the microcontroller circuit, then set the motor speed as needed on the rotary and setting the timer according to the needs of the patient. The microcontroller will process the data according to the settings selected by the user which will be displayed on the LCD. The microcontroller aims as a motor drive so that the motor will work according to the speed and timer settings that have been selected by the user, when the timer has run out, the motor driver will stop working and indicate chest therapy has been completed. These steps can be seen following flowchart:

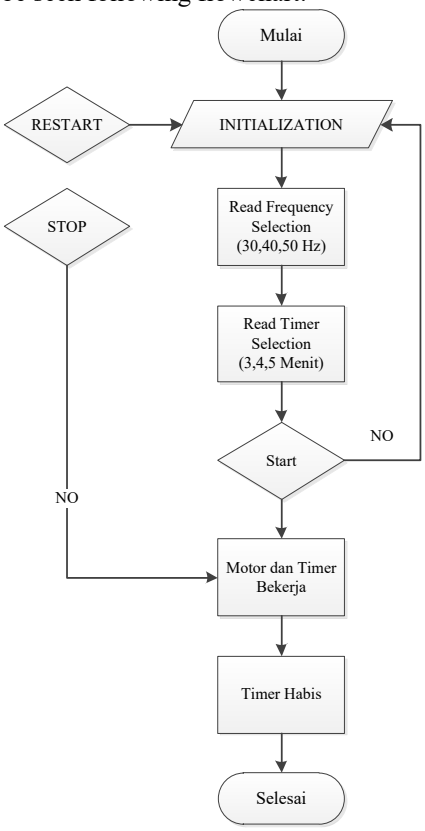

Fig.2. The Flowchart of the Arduino

The most important part of this design is the analog circuit described in Figure 4 (Driver), Figure 5 (Switch), Figure 6 (Supply), Figure 7 (Microcontroller). This circuit is used to process heart sound signals. Therefore, a minimum system is needed to process it into a digital signal.

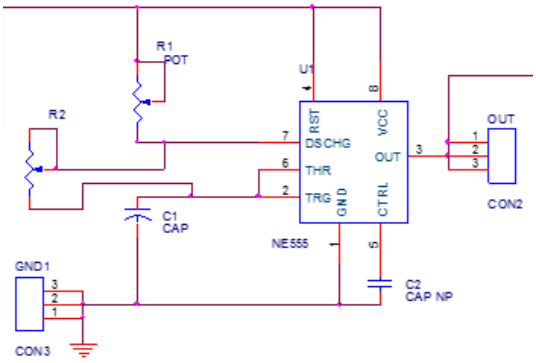

Fig.3. Driver

B. Experiment

The measurement of the frequency value in this module is repeated 3 times using an oscilloscope. The measurement of the frequency value is carried out at the output of the driver circuit. The frequencies to be measured are 30 Hz, 40 Hz, and 50 Hz. This module did not have a comparison so that measurements are made by looking at the output on this module using an oscilloscope

III. RESULT

A. Frequency Value Measurement Results

The measurement of the frequency value in this module is repeated 3 times using an oscilloscope. The measurement of the frequency value is carried out at the output of the driver circuit. The frequencies to be measured are 30 Hz, 40 Hz, and 50 Hz. This module does not have a comparison so that measurements are made by looking at the output on this module using an oscilloscope.

Based on the data in table 1, it is known that the results of taking frequency data with an oscilloscope. Data collection is done by comparing the value of the setting on the module with the converted measurement results. The results obtained with a minimum error value of ± 0.008% and a maximum error value of ± 0.02%. This indicates that the motor driver has worked well.

Table 4.1 Frequency Measurement Results

Frequency Values	1st Measurement Results	2nd Measurement Results	3rd Measurement Results
30 Hz	30,6171 Hz	30,6183 Hz	30,6220 Hz
40 Hz	40,8265 Hz	40,8300 Hz	40,8265 Hz
50 Hz	50,3885 Hz	50,6859 Hz	50,2544 Hz

B. Value Measurement Results PWM (Pulse Width Modulation)

The measurement of the PWM value on this module is repeated twice using an oscilloscope. Measurement of the PWM value is carried out at the output of the driver circuit. The duty cycle to be measured is for frequencies of 30 Hz, 40 Hz, and 50 Hz.

Here, attached data retrieval before the tool is properly set. According to the correct settings, the 30 Hz frequency uses a 70% duty cycle, for the 40 Hz frequency it uses an 80% duty cycle, and for the 50 Hz frequency uses a 90% duty cycle.

Table 2 Measurement Results of PWM

Frequency Values	1st Measurement Results	2nd Measurement Results	3rd Measurement Results
30 Hz	57,76 %	57,76 %	57,76%
40 Hz	60,56 %	60,56 %	60,56%
50 Hz	67,12 %	67,18 %	66,99%

IV. DISCUSSION

5.1 Measurement Results

Data retrieval on this module is done by comparing the setting value on the module with the measurement results on the oscilloscope and will be converted.

Table 5.1 Frequency Measurement Results

Frequency Values	1st Measurement Results	2nd Measurement Results	3rd Measurement Results
30 Hz	30,6171 Hz	30,6183 Hz	30,6220 Hz
40 Hz	40,8265 Hz	40,8300 Hz	40,8265 Hz
50 Hz	50,3885 Hz	50,6859 Hz	50,2544 Hz

Calculation of 30 Hz Frequency Error Value Results

$$\text{Error} = \frac{(average\ setting - module\ average)}{average\ setting} \text{x}100\%$$
$$= \frac{30{,}000 - 30{,}6191}{30{,}000} \text{ x } 100\%$$
$$= \pm\ 0.02\%$$

Calculation of 40 Hz Frequency Error Value Results

$$\text{Error} = \frac{(average\ setting - module\ average)}{average\ setting} \text{x}100\%$$
$$= \frac{40{,}000 - 40{,}8276}{40{,}000} \text{ x } 100\%$$
$$= \pm\ 0.02\%$$

Calculation of 50 Hz Frequency Error Value Results

$$\text{Error} = \frac{(average\ setting - module\ average)}{average\ setting} \text{x}100\%$$
$$= \frac{50{,}000 - 50{,}4432}{50{,}000} \text{ x } 100\%$$
$$= \pm\ 0{,}008\%$$

Based on the table data and calculations above, the results obtained with a minimum error value of ± 0.008 % and a maximum error value of ± 0.02 %. This shows that the motor driver has worked well.

V. CONCLUSION

The Chest Vibrator module was made for chest therapy in patients with bronchitis with an age range of 12-45 years using DC motors and paddles as chest therapy media with frequency settings ranging from 30,40, and 50 Hz equipped with a selection of a 3-5 minute timer using the Arduino microcontroller system which is displayed on a 2x16 LCD display. In this study, it was found that by using IC NE 555 as an important component in the driver, the system accuracy can be categorized as sufficient, the results of frequency data collection are obtained with a minimum error value of ± 0.008% and a maximum error value of ± 0.02%. The level of error at that frequency is caused by the rotation of the DC motor because the DC motor has a load. The advantage of this module compared to the tools seen by researchers at RSUD Jombang is that this module is equipped with a 3-5 minute timer so that it can provide therapeutic treatment efficiently according to the time needed and is equipped with an LCD display.The following are suggestions that can be considered for further refinement of research are the display should use TFT so that the display of the frequency selection and timer is more modern; added frequency selection for children's use; the device can be made smaller again to make it look simpler.

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