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Aroma Electric Therapy device with Atmega8-Based Heart Rate Monitoring

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***Abstract*— Aromatherapy is an alternative treatment method that uses essential oil vapors from various plants inhaled for health therapy. It affects mood, reduces fatigue and anxiety, and stimulates relaxation. Relaxation is the process of relieving anxiety or stress. It is interpreted as a calm state with a normal pulse. When someone is stressful and anxious, the pulse is higher. Measuring the level of anxiety is done by measuring the heart rate. The research aimed to design an electric aromatherapy device equipped with Atmega 8-based heart rate monitoring as a therapeutic tool that can help reduce various kinds of health problems, one of which is anxiety or stress disorder. The test was carried out by comparing the values of the heart rate monitoring to a pulse oximeter. The oximeter was used as a reference to get high accuracy values. The device is expected to help reduce various kinds of health problems caused by heart problems.**

***Keywords*— aromatherapy, heart rate, microcontroller**

I. INTRODUCTION

Aromatherapy is an alternative treatment method that uses essential oil vapors from various plants. The aim is to improve physical, mental, and emotional health. Aromatic plant extracts are obtained through various processing methods and known as essential oils. This essential oil can help reduce anxiety by improving mood, reducing pain, nausea, fatigue, or inflammation. Symptoms of anxiety disorders are panic and fears, obsessive thoughts, nausea, cold sweating, and other uncomfortable physical reactions. The smell of oil burning gives a calming effect.

Various kinds of anxiety disorders experienced by a person can trigger several health problems. Another impact that will occur is the disruption of daily life, for example, decreased appetite, disturbed relationships with people around, irregular hours of sleep, decreased work performance, and also prone to dangerous lifestyles such as overeating, smoking, or consuming alcohol and medicine.

Several researchers have carried out researches on therapeutic devices using a microcontroller such as Grossman et al. who studied computer-controlled ultrasound therapy systems for the treatment of breast cancer [1], Felber and Candidate who investigate automation of ventilator control for hyperbaric oxygen therapy [2]. Li Chengwei and Zhen who designed a laser acupuncture therapy instrument [3], and Hao-Li Liu et al. who designed and carried out experiments on the evaluation of low frequency-array hemispherical frequency-array systems for blood-brain transcranial disorders barriers [4].

Smith and Bagley studied and examined miniature monitors, activities to assess the effectiveness of mobility therapy for children with cerebral palsy during daily life [5]. Stanescu and Cristea examined a simple low-level laser therapy device approach [6]. Petreus et al. examined low frequency pulsed magnetic therapy systems [7]. Proto et al. investigated a new microcontroller-based system for optimizing the digital conversion of signals originating from load cells to the pedal [8]. Burke, Murphy, and Geraghty studied measurements of sub-bandage pressure during venous compression therapy using flexible force sensors [9]. Mercado et al. investigated a smart cane, a quad cane instrumentation with an audio feedback monitoring system for load-bearing support [10].

Researches and designs on therapeutic devices have been done, among others are the development of an artificial arm for the therapeutic process using a microcontroller system by Ali et al [11], the design of a closed loop laser diode temperature control system for photodynamic therapy applications by Kazan, Guler, and Yildiz [12], the development of portable shock wave therapy devices using PIC microcontrollers by Song, Lin, and Chen [13], the development of hand therapy devices for cerebral palsy on the FKE-UiTM capstone design subject by Som et al [14], Neuro-based racing cars for cognitive training by Azman, Mansor and Lee [15], the wound healing therapy machine by Kapoor [16], the design and application of new motorized traction devices by Fidan and Coban [17], Fuzzy control of oxygen gas content for oxygen therapy in preterm labor by Chanyagorn and Kiratiwudhikul [18], transferring electromyogram signals between body parts by Hamed et al [19], and interactive speech therapy sessions using linear prediction coding in Matlab and Arduino by Vijayalakshmi and Priya [20].

Based on the problem identification, the author created a more practical electric aromatherapy tool compared to the existing tool available in the market. The heating system was made more effective for heating essential oil liquids and accelerating evaporation to maximize the therapeutic process equipped with a heart rate monitor connected to the finger sensor. The patient's heart rate monitoring aimed to see the development of the effects of the aromatherapy given so that the changes in the patient's heart rate during the therapy process could be recognized.

Some other researchers have researched heart rate monitoring devices for patients using a microcontroller including Saquib et al. who conducted heart rate measurements using photo plethysmography. The system consisted of a heart rate sensor using photo plethysmography, a PIC microcontroller, and a seven-segment display [21]. Mahmood et al. examined LED indicators for heart rate monitoring systems in sports applications using a heart rate sensor, a Zigbee, an nRF24L01, and an Arduino microcontroller [22]. Bishnu et al. examined heart rate monitoring systems using IR-photodetector sensors. The system consisted of a heart rate sensor using an IR-photodetector sensor, a microcontroller type PIC, and a seven-segment display [23]. Hoilett et al. studied smartwatches to monitor respiration and heart rate using photo plethysmography consisting of heart rate and breathing sensors using Photo plethysmography, ARM Cortex M0 microcontroller, Bluetooth, and OLED Display [24]. Sosa and Solar designed a wireless and battery-free heart rate monitor. The heart rate was read by the system using RSQ heart signals [25].

Researchers have obtained test measures of the heart rate measurements. Kolarik et al. studied low-cost devices for measurement of fetal heart rate consisting of a heart rate sensor using phonocardiography, an analog-digital converter, and a computer [26]. Hodge, Humnabadkar, and Bidwai developed a wireless heart rate monitoring and vigilant systems that consisted of a heart rate sensor using IR-photodiode, an Arduino microcontroller, NRF module, and a system detector [27]. Akhter et al. investigated RR-Interval based microcontroller measurement using ppg signals for biometric applications based on heart rate variability using a photodiode-IR sensor for heart rate detection and an ATMEGA32 microcontroller [28]. Mansor et al. developed a portable heart rate measurement for a remote health monitoring system. The system consisted of an Arduino microcontroller, a heart rate sensor with IR-photodiode, and an LCD [29].

Based on the researches about heart rate monitoring, many heart rate monitoring devices are integrated with temperature monitoring, but not with therapeutic tools. Hence, this study aims to design a pulse monitoring device by integrating it with a therapeutic tool. This system uses an ATMEGA8 microcontroller to control the therapy and monitor the heart rate.

II. METHODS

Figure 1 illustrates the block diagram of an electric aromatherapy equipment system with heart rate monitoring. The system consists of an atmega8 microcontroller, a heart rate sensor, a temperature sensor, a fan and a water heater. When the button is pressed, the microcontroller activates the water heater to heat the aromatherapy.

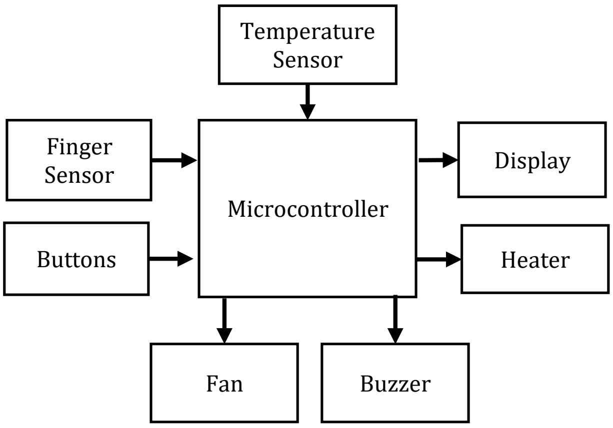

Fig. 1. System block diagram

a. System components

The finger sensor worked to detect the flow of blood that passed through the finger. It had an infrared that illuminated the fingers and also the photodiode which was sensitive to the light intensity. Every time there was blood flow, there would be a difference in the light intensity received by the photodiode.

The device interface was made with four buttons, namely, start to start the work process of the tool when all settings are set, set to move the setting mode choices, fan and timer speeds, up to increase the fan speed level and set the time needed, and Reset to restart the program.

The microcontroller worked as control of both input (button and monostable) and output (driver, buzzer, LM35, and LCD). It contained a program that controlled the entire course of the module system. LCD functioned as an output that displays various kinds of character data.

The driver heater served as a link between the microcontroller running at the physical level (5V voltage) and the AC heater operating at 220V voltage. This circuit will control the heater on or off with the input from the high (1) or low (0) logic controller set in the program. LM35 was used to detect temperatures on the heater. The data from the LM35 would be sent to the microcontroller used to monitor the heater On or Off state.

The fan driver acted as a bridge between the microcontroller at the digital level (5V voltage) and the DC fan as a load at 12V voltage. The driver managed the fan On or Off with the input coming from a microcontroller that provided logic high (1) or low (0) set in the program. The buzzer indicated whether the work process had been completed. Figure 1 illustrates the system block diagram.

b. System work flow

Figure 2 shows the workflow of the system of electric aromatherapy tool integrated with heart rate monitoring. It started with setting fan and time, activating the aromatherapy tool, setting the time, and turning off the tool.

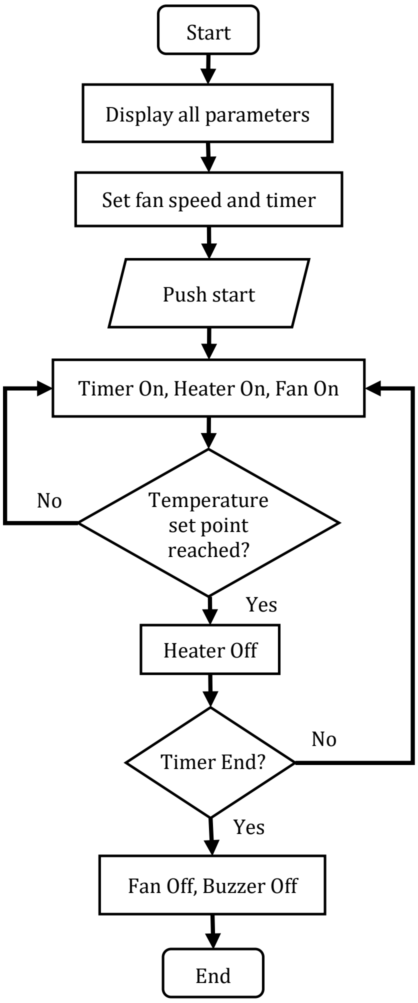

Fig. 2. System workflow

Figure 2 shows the system workflow. After receiving the power supply, the microcontroller power initialized the LCD which displayed Beats Per Minute (BPM), temperature, fan speed, and timer. The finger sensor started to work when being placed on the patient's finger. The finger sensor began to monitor the heart rate every 20 seconds. The yellow LED indicator (bradycardia) would lighten when the BPM results <60, the green LED (normal) when the BPM results between 60-100, and the red LED (tachycardia) when the BPM >100. Pressing the Set button would start the initial settings, namely, the fan and timer speed settings while pressing the Start button would start the module work process. Before the temperature reached 40oc, the heater would continue working, but when the temperature was equal to 40oc, the heater turned off, and when the temperature was decreasing and reaching or equal to 35oc, the heater would be back on. When the time was up, the fan turned off, so the buzzer sounded, indicating that the therapy process had finished.

III. IMPLEMENTATION

a. Signal conditioner

The signal conditioning schematic in Figure 3 used an IC LM324 with four op-amps, but the signal conditioning circuit only used three op-amps which were useful to amplify the output of the finger sensor. Afterward, the signal was transmitted to the non-inverting amplifier circuit to be used as a comparator input, which compared it to the reference voltage that had been set, according to the precision level of the counter calculation. The output of the finger sensor would be filtered using a high-pass filter to pass the body signals. It would greatly affect the calculation at the T0 pin of the microcontroller counter. The calculation would be random If it was not precise because the comparator worked only to limit the lowest signal read like a beat. A little noise would interfere with the counter calculation.

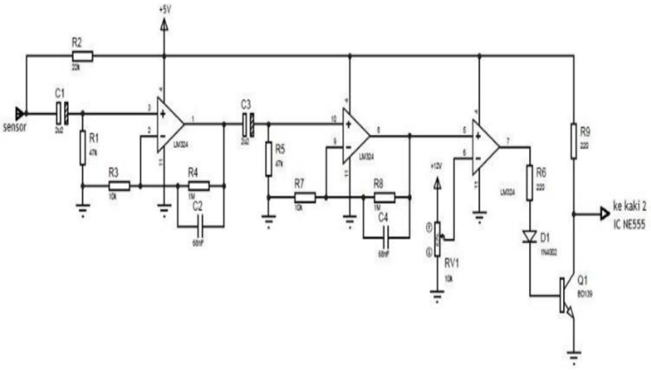

Fig. 3. Signal conditioner schematic

b. Monostable

Monostable circuit generated or produced one pulse following the specified time. The output of the comparator triggered the transistor which induced the monostable to work. When the monostable received a trigger input in the form of a change of high voltage to low, the output would be logic 1 for the time determined by monostable calculation. The output of the monostable formed a square wave of 5V and 0V to be read by a microcontroller pin counter. The monostable schematic is displayed in Figure 4.

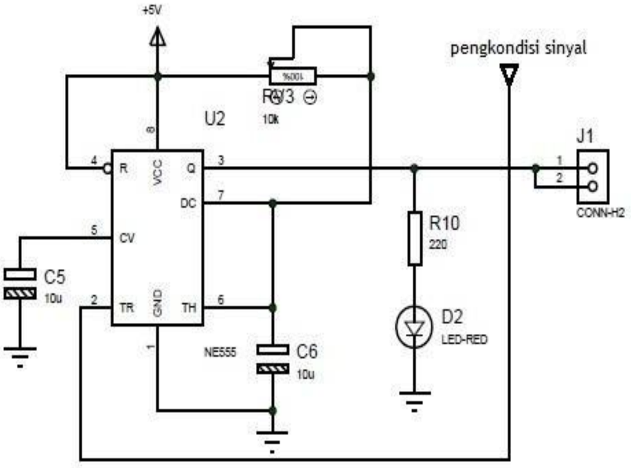

Fig. 4. Monostable schematic

c. Minimum system

The minimum system circuit is a circuit created to place the microcontroller, in this case, the IC Atmega8, so that it can operate, and can be reprogrammed. The minimum system schematic is shown in Figure 5. The clock frequency is using crystal 11.05920Mhz.

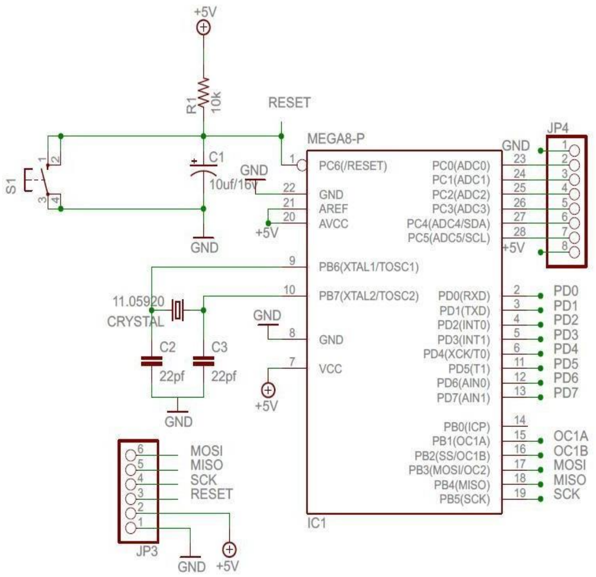

Fig. 5. Minimum system schematic

d. *Driver heater and fan*

The driver heater circuit acted as a bridge between the microcontroller that worked at the digital level (5V voltage) and the AC heater as a load that worked at 220V voltage. This circuit controlled the heaters On or Off state with the input coming from the microcontroller that provided the logic high (1) or low (0) set in the program.

The motor driver circuit operated as a bridge between the microcontroller that worked at the digital level (5V voltage) and the DC fan as a load that worked at 12V voltage. This circuit controlled the fans On or Off state with the input coming from the microcontroller that provided the logic high (1) or low (0) set in the program.

IV. RESULT AND DISCUSSION

The next stage is to test and measure after constructing the module. Data collection of the Heartbeat was carried out through multiple stages of the assessment and testing process. Measurement and test aimed to assess the thickness of the modules and to ensure that each portion (component) of the entire series of modules performs as expected.

To get accurate test results, the authors experimented with calculating heart rates for seven people with two different conditions, namely conditions when not relaxed and when relaxed, because these conditions affected the number of heartbeats in each person. Researchers used Pulse Oximeter as a comparison. The test was performed by comparing the value of the heart rate between the comparator with the module simultaneously.

Based on the diagram of the heart rate measurements in Figure 6, the results showed a heart rate increase in a condition before relaxation and a significant decrease in conditions after relaxation, where everyone is relaxing and enjoying the scent lavender therapy. The average heart rate increase was 92.4, and the average heart charge decrease was 73.6. The use of aromatherapy proved to help someone in the relaxation.

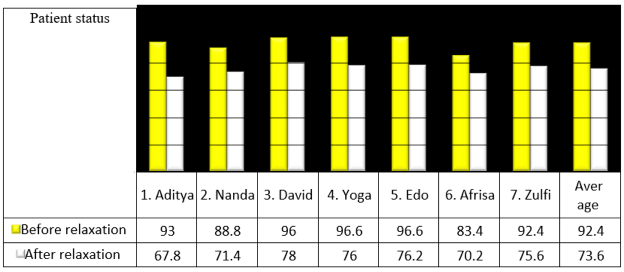
Patient status	1. Aditya	2. Nanda	3. David	4. Yoga	5. Edo	6. Afrisa	7. Zulfi	Average
▨ Before relaxation	93	88.8	96	96.6	96.6	83.4	92.4	92.4
☐ After relaxation	67.8	71.4	78	76	76.2	70.2	75.6	73.6

Fig. 6. Patients test result

In general, the factors that influence heart rate are Gender, Age, body weight, Emotional or psychological state, Habits of daily activities, Body attitude when measuring pulse, Temperature/air temperature around it, and Drug Consumption.

Too high or low heart pulse indicates a health problem, especially if accompanied by other symptoms such as dizziness, shortness of breath, or frequent fainting. A person's heart rate is influenced by age and activity. Sports or physical activity increases the number of heartbeats, but excessive activity can harm the body. Table 1 presents the patient’s state before and after relaxation for data analysis calculations to determine the quality of the measurements on the module.

TABLE I. TEST RESULT DIFFERENCE AND ERROR

No	Name	Patient status	Difference	Error
1	Adit	Before relaxation	0.2	0.21%
		After relaxation	0.4	0.58%
2	Nanda	Before relaxation	1	1.13%
		After relaxation	0.8	1.10%
3	David	Before relaxation	0.4	0.41%
		After relaxation	0.2	0.25%
4	Yoga	Before relaxation	1	1.02%
		After relaxation	0.4	0.52%
5	Edo	Before relaxation	0.4	0.41%
		After relaxation	0.2	0.26%
6	Afrisa	Before relaxation	0.2	0.23%
		After relaxation	0.2	0.28%
7	Zulfi	Before relaxation	0.4	0.43%
		After relaxation	1.4	1.88%
Average			0.51	0.62%

After measuring and testing the module, the smallest heart rate error obtained was 0.21% with a deviation of 0.2 in a condition before relaxation, while the greatest heart rate error was 1.88% with a deviation of 1.4 after relaxation. The average heart rate error obtained was 0.62%, with a deviation of 0.51.

Table 2 presents the aromatherapy oil heating. The heating on aromatherapy oils was very influential in their performance. The higher the heating temperature, the faster the aromatherapy oils work.

TABLE II. AROMA THERAPY OIL HEATING

No	Heating set point	Oil volume (ml)	Timer (Minute)	Device timer	Maximum temperature after Heater Off (°C)
1	40 °C	35	15	50 seconds	67
2		45	20	1 minute	64
3		55	25	1 minute 10 seconds	63
4		65	30	1 minute 30 seconds	61

V. CONCLUSIONS

After carrying out the process of planning, experimenting, making modules, and testing the tool, it is found that the tool can be used properly and under the objectives desired by the author. After evaluating and measuring the heart rate, the average error of the heart rate was 0.62%, in which the highest was 1.88% after relaxation, and the lowest was 0.21% before relaxation. It shows that there are differences before and after relaxation or after being given aromatherapy. It proves that the tool helps people in relaxation that can help reduce various kinds of health problems, one of which is anxiety or stress disorder.

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