

Modification of Infant Warmer with PID Temperature Controlled with Apgar Monitoring and Respiration Rate

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Abstract

Newborns, both healthy and premature babies, have a difficult problem, newborns withstood the environment with new ones that previously depended on the mother's uterus and also as a place for initial examination in nayi after just being discussed. The purpose of this study was to add a baby warmer with PID temperature control and add respiration parameters and APGAR. The contribution in this study is the PID control system which is used to control temperature and is also a sensor of respiration rates to determine respiration in infants. So that the values of the temperature sensor and Respiration Rate sensor can be stable it is necessary to adjust the sensor's reading time. The LM35 sensor can activate temperature in the body, the Flex Sensor is used to read respiration values in infants. Based on data collection of respiration rates taken from adults, an average value of 18.5 times per minute was obtained in the first attempt, and 21 times per minute in the second trial. Respiratory rate values that have not been stable take data because there are still external factors, such as changes from respondents and others. The results of this research can be implemented on baby warmers to improve the application of updates to the baby.

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I. INTRODUCTION

Generally, babies are born at 37-41 gestational age weeks, but there have been cases of babies born although the gestational age has not reached 37 weeks. That baby born before 37 weeks gestation calculated from the last menstrual period is called premature birth. [1]. Newborns lose four times as much heat than in adults, so that results in a decrease in temperature. In the first 30 minutes of the baby can experience a temperature drop of 3-4 C. In the room with a temperature of 20-25 C the baby's skin temperature drops around 0.3 C per minute. The decrease in temperature is caused by loss of heat by conduction, convection, evaporation, and radiation [2]

Infant Warmer Tool is a medical device used to optimize the temperature of a new baby born. Newborns are both healthy and healthy babies the premature has a problem that is the difficulty of the baby adjust body temperature to the new environment from what was before the mother's womb.2 If the temperature received by the baby is less or more than prescribed standards will be at risk of death on a baby. There are more than 20 million premature and weight babies low births are born every year globally, with more than 95% born in developing countries. Three million babies die in the first 28 days of their lives [3] After various studies that have been developed. An Infant The warmer tool has been made by Edo Bagus Prastika and Abdi Wibowo in 2014 with the title

"Infant Warmer Equipped with Phototherapy Indicator of Hyperthermia and Hypothermia ". The tool using a microcontroller as a data processor and using the LCD display as an indicator of Hyperthermia and hypothermia. Weaknesses in the tool when the heater turns off and then there is an increase in temperature skin 0.2 ° C. Infant Warmer development and research as well as happening abroad, in Thailand with the title "Heat Transfer Efficiency Analysis of Infant Radiant Warmer by 3D Finite Element Method ". In that study using FEM analysis with the help of software COMSOL Multiphysics (version 3.5a). The software function as a simulation module for the spread of temperature on the mat in the form of image processing. 3 Then in the United States also researched Infant Warmers with the Servo-controlled System. The device uses a servo-controlled system as a system to control temperature stability at Infant Warmer This can cause temperatures on Infant Warmers will not experience an overheating will have an impact on the baby's safety, so the baby does not will become dehydrated or hyperthermia. Then in Iraq "Smart" research was also carried out Incubator Based on PID Controller "by Zain-Aldeen S. A. Rahman and Farahan S. A. Hussain in 2017. These devices use the DHT-11 sensor as a temperature sensor and LM 35 sensor as skin sensors, with PID control that uses the C programming language with IDE software and is processed on Arduino Mega. Economical Control System in Consumption

Power. Research with the title "PID Temperature Controller Infant Incubator Using RTD "by Harsh Jadav and Amar Bansod explained that the method PID algorithm that controls PWM to control the heater to keep the temperature setting at want, using the PT100 RTD sensor. However, the device has additional parameters that remain less to see the baby's condition. 4 Furthermore, research was re-developed by Brahminindya Resi Kanastriloka and Maimunah Novita Sari in 2018 with the title "Infant Warmer equipped with Phototherapy ". The tool uses Arduino Uno as data processing then uses LCD as a temperature display. Weaknesses in the tool is a heater that is used is not equipped with an iron plate for faster temperature propagation. Then the next research was carried out by I. W. Aris Wiyadnyana Putra, W. Widhiada, and I. N. Suarnadwipa with the title "Temperature Stability Control PID System and Humidity in Microcontroller-Based Baby Incubators Arduino ". This tool using the PID system with the tunning trial and error method using DHT 22 sensor and LM 35 sensor as skin sensors. The weakness in this study is the DHT 22 sensor which is less sensitive than other sensors. In a study conducted by Anggraeni Dara Pratiwi with the title "Proportional Based Infant Incubator Integral and Derivative (PID) Equipped with Mode Kangaroos "researchers use the PID control system as well combined with kangaroo mode, using a minimum ATmega 328 system which processes analog data from LM 35 and a Thermistor sensor with a temperature setting of 32 ° C to 37 ° C. In these tools there are still weaknesses in PID response to the heater performance due to wattage heater that is too small so that the PID response is little slow.

Based on the results of the identification of the problems contained from existing research, the writer wants to develop and complete these deficiencies by making a thesis with the title above, the writer wants to make a thesis with the title "Infant modification Warmer (PID, RR & APGAR Temperature Control) ". Wherewith the addition of added parameters and safety systems which is also improved.

II. MATERIALS AND METHODS

A. Experimental Setup

This study used ten subjects. Subjects were taken randomly and data collection was repeated 2 times.

B. Materials and Device

This study uses the Flex Sensor (2.2", China) to monitor respiration rate and an LM35 (SNIS159H, America) sensor to detect the temperature to be controlled by the PID. The differential amplifier circuit is used to amplify the output voltage of the flex sensor and make the output range between 0-5V. The envelope series is used to give the output of the highest voltage coming from differential amplifier circuit. From the second the series above, obtained the difference between PSA output circuit with envelope circuit. Arduino UNO (R3, Italy) was used to process the data read by the sensor Flex and LM35. Character LCD as a screen to display (20x4 LCD with I2C, basic, China) the Respiartion Rate value and temperature.

C. Experiment

In this study, researchers measured the value of temperature and respiration rate from respondents who were randomly selected and the results were compared with standard.

D. The Diagram Block

Arduino UNO as a microcontroller processes the temperature and time settings that have been input as temperature control settings. The data will be sent to Arduino Uno and then forced to control the heater according to the temperature set between 35 ° C - 37 ° C. For Infant Warmers, first choose setting the temperature you want by pressing the Up / Down button. Then the start button indicates that Arduino Uno is starting to process the work of the infant warmer tool. The Reset button is used to stop the buzzer alarm. The APGAR timer is used for giving newborn APGAR scores. The RR sensor reads the respiration value and then processes the microcontroller and then displays it on the LCD. If the room temperature sensor does not read the temperature or the excess temperature, the thermostat will turn off the heater when it reaches the thermostat setting temperature. The thermostat locking circuit is used to lock the condition when the thermostat setting temperature is reached (the buzzer still sounds and the heater turns off).

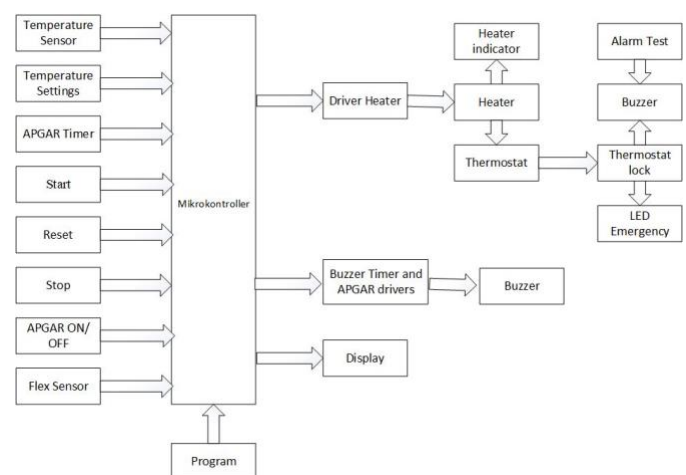


Fig 1. The diagram block

E. The Flowchart

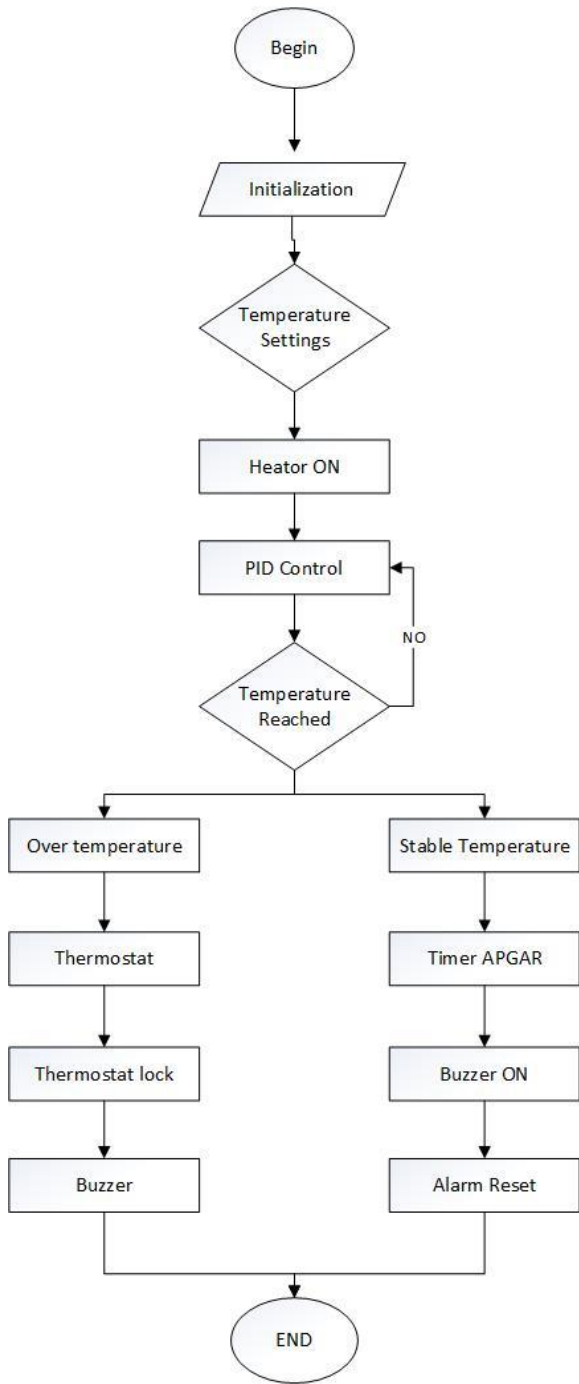


Fig 2. The Flowchart

At start (start) the microcontroller initializes and then the user sets the temperature so that the microcontroller detects the difference between the set point temperature and the actual temperature, the difference in value will be input to the PID control. The PID control processes the error value and determines the output value for the heater. Then the temperature sensor will read the actual temperature value and compare it to the setting temperature. The PID control will continue to process the error value and determine the output value so that the actual temperature is the same as the setting temperature (error value = 0). If the temperature is stable, the APGAR timer is activated by the user, the APGAR timer

buzzer sounds at 1, 5 and 10 minutes the buzzer is turned off by using an alarm reset, if finished the process ends.

F. Circuit

1) Amplifier Circuit

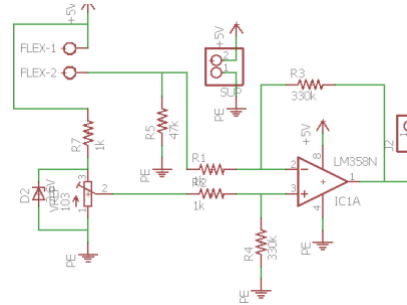


Fig 3. Circuit of Amplifier

The differential amplifier circuit is used to amplify the output voltage of the flex sensor and make the output range range from 0-5V.

2) Envelope Circuit

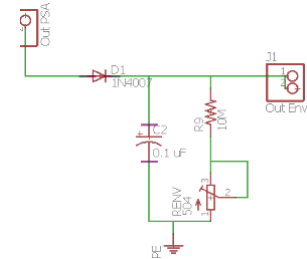


Fig 4. Circuit of Envelope

the envelope circuit is used to output the highest voltage coming from the differential amplifier circuit. from the two series above, we get the difference between the psa circuit output and the envelope circuit.

III. RESULTS

In this study, respiration is known as the following data results

A. Experiment 1 Respiration Rate

| Measurement | RR Value |
|-------------|----------|
| 1. | 18 |
| 2. | 18 |
| 3. | 16 |
| 4. | 20 |
| 5. | 20 |
| 6. | 21 |
| 7. | 11 |
| 8. | 23 |
| 9. | 17 |
| 10. | 21 |
| Mean | 18,5 |
| SD | 3,06 |
| UA | 0,97 |

From the table above it can be seen that the data collection is done by placing the sensor on the stomach for 10 attempts, so that the average value is 18.5 times per minute, the standard deviation of 3.06 and the uncertainty value is 0.97

B. Experiment 2 Respiration Rate

| Measurement | RR Value |
|-------------|----------|
| 1. | 22 |
| 2. | 18 |
| 3. | 22 |
| 4. | 25 |
| 5. | 20 |
| 6. | 21 |
| 7. | 20 |
| 8. | 23 |
| 9. | 17 |
| 10. | 22 |
| Mean | 21 |
| SD | 2,36 |
| UA | 0,75 |

The table above is the result of the measurement of the output produced by the flex sensor which is measured using a multimeter / avometer.

From the table above it can be seen that the data collection is done by placing the sensor on the stomach for 10 attempts, so that the average value is 21 times per minute, the standard deviation of 2.36 and the uncertainty value is 0.75

| Measurement | Voltage |
|-------------|---------|
| 1. | 2,6 V |
| 2. | 2,9 V |
| 3. | 3,2 V |
| 4. | 3,8 V |
| 5. | 3,6 V |

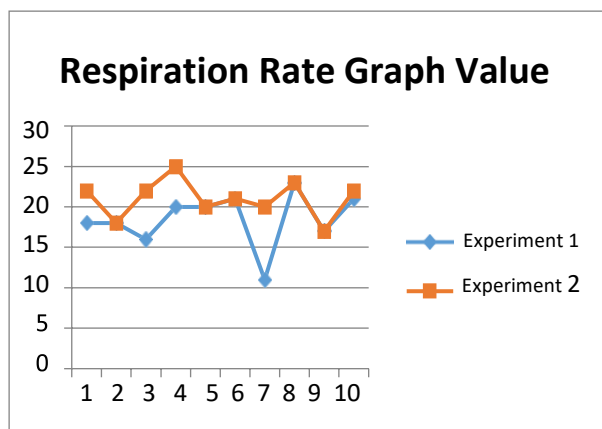


Fig 5. The result of the reading between the comparison Experiment

Based on the above results it is known that on the x-axis is the number of experiments carried out and on the y-axis is the respiration rate value. Respiration rate data collection was taken from respondents with 2 trials with respondents as many as 10 people, obtained the highest respiration value 23 in experiments 1 and 25 in experiment 2, then for the lowest value 11 in experiments 1 and 17 in experiment 2. Respiratory values that are not stable when collecting data caused by external factors, such as respondent movements and others.

C. Tool voltage measurement results

D. Listing program for Respiration Rate

```

Int flexADC =analogRead(FLEX_PIN); float
flexV = flexADC *VCC / 1023.0; float flexR
= R_DIV *(VCC / flexV -1.0);
float angle = map(flexR, STRAIGHT_RESISTANCE,
BEND_RESISTANCE,
0, 90.0);
int buttonState = flexR;
waktu=millis()-
waktusekarang;
if(waktu<=60000)
{
    if(buttonState>15000)
    {
        del
        ay(
        20);
        a=1
        ; }
    if (a==1&&buttonState<=11000)
    {
        hitung
        an++;
        a=0; }
    }
else
{
    waktusekarang=
    millis();
    hitungan1 =
    hitungan;
    hitungan=0;
}

```

The above program is a program for reading flex sensors. The flex sensor is entered at pin A0. The resistance when the sensor is straight is set at 37300 and when it is bent at 90000. Flex sensor data will first be converted from adc data to resistance data (flexR) and standalone data (flexV). Then it will be converted again into a bend angle right flex sensor. FlexR data will be used as a resistance signal value to calculate the respiratory rate every minute. The program for calculating the respiratory rate uses 2 limits for its signal value, after the upper limit is met then the lower limit detection program will be active, and after the lower limit is fulfilled then the program will add a count of +1 to the RR value.

E. Program PID Control Program

```

void PID()
{
    adclm = analogRead(A6);
    suhu = (adclm *
    0.48828125)-10; float
    Input=suhu;
    float selisih=setsuhu -
    suhu; unsigned long now =
    millis();
    double timeChange = (double)(now -
    lastTime); double error = setsuhu - Input;
    double errSum = (error *
    timeChange); double dErr = (error -
    lastErr)/timeChange;

```

```

int Output = (((kp * error) + (ki * errSum)) + (kd*
dErr)); lastErr= error;
lastTime= now;
if (Output<=0){Output=0;}
if
(Output>=250){Output=2
55;}
analogWrite(pwmpid,Out
put);
}

```

In the above program is a program to control temperature using the PID method. There is a temperature reading of LM 35 on analog pin A6 as the temperature data input. In the pid method setting there are variables kp (Propotional), ki (integral), and kd (derivative). This variable is the setting constant for the PID. The error value can be obtained from the temperature set with the actual temperature. ErrSum value is obtained from the change of time in each cycle of the error value. The dErr value can be obtained from the difference in error before the most recent error, the difference will be divided over time. Results Output from the sum of kp, ki, and kd will be used as the driver heater. The output results will be first converted into 8-bit data because pwm on Arduino uses 8 bits of data. After the data conversion will be issued on the pin PWM.

F. Listing program for Display

```

#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,2,1,0,4,5,6,7,3,POSITIVE);
lcd.clear();
lcd.setCursor(
2, 0);
lcd.print("RR"
);
lcd.setCursor(
5, 0);
lcd.print(hitun
gan);
lcd.setCursor(
2, 1);
lcd.print("RR
FIX");
lcd.setCursor(
10, 1);
lcd.print(hitun
gan1);
delay(100);

```

Explanation of the program above is the program display appearance on the LCD character where in the program there is a library of LCDs and also the placement of words on the display.

In this study, researchers measured the Respiration Rate value of 10 respondents who were randomly selected and the results in the first experiment were found to be 18.5 times per minute on average while in the second experiment was 21 times per minute. From the measurement results this device can work well. However, the weakness of this module is that when

there is patient data collection or external factors that will cause different values.

IV. CONCLUSION

Based on the results of the discussion and the purpose of making the module, it can be concluded that the results of the respiration rate yield an average value of 18.5 times per minute, a standard deviation of 3.06 and an uncertainty value of 0.97 for the first respondent and 21 times per minute, the standard deviation is 2.36 and the uncertainty value is 0.75 for the second respondent. The value of respiration rate is not yet stable due to the presence of external factors, such as movement of the subject. Respiratory rate values that have not been stable take data because there are still external factors, such as changes from respondents and others. Missing data generated by data related to the data collected and correct data using multimeter output obtained 2.6 volts and 2.9 volts, then 3.2 volts and 3.8 volts and the final measurements are 3.6 volts.

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