

**DEVELOPMENT OF PORTABLE TEMPERATURE AND
HEART RATE MONITOR IN WRIST AREA**

By

Aditya Dyan Pratama
14310049

A thesis submitted to the Faculty of
LIFE SCIENCES AND TECHNOLOGY

in partial fulfillment of the requirements
for the
BACHELOR'S DEGREE
in
BIOMEDICAL ENGINEERING



SWISS GERMAN UNIVERSITY
EduTown BSD City
Tangerang 15339
Indonesia

August 2014

Revision after the Thesis Defense on 19th July 2014

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.

Aditya Dyan Pratama

Student

Date

Approved by:

Fuad Ughi, MT.

Thesis Advisor

Date

Dr. rer. nat. Maruli Pandjaitan

Thesis Co-Advisor

Date

Irvan Kartawiria, M.Sc.

Dean

Date

Aditya Dyan Pratama

ABSTRACT

DEVELOPMENT OF PORTABLE TEMPERATURE AND HEART RATE MONITOR IN WRIST AREA

By

Aditya Dyan Pratama
Fuad Ughi, MT. Advisor.
Dr.rer.nat.Maruli Pandjaitan. Co-Advisor.

SWISS GERMAN UNIVERSITY

Healthcare monitor is important to maintain self condition to avoid excessive exercise or daily activity. Some indicator of excessive activity including heart rate and body temperature. The development of portable temperature and heart rate monitor are based on the importance of maintaining heart rate and body temperature in safe value to prevent the risk of overworking. By reading the difference of reflected infra red by photo diode, heart rate can be determined, by recognizing the maximum and minimum peak value of the voltage output from the photo diode. Thermistor are used as temperature sensor, allowing the change of voltage from the heat surrounding the thermistors can determine the skin temperature of the user. Both sensors are located in the wrist area and controlled by arduino microcontroller board, concerned on the integration to smartwatch as a future research. The location of the sensors also concerned on reducing of interference on user daily activity. Calibration are done for both sensors, with the result is the formula to determine each sensors standard. Data analysis shows the accuracy of 92,78% with deviation of $\pm 4,80$ BPM for the heart rate sensor and 99,72% of accuracy with deviation of $\pm 0,51$ °C on the temperature sensor.

Keywords: Healthcare monitor, temperature, heart rate, sensor, arduino.

© Copyright 2014
by Aditya Dyan Pratama
All rights reserved

DEDICATION

I dedicate this thesis for Allah SWT and my family who always support me and give me strength to overcome hardship.

ACKNOWLEDGEMENTS

The author wishes to thank Allah SWT, for everything, and for His blessing so this thesis can be finished in time.

I'd also want to thank Fuad Ughi, MT. as my advisor. Thanks to you sir I could finally finish this thesis. Thank you for your guidance, advice, and your ideas which could help me to work on this thesis. Thank you for your support all this time.

I'd also like to thank Dr. rer. nat .Maruli Pandjaitan as my co-advisor. Thank you for sharing me your knowledge and give me moral support to overcome the hardship in doing this thesis.

Also a lot of thanks to my family (Bunda, Ayah, Arya, Ardha), thank you for the support and prayer all this time. And also I'd like to thank my friends who had helped me during this thesis works, including :

To Megantara Pura, thank you for your advice and for sharing your knowledge. Thank you for your ride every day of my thesis day from SGU to taxi pool.

To Tabligh Permana, thank you for your advice and for your ideas. Your ideas has inspired me to think deeper to write my arduino programming.

To Andre, Andika, Tika, Nabila, Melliany, Marsha, Jason, Raka, Gerald, Irene, Sandy, my fellow Biomedical Engineering students, for their support, advice, for sharing their knowledge, and for all the things in this 4 years together, thank you guys!

To all of my fellow life sciences students, thank you guys for sharing this college life together. May we always succes and have a great future ahead. Life Sciences Rocks!

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR.....	2
ABSTRACT	3
DEDICATION	5
ACKNOWLEDGEMENTS.....	6
TABLE OF CONTENTS	7
LIST OF FIGURES	9
LIST OF TABLES	10
CHAPTER 1 – INTRODUCTION	11
1.1 Background	11
1.2 Research Problems	13
1.3 Research Objectives.....	13
1.4 Significance Of Study	13
1.5 Research Questions	14
1.6 Hipotesis.....	14
CHAPTER 2 – LITERATURE REVIEW	15
2.1 Health Monitor	15
2.2 Temperature Sensor.....	16
2.3 Heart Rate Sensor	17
2.4 Arduino Software and Microcontroller Board	19
CHAPTER 3 – METHODOLOGY	21
3.1 Design Justification.....	21
3.2 Component of Design	23
3.2.1 Heart Rate Sensor	23
3.2.1.1 Hardware	23
3.2.1.2 Software	24
3.2.2 Temperature Sensor.....	29
3.2.2.1 Hardware	29
3.2.2.2 Software	30
3.2.3 Display and Power Source	33
CHAPTER 4 – RESULTS AND DISCUSSION	35

4.1 Final Design.....	35
4.2 Heart Rate Sensor	36
4.3 Temperature Sensor.....	41
4.4 Integrated System.....	46
CHAPTER 5 – CONCLUSIONS AND RECOMMENDATIONS.....	47
5.1 Conclusions	47
5.2 Future Recommendations	48
GLOSSARY	49
REFERENCES	50
APPENDICES	52
CURRICULUM VITAE	127

LIST OF FIGURES

Figure	Page
1. System Flowchart of Remote Monitoring Device for Heart Rate and Body Temperature Measurement (Rahman et al. 2012)	17
2. General Block Diagram of Portable Temperature and Heart Rate Monitor	21
3. Block Diagram of Heart Rate Sensor	23
4. Heart Rate Sensor Schematic Design.....	24
5. Raw Data Output of Heart Rate Sensor	24
6. Flowchart of Heart Rate Sensor Arduino Program	25
7. Flowchart of Smoothing and Amplifying Program of Heart Rate Sensor	26
9. Flowchart of Threshold Determination on Heart Rate Data.....	27
10. Flowchart of Sensor Reminder of Heart Rate Sensor	29
11. Block Diagram of Temperature Sensors.....	30
12. Voltage Divider Circuit with Thermistor.....	30
13. Calibrating Proccess to Determine Temperature Formula	31
14. Linear Trendline from Calibrating Results	32
15. Flowchart of Arduino Program for Temperature Sensor	32
16. Voltage Regulator Circuit using MC78L05AB.....	33
17. Voltage Regulator Circuit Using AMS1117	34
18. LCD Display Circuit	34
19. Final PCB Design	35
20. Raw Data Voltage Output.....	36
21. Heart Rate Sensor Output Measured in 15 Seconds	37
22. Heart Rate Sensor Location in Measurement.....	38

LIST OF TABLES

Table	Page
1. Temperature Sensor Calibration Results.....	31
2. Heart Rate Sensor Results in Finger	39
3. Heart Rate Sensor Results in Wrist.....	39
4. Standard Deviation of Heart Rate Measurement in Finger	40
5. Standard Deviation of Heart Rate Measurement in Wrist	40
6. Calibrating Results of Temperature Sensors.....	41
7. Error in Temperature Measurements	42
8. Standard Deviation of Temperature Measurements	43
9. Temperature Comparison of Wrist and Mouth Measurement.....	44
10. Temperature Comparison of Wrist and Axilla Measurement	44
11. Temperature Comparison of Wrist and Ear Measurement	44
12. Error Percentage of Wrist Measurement	45
13. Measurement Results using Integrated System	46