

**DEVELOPMENT OF A MICROCONTROLLER-BASED  
BODY STATISTICS ANALYZER**

**THESIS**

**JUMEL R. HERNANDEZ**

**KEYVIN I. LUNGCAY**

**College of Engineering and Information Technology**

**CAVITE STATE UNIVERSITY**

**Indang, Cavite**

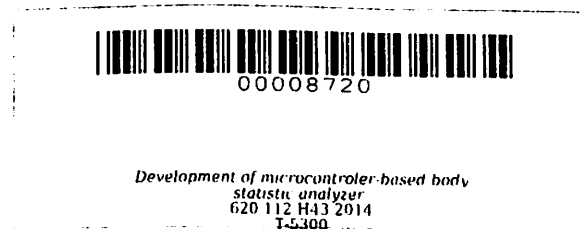
**April 2014**



**DEVELOPMENT OF A MICROCONTROLLER-BASED  
BODY STATISTICS ANALYZER**

Undergraduate Thesis  
Submitted to the Faculty of the  
College of Engineering and Information Technology  
Cavite State University  
Indang, Cavite

In partial fulfillment  
of the requirements for the degree  
Bachelor of Science in Computer Engineering and  
Bachelor of Science in Electronics and Communications Engineering



**JUMEL R. HERNANDEZ**  
**KEVIN I. LUNGCAY**

April 2014

## **ABSTRACT**

**HERNANDEZ, JUMEL R. and LUNGCAY, KEVIN I., Development Microcontroller-Based Body Statistics Analyzer.** Undergraduate Design Project. Bachelor of Science in Computer Engineering and Bachelor of Science in Electronics and Communications Engineering. Cavite State University, Indang, Cavite. April 2014. Adviser: Engr. Michael T. Costa

The main objective of the project was to develop a microcontroller-based body statistics analyzer. Specifically, it aimed to design and construct the circuit of the device. The interfacing of the sensors, specifically the load cell, ultrasonic sonar sensor, and pulse oximeter; LCD module; thermal printer; coin slot; and keypad to the microcontroller of the device. The test and evaluation of the design project was done by the comparing the results obtained in the digital body statistics analyzer to actual measurements and computations. The cost computation of the study was also conducted.

The microcontroller-based body statistics analyzer consisted of GizDuino X microcontroller as the processing unit. The microcontroller was responsible for the entire operation of the system.

The testing and evaluation of the project was done at the Engineering Science Building of the Department of Computer and Electronics Engineering by 30 participants to determine the accuracy, consistency, efficiency, and reliability of the designed project. The adviser, technical critic, some faculty member of CvSU tested the functionality of the device. Based on the results of the evaluation, the device proved to be accurate by the statistical analysis from the results of the evaluations.

The total cost of the design project was PhP 22,725.25.

## TABLE OF CONTENTS

	Page
BIOGRAPHICAL DATA .....	iii
ACKNOWLEDGMENT .....	v
ABSTRACT.....	viii
LIST OF TABLES.....	xi
LIST OF FIGURES.....	xiii
LIST OF APPENDICES .....	xiv
LIST OF APPENDIX TABLES .....	xv
LIST OF APPENDIX FIGURES .....	xvi
INTRODUCTION .....	1
Objectives of the Study.....	3
Significance of the Study.....	3
Time and Place of the Study .....	5
Scope and Limitation of the Study .....	5
Definition of Technical Terms.....	8
REVIEW OF RELATED LITERATURE .....	11
MATERIALS AND METHODOLOGY .....	27
Materials .....	27
Methods .....	30

<b>RESULTS AND DISCUSSION .....</b>	<b>43</b>
<b>SUMMARY, CONCLUSION AND RECOMMENDATION.....</b>	<b>65</b>
Summary .....	65
Conclusion .....	66
Recommendations.....	67
<b>REFERENCES .....</b>	<b>69</b>
<b>APPENDICES.....</b>	<b>70</b>

## LIST OF TABLES

Table		Page
1	Body Fat Percentage Chart.....	15
2	Standardize BMI Table of Turcotte .....	16
3	Recommended Asia BMI Cut-offs.....	17
4	Result of difference in height measurement using actual calculation and BSA.....	52
5	Result of difference in weight measurement using actual calculation and BSA.....	52
6	Result of difference in BMI computation using actual calculation and BSA.....	53
7	Result of difference in IBW measurement using actual calculation and BSA.....	54
8	Result of difference in body fat percentage using actual calculation and BSA.....	54
9	Result of difference in pulse oximeter reading using digital pulse oximeter and BSA. ....	55
10	Result of difference in SPO2 reading using digital pulse oximeter and BSA. ....	55
11	Scale for rating the performance of microcontroller-based Body Statistics Analyzer.....	56
12	Assessment of the participants on the user interaction of the BSA .....	57
13	Assessment of the participants on the consistency of the BSA .....	58
14	Assessment of the participants on the efficiency of the BSA .....	58
15	Assessment of the participants on the accuracy of the BSA .....	59
16	Assessment of the participants on the reliability of the BSA.....	60
17	Assessment of overall rating of the participants on the BSA.....	60

18	Mean range interpretation .....	61
19	Distribution of the participants' perception on the system. ....	61
20	Price list of the materials.....	63

## LIST OF FIGURES

Figure		Page
1	The graph of the absorption curves for both types of hemoglobin (oxygenated and deoxygenated) as a function of wavelength (Fox, 2006) .....	21
2	The block diagram of the unit.....	30
3	The PCB layout of the BSA components to the microcontroller .....	31
4	LCD display to microcontroller connection .....	32
5	Load cell amplifier circuit .....	32
6	Load cell, RTC and ultrasonic sensor connections to Gizduino X.....	33
7	Pulse oximeter connection to the microcontroller .....	34
8	Keypad encoder connection to the microcontroller.....	35
9	SD/MMC shield connection to the microcontroller .....	36
10	Thermal printer and coin acceptor connection to the microcontroller .....	37
11	The schematics of the 5V/3A and 12V/1A power supply .....	38
12	The schematics of the 5V/3A and 12V/1A power supply .....	39
13	The program flow chart .....	42
14	The microcontroller-based body statistics analyzer .....	44
15	The main display of the BSA.....	45
16	Sample printed result of the body statistics analyzer.....	47



## LIST OF APPENDICES

<b>Appendix</b>		<b>Page</b>
1	Appendix Tables .....	71
2	Appendix Figures .....	86
3	Program Listing .....	100
4	Evaluation Sheets .....	135
5	Forms and Letters .....	140
6	Data Sheets .....	155

## LIST OF APPENDIX TABLES

<b>Appendix Table</b>		<b>Page</b>
1	Actual and computed body statistics data of the 30 participants.....	72
2	Mean, Std. deviation and percent error for different parameters.....	73
3	Interpretation for the results of the evaluation.....	74
4	Statistical result for individual questions.....	75
5	T-test for height measurement .....	76
6	T-test for weight measurement .....	77
7	T-test for BMI measurement .....	78
8	T-test for IBW measurement .....	79
9	T-test for body fat percentage measurement .....	80
10	T-test for pulse rate measurement.....	81
11	T-test for oxygen saturation measurement .....	82
12	The T-Test table.....	83

## LIST OF APPENDIX FIGURES

Appendix Figure		Page
1	The load cell .....	87
2	The power supply unit .....	87
3	The pulse oximeter .....	88
4	I/O to Gizduino board.....	88
5	Ultrasonic sensor in casing.....	89
6	The weighing scale .....	89
8	The control unit- LCD, keypad, coin acceptor and pulse oximeter .....	90
9	The thermal printer while printing results .....	90
10	Locked right side view of the control unit.....	91
11	Left side view of the control unit.....	91
12	Inside the control unit, connections of input/output components to Gizduino X, the coin acceptor, coin bank, RTC module, pulse oximeter, thermal printer and LCD .....	92
13	Isometric view of the microcontroller-based body statistics analyzer...	93
14	Purchasing locally available materials.....	94
15	Purchasing pre-ordered components.....	94
16	Fabrication of casing.....	95
17	Construction of power supply unit .....	95
18	Constructing the microcontroller-based circuit .....	96
19	Wiring of the components .....	96
20	Uploading program, covering fiber sticker and polishing device.....	97

21	Initial testing by a panelist.....	98
22	Initial testing by the college research coordinator.....	98
23	Evaluations of CEIT students .....	99
24	Evaluation of CvSU faculty.....	99

# **DEVELOPMENT OF A MICROCONTROLLER-BASED BODY STATISTICS ANALYZER**

**Jumel R. Hernandez  
Kevin I. Lungcay**

---

An undergraduate design project submitted to the faculty of the Department of Computer and Electronics and Communications Engineering, College of Engineering and Information Technology, Cavite State University, Indang, Cavite in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Engineering and Bachelor of Science in Electronics Engineering. Contribution No. CEIT – 2013 – 14 - 039. Prepared under the supervision of Engr. Michael T. Costa

---

## **INTRODUCTION**

The assessment of body statistics involves using the most appropriate, and accessible, method possible to 'estimate' a person's body composition. Body composition was analyzed by means of evaluating one's height, body weight, age, body mass index, ideal weight, body fat percentage, body age, oxygen saturation in blood, heart rate and a lot more of parameters. Body statistics analyzer for most people was used to screen health composition categories that may lead to health problems if not given prior attention.

Body Mass Index (BMI) was a simple, quick calculation meant for use in classifying people who were not physically active and who have an average body composition, and was generally considered a good indicator of whether people were at a healthy, normal weight for their height. Body Fat, in its simplest form was the amount of fat in the body, compared to everything else (which includes organs, muscles, bones, tendons, water, and so on). The ideal weight on the other hand was the lean weight of the