

**DEVELOPMENT OF A SIMULATED MEASURING OBJECT FOR THE
EVALUATION OF DIFFERENT SENSORS**

By

Kristophorus Peter
1-1301-028

BACHELOR'S DEGREE
in

MECHANICAL ENGINEERING – MECHATRONICS CONCENTRATION
FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY



SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 - Indonesia

August 2017

Revision after the Thesis Defense on 26th July

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.

Kristophorus Peter

Student

Date

Approved by:

Prof. Dr. -Ing. Werner Krybus

Thesis Advisor

Date

Ir. Arko, Ph.D

Thesis Co-Advisor

Date

Dr. Ir. Gembong Baskoro, M.Sc,

Dean

Date

Kristophorus Peter

ABSTRACT

DEVELOPMENT OF A SIMULATED MEASURING OBJECT FOR THE
EVALUATION OF DIFFERENT SENSORS

By

Kristophorus Peter
Prof. Dr.–Ing. Werner Krybus, Advisor
Ir. Arko, Ph.D., Co-Advisor

SWISS GERMAN UNIVERSITY

Position measurement by using sensors is crucial for many applications especially in industrial and safety-related fields. Therefore, a well-calibrated sensor is essential in all measuring systems. Currently, a laboratory exercise for students taking subject “Messwerterfassung und Umformung” in FH Südwestfalen Soest is not optimized for the purpose. This thesis work is an effort to develop and optimize the laboratory equipment for exercising with different types of position sensors and their comparison. A new position measuring system that consists of an electronic control box, a mechanical positioning system, electronic position sensors, and PC with LabVIEW will be designed and developed. Interconnection between the control box and LabVIEW will be developed using serial connection via USB. The control box is utilizing STM32F429I-DISC1 32-bit ARM microcontroller to controls the stepper motor driver of the mechanical positioning system and communicate with LabVIEW on the PC. CooCox IDE is used as the development environment of the control box. Three type of sensors can be exercised and evaluated using the newly developed system, namely position sensors based on linear potentiometer, magnetostrictive, and LVDT. All the measurement process is controllable from the PC and the results are graphically and numerically displayed on a GUI. Experiments and calibration reveals that the accuracy of this system is dependent on the NI DAQ 11-bit resolution. LVDT shows its superiority compared to two other sensors in accuracy with only ± 0.05 mm while potentiometer and magnetostrictive sensors are ± 0.07 mm and ± 0.1 mm respective.

Keywords: LabVIEW, STM32F429, CooCox, position measurement, microcontroller, serial connection



DEDICATION

I dedicate this works to God Almighty Who makes everything possible.



ACKNOWLEDGEMENTS

For the completion of this thesis, first of all, I would like to express my gratitude to God Almighty for his blessings from start until the end of this journey. I would like to thank my advisor Prof. Dr.-Ing. Werner Krybus for giving me this chance for doing my thesis work in Germany, and Sascha Schmidt, B. Eng. For his guidance and patience during this thesis work. Also for Ir. Arko, Ph.D. for his guidance and supports during this thesis work and during pre-thesis defense.

I would like to thank for all the supports that has been given from my families, especially my parents who keep worrying about me.

Last but not least, I want to thank to all of my friends who are also doing their thesis in Germany, especially who is also doing their thesis in FH Soest, for all of encouragement and their company during this journey.

SWISS GERMAN UNIVERSITY

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	5
ACKNOWLEDGEMENTS.....	6
TABLE OF CONTENTS.....	7
LIST OF FIGURES.....	10
LIST OF TABLES.....	12
CHAPTER 1 – INTRODUCTION	13
1.1 Background.....	13
1.2 Thesis Objectives.....	14
1.4 Thesis Scope.....	14
1.5 Thesis Limitation.....	15
1.6 Thesis Organization.....	15
CHAPTER 2 - LITERATURE REVIEW	16
2.1 Theoretical Perspectives.....	16
2.1.1 Stepper Motor.....	16
2.1.2 STM32F429I-DISC1 [2].....	17
2.1.3 CooCox CoIDE [3].....	17
2.1.4 LabVIEW [15].....	17
2.1.5 Position Sensors.....	18
2.1.6 Data Acquisition [4].....	19
2.1.7 Sensitivity.....	20

2.1.8	Central Tendency	20
2.2	Previous Study	21
2.2.1	Stepper Motor Control based on AT89S51 Microcontroller [5]	21==
2.2.2	An Education Tool Study on Mechatronics: Emulation of Stepper Motor Driving Systems by Using a Microcontroller Based System Interface [6].....	22
2.2.3	Stepper Motor Drives for Robotic Applications [7]	22
CHAPTER 3 – RESEARCH METHODS		23
3.1	Materials and Equipment	23
3.1.1	Previous Laboratory Exercise	23
3.1.2	Addition Components	30
3.2	Development of Stepper Motor Control Box.....	31
3.2.1	Problem Analysis	31
3.2.2	Requirement Analysis.....	32
3.2.3	Solution Analysis	32
3.3	Implementation of Design.....	35
3.3.1	Microcontroller Programming	35
3.3.2	Stepper Motor Control Box Circuit Wiring	38
3.3.3	LabVIEW Communication	40
3.3.4	Position Sensors Integration with Stepper Motor	43
CHAPTER 4 - RESULTS AND DISCUSSION		46
4.1	Evaluation Plan	46
4.1.1	Linearity Measurement	46
4.1.2	Range of Error Measurement.....	48
4.2	Position Data Measurement Process	48
4.2.1	Linearity Measurement Data.....	49
4.1.2	Error and Sensitivity Measurement	55

CHAPTER 5 – CONCLUSIONS AND RECOMMENDATIONS	63
5.1 Conclusions.....	63
5.2 Recommendation	64
Glossary	65
References.....	66
APPENDICES	69
APPENDIX A – MEASUREMENT DATA	70
Testing 4.....	70
Testing 5.....	72
Testing 6.....	77
Testing 7.....	82
Testing 8.....	87
APPENDIX B – DATASHEET.....	90
STEPPER MOTOR	90
APPENDIX C- COOCOX PROGRAM CODE (COIDE Version: 2.0.3).....	91

SWISS GERMAN UNIVERSITY