

Indiana University – Purdue University Fort Wayne
Opus: Research & Creativity at IPFW

Computer and Electrical Engineering Technology &
Information Systems and Technology Senior Design
Projects

School of Engineering, Technology and Computer
Science Design Projects

Spring 4-2012

Conveyer Width and Sensor Positioning Automation Upgrade

Allan Barb

Follow this and additional works at: http://opus.ipfw.edu/etcs_seniorproj



Part of the [Computer Sciences Commons](#), and the [Engineering Commons](#)

Opus Citation

Allan Barb (2012). Conveyer Width and Sensor Positioning Automation Upgrade.
http://opus.ipfw.edu/etcs_seniorproj/925

This Senior Design Project is brought to you for free and open access by the School of Engineering, Technology and Computer Science Design Projects at Opus: Research & Creativity at IPFW. It has been accepted for inclusion in Computer and Electrical Engineering Technology & Information Systems and Technology Senior Design Projects by an authorized administrator of Opus: Research & Creativity at IPFW. For more information, please contact admin@lib.ipfw.edu.



ECET-CPET 491 Senior Design Project Phase II

Conveyor Width and Sensor Positioning Automation Upgrade

Final Report

To Fulfill B.S. Electrical Engineering Technology
Degree Requirements

Date Submitted: 27 April, 2012

Submitted By: Allan Barb

Faculty Advisor: Harold L. Broberg
Course Instructor: Paul I. Lin

Department Computer Engineering and Electrical Engineering Technology &
Information Systems and Technology
College of Engineering, Technology, and Computer Science
Indiana University-Purdue University Fort Wayne, Indiana

Abstract

It has become common place for technology to replace human intervention through automation. Automation provides a means for precise and repeatable performance of a task where it is impossible for a person. The PPS 7000 Board Marking System is one such example of an automated application. The system however, does have areas that require operator intervention that could still be automated. There are also areas of concern with repeated maintenance due to identifiable issues related to setup and product specific design. This project hopes to automate one such area in order to improve reliability of the system with minimal intervention.

Terms and Abbreviations

PCB – Printed Circuit Board,

PPS – Pulses per Second

PPS 7000 - Prototype & Production Systems, Inc., board marking system

RPM – Revolutions per Minute

RPS – Revolutions per Second

TPI – Turns per Inch

UV lamp – Ultra Violet cure lamp

VAC – Voltage Alternating Current

VDC – Voltage Direct Current

Table of Contents

1	Summary	6
	1.1 Introduction	6
	1.2 Background.....	6
	1.3 Statement of Need	7
	1.4 Objective	7
	1.5 Solution Statement	7
	1.6 Scope	8
	1.7 Schedule	8
	1.8 Cost	8
	1.9 Project Charter	9
2	Design	10
	2.1 Overview	10
	2.2 System Overview.....	10
	2.2 Board Conveyor.....	11
	2.3 Conveyor Automation	12
	2.4 Load Considerations.....	12
	2.4.1 Torque Requirements.....	12
	2.4.2 Motion Requirements.....	13
	2.5 Sensor Positioning.....	14
	2.5.1 Sensor Considerations	14
	2.6 Motor Selection	14
	2.6.1 Stepper Motor	15
	2.6.2 Motor Control.....	17
	2.6.3 Controller / Driver.....	20
	2.7 PC Control.....	21
3	Project Cost	23
	3.1 Cost	23
4	Implementation Plan	24
	4.1 Project Implementation	24
	4.2 Procurement.....	24
	4.2.1 Hardware Selection	24
	4.2.2 Schematic Layout	24
	4.3 GUI.....	24
	4.4 Prototype Construction	25
	4.5 Project Evaluation	25
	4.5.1 Evaluation Plan.....	25
	4.5.2 Project Requirements.....	26
	4.6 Project Schedule	27
	4.7 Risk Analysis	29
5	Project Build	30
	5.1 System Build.....	30
	5.2 Hardware.....	30
	5.2.1 Conveyor Demonstration	31

5.2.2 Motor Mounting and Alignment	31
5.2.3 Limits	33
5.2.4 Power Source.....	34
5.2.5 Stepper Bee Plus	35
5.3 Software Build.....	37
5.3.1 Interface Development	38
6 Evaluation and Testing Results	41
6.1 Evaluation and Testing	41
6.1.1 Test Log (001) Motor 1 - 57BYGH803 (Jameco Part# 237631)	42
6.1.2 Test Log (002) Motor 2 – S17HT44 (Stepper 3 LLC.)	44
6.1.3 Test Log (003) Motor Control/Driver (Stepper Bee Plus, P/N -BRD006).....	45
6.1.4 Test Log (004) Call System Parameters, Requirement 002	48
6.1.5 Test Log (005) Communications and Initialization.....	52
6.1.6 Test Log (006) Motor Zero Reference Function	55
6.1.7 Test Log (007) Manual Positioning Controls	57
6.1.8 Test Log (008) Positioning accuracy and repeatability	59
6.1.9 Test Log (009) Timing Analysis for Requirement 005	64
7 Summary	66
7.1 Conclusion	66
7.2 Recommendations for Full Scale Application.....	67
7.3 Lessons Learned	68
References.....	69
Appendix A.....	70
Graphical User Interface Code	70
Appendix B.....	71
Stepper Bee + User’s Manual	71
Appendix C.....	72
Vendor Data Sheets	72
Appendix D.....	73
Project Phase I Proposal	73
Appendix E.....	74
Communications	74

List of Illustrations

Figure 2.1, PPS Board Marking System.....	10
Figure 2.2, Board Conveyor	12
Figure 2.3, 4 Phase Stepper Motor [3].....	15
Figure 2.4, Simplified Equivalent Phase Circuit	17
Figure 2.5, Moving Rail Scaling	19
Figure 2.6, Stepper Bee (BRD006) PC Controlled Drive [7].....	20
Figure 2.7, System Block Diagram	21
Figure 2.8, Basic Logic Flow Control	22
Figure 5.1, Prototype Demonstration Setup	31
Figure 5.2, Conveyor Motor Alignment and Mounting	32
Figure 5.3, Sensor Motor Mounting	32
Figure 5.4, Conveyor Limit Switch.....	33

Figure 5.5, Limit Switch I/O Inputs	34
Figure 5.6 , Power Supply	34
Figure 5.7, Controller/Driver and I/O Input Integration.....	35
Figure 5.8, Stepper Bee Plus Circuit Diagram	36
Figure 5.9, Customized User Interface Control.....	38
Figure 5.10, Vendor Example Design	39
Figure 6.1, Motor 1 Drive Circuit Point of Test.....	42
Figure 6.2, Motor 2 Drive Circuit Point of Test.....	44
Figure 6.3, Pulse Control Circuit Point of Test	45
Figure 6.4, Step Output.....	46
Figure 6.5, Pulse Response with motor not running.....	46
Figure 6.6, Pulse Response with motor running.....	47
Figure 6.7, Full Step Control Sequence.....	47
Figure 6.8, User Display before Product Load	49
Figure 6.9, User Display after Product Load.....	49
Figure 6.10, User Display After New Product Load	50
Figure 6.11, User Interface Initialize Function.....	52
Figure 6.12, Modified User Interface	53
Figure 6.13, System and Mode Initialized.....	54
Figure 6.14, Motor Zero Function	55
Figure 6.15, Motor Zero Function Corrected	56
Figure 6.16, Manual Positioning Test	57
Figure 6.17, Automatic Positioning Test Product 1139-510	60
Figure 6.18, Automatic Positioning Test Product 1165-410	61
Figure 6.19, Graphical Results of 1 Inch Movement Test.....	62
Figure 6.20, Amount of Error over Range of Motion	63
Figure 7.1, Example Step Motor Torque versus Speed Curve	68

List of Tables

Table 2.1, System Lead Screw Specifications.....	13
Table 2.2, Prototype Lead Screw Specifications.....	13
Table 2.3, Motor Type Comparison [2].....	15
Table 2.4, Motor Ratings	16
Table 3.1, Material Cost	23
Table 3.2, Labor Cost	23
Table 4.1, Requirements List.....	26
Table 5.1, Hardware Build Log.....	30
Table 5.2, Software Build Log	37
Table 6.1, Measurements and Specifications	42
Table 6.2, Motor Timing Test Results.....	43
Table 6.3, Motor 2 Measurements and Specifications	44
Table 6.4, 1 Inch Movement Test Measurements	62