ECET-CPET 491 Senior Design
Project Phase II

Conveyor Width and Sensor Positioning Automation Upgrade

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27 April, 2012

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Conveyor Width and Sensor Positioning Automation Upgrade

- Background
- Problem Statement
- Proposed Solution
- System Software Design
- System Hardware Design
- Integration and Testing
- Proposal for Full Scale Application
- Lessons Learned

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Background

Employed by United Technologies Corp.

Huntington Electronic Controls Facility

Build Printed Circuit Board Controls

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Project Scope

Process Improvement

- Increase Productivity
- Increase Reliability and Repeatability
- Reduce Downtime
  - Associated Setup

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PPS 7000 Board Marking System

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Problem Statement

PPS 7000 BMS has a high maintenance down time due to improper setup and mechanical wear.

Root Causes

- Mechanical wear to conveyor system
- Improper Conveyor Setup
- Improper Alignment of sensors to product

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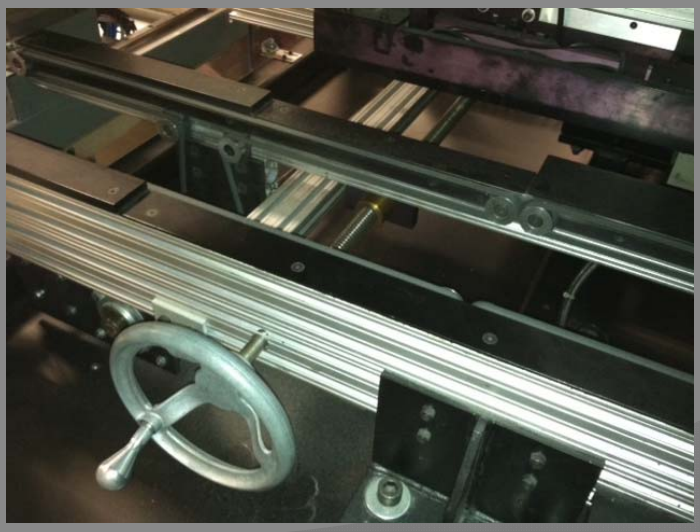
Current Conveyor Width Adjustment



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Conveyor Width

- Manually set by operator for product
- Average time to set 4 sec/inch
  - 4 * 9 = 36 sec full range
  - RPS = 6/4 = 1.5
  - RPM = 1.5 * 60 = 90
- Requires approximately 9 in/lbs of Torque to move load

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Current Sensor Positioning

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Sensor Positioning

- Currently Mounted in Fixed Position with less than 1 inch adjustable range
- Is a Fiber Optic Through-Beam sensor used to count boards entering and exiting Cure Module

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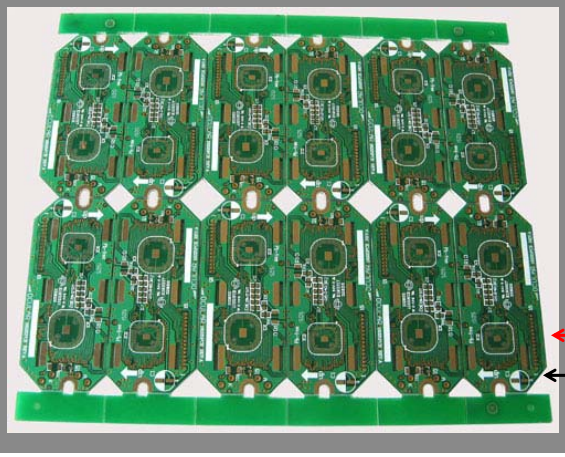
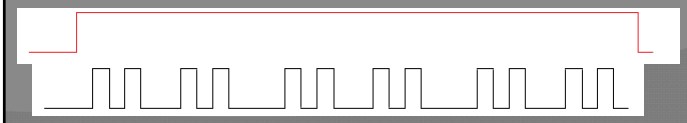
Sensor Count Fault





Pos 1 Count = 1

Pos 2 Count = 1-12

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Proposed Solution

- Automate the process
  - Install stepper motors to replace conveyor manual setup and position sensors

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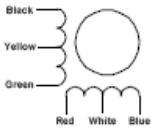
Stepper Motor

Advantages

- Stepper Motor provides an accurate and repeatable method of movement.
- Provides several options for circuit configuration
- Provides Direct Digital Control
- Inexpensive solution



Disadvantages

- Lose positional data (stall) if over torqued
- Can be Noisy due to vibration at resonant frequency
- Can skip steps

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System Design

- Software
  - Develop standalone GUI for automatic/manual control of stepper motors
- Hardware
  - Stepper Motors
  - Controller/Drive

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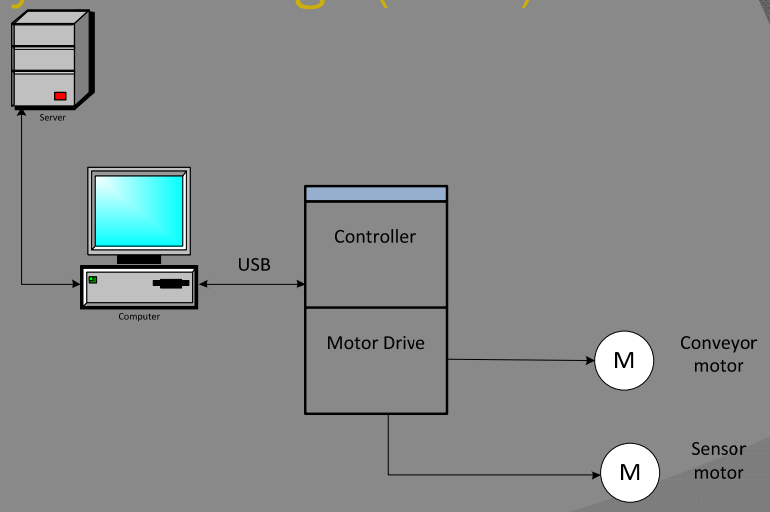
System Design (cont.)



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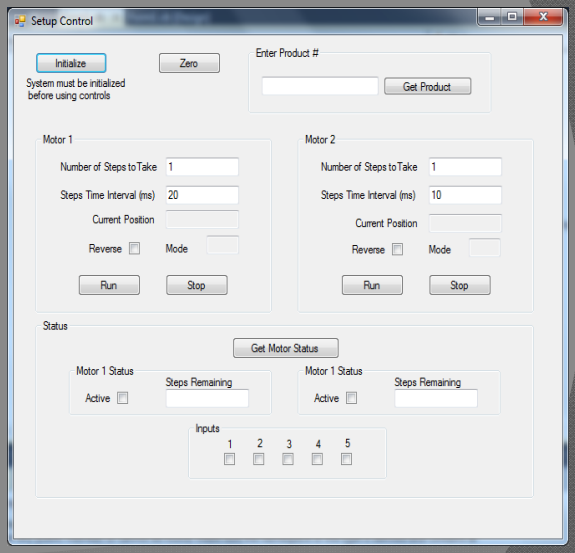
System Software

- Developed in Visual Studio 2010 VB.Net
- Compatible with PPS 7000 software and motor Control/Driver application
- Manual/Automatic Control



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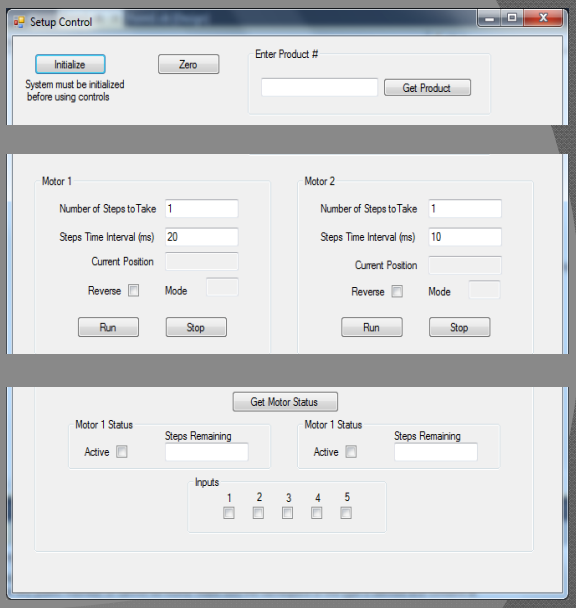
Controls
- Initialization
- System Zero
- Automatic Control

Controls
- Manual Control of Individual Motors

Controls
- Display Status



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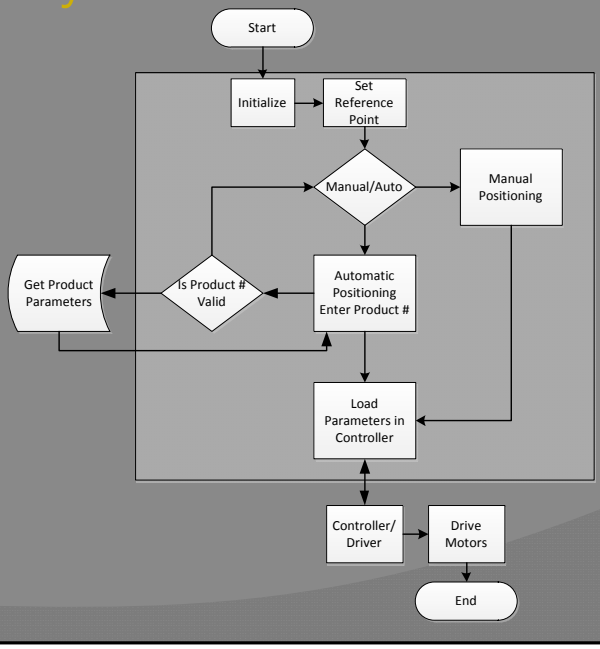
Basic System Flow



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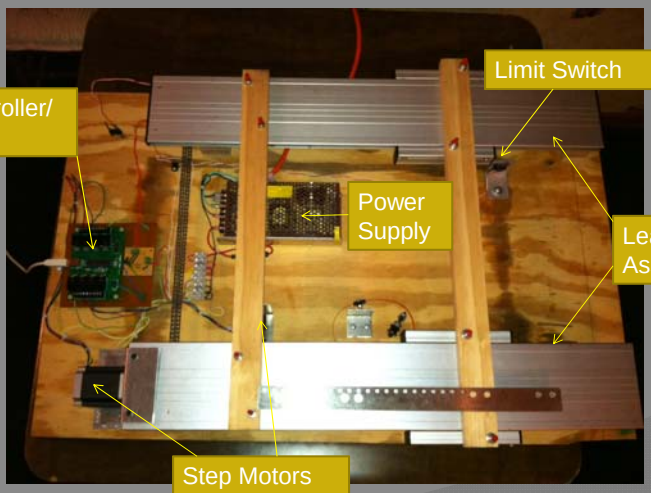
System Hardware



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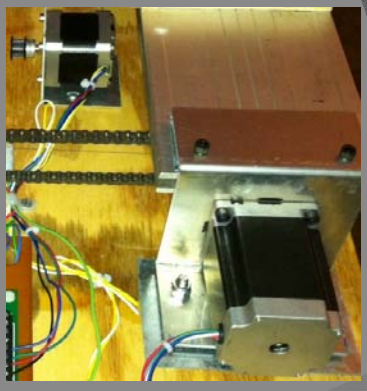
Stepper Motor

Configuration

- Open Loop
- 4 Phase Unipolar
- Full Step Mode
  - 200 Steps/rev
  - 1.8°/step



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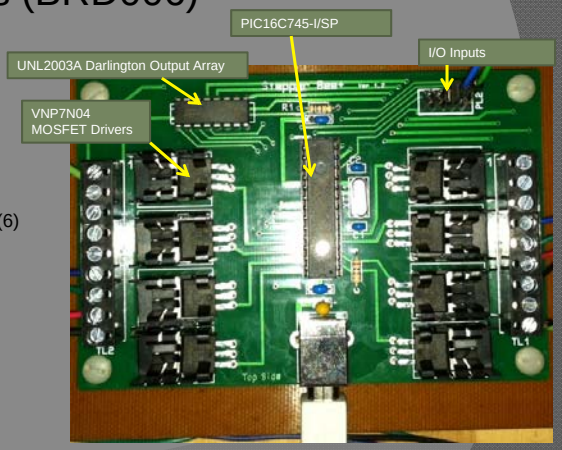
Controller/Drive

Stepper Bee Plus (BRD006)

www.pc-control.co.uk

- USB PC Control Link
- PIC16C745-I/SP Microcontroller
- UNL2003A Darlington Output Array (6)
- VNP7N04 MOSFET Drivers
- I/O Input (5)



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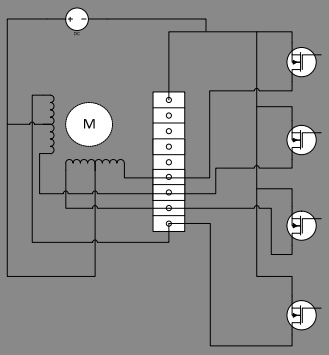
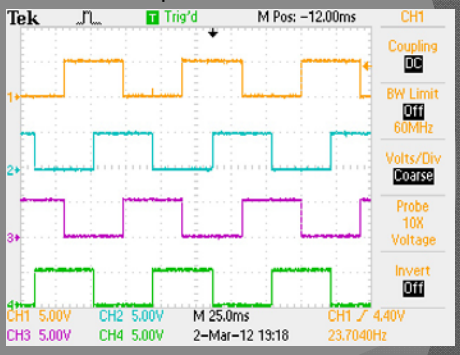
Drive Circuit



Full Step Mode



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Integration and Testing

- Software to Hardware Communications
- Speed /Torque Characteristics
- Accuracy of Positioning System
- Repeatability of Positioning System

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Step Response

Motor:
200 steps /revolution
1.8° per step

Lead screw(Demo):
8 revolutions /inch
8 * 200 = 1600 steps /inch
1/ 1600 = 0.000625 inches = 1 step

3.5 inches = 3.5 / 0.000625 = 5600 steps

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Speed

Step Interval = 4 ms
Pulses per Second
$= 0.004^{-1} = \frac{1}{0.004} = 250$ PPS

200 steps = 1 Rev
Rotations per Second
$= (0.004 * 200)^{-1} = \frac{1}{0.004*200} = 1.25$ RPS

Rotations per Minute
$= 1.25 * 60 = 75$ RPM

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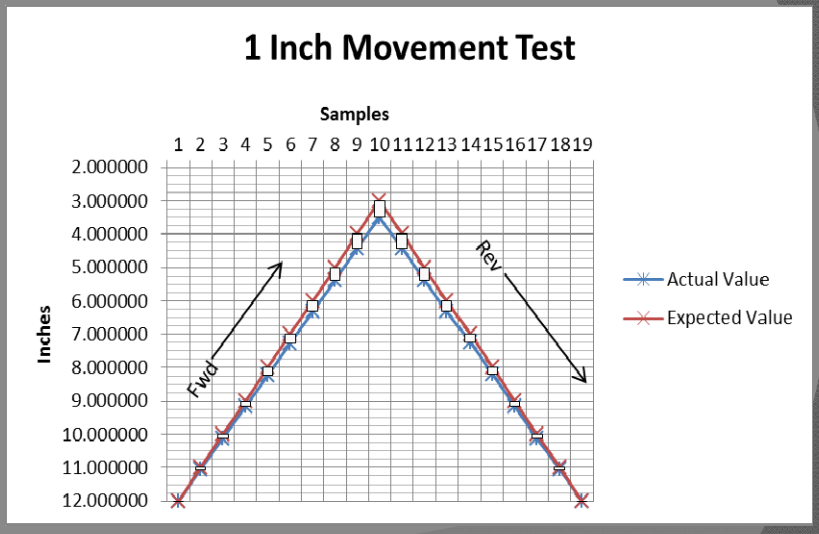
Accuracy and Repeatability



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Conclusion

- Project does demonstrate feasibility for full scale application
- Requires Proper Motor Selection for PPS 7000 based on Speed/Torque curve
- Sensor Motor scaling Relies on additional Mounting framework for Sensors (Not within Scope)

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Lessons Learned

- Speed ,Torque, Current, and other characteristics are interrelated and very important in motor selection
- The simplest motor drive circuit is not always the best solution
  - Unipolar vs Bipolar

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Questions

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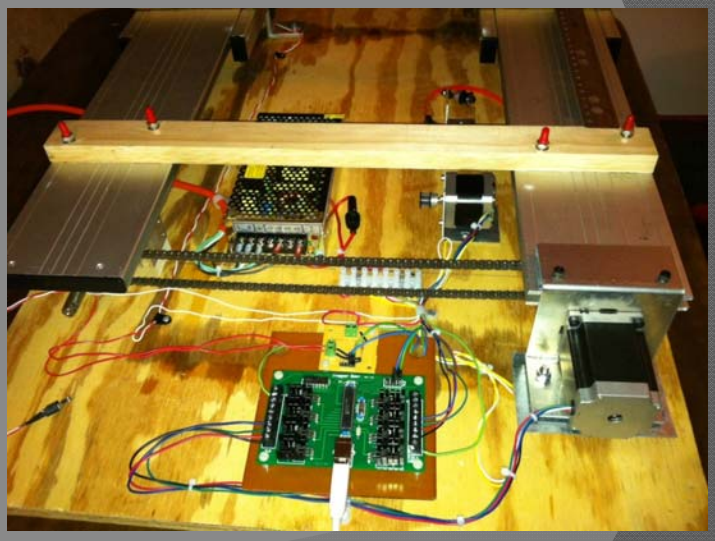
Demo



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