Robotic Assembly, Inspection & Test Automation

ELECOMP Capstone Design Project 2024-2025

Sponsoring Company:

Hayward Industries, Inc.
61 Whitecap Dr.
N. Kingstown, RI 02853
http://www.hayward.com

Company Overview:

For nearly 100 years, Hayward has built industry-leading equipment, filters, and pumps. Today we are at the forefront of innovation for pool and outdoor living technology and internet-connected homes.

We offer a full line of energy-efficient and sustainable residential and commercial pool equipment including pumps, filters, heaters, cleaners, sanitizers, LED lighting, and water features—all of which are digitally connected through Hayward's intuitive IoT-enabled SmartPad™.

Hayward is also the leading manufacturer of industrial thermoplastic flow control valves. And all of our pumps have secured EnergyStar certification, meaning we can save pool owners money on their energy bills.

We are the brand of choice for both new pool builds as well as the aftermarket and help commercial and residential pool owners create their own water experience through convenient solutions that improve ambiance, efficiency, and comfort.

Our global headquarters is in Charlotte, North Carolina, and we have operations across the United States, Australia, Canada, China, France and Spain. We are publicly traded on the New York Stock Exchange under the ticker HAYW.

Technical Director:

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BSEE 1992 University of RI
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Project Motivation:

Hayward Industries' RI facility builds a over 100 different printed circuit board assemblies (PCBA's) utilizing two fully functioning, surface mount production lines and three through-hole assembly production lines. The three through-hole assembly production lines utilize a manual process to populate and visually inspect the circuit boards. This tedious, and error prone process can result in significant discrepant PCBA's, due to incorrectly labeled parts and human error. These discrepant PCBA's will then need to go through a costly rework process or be scrapped completely, resulting in significant costs to the company.

The goal of this project is to develop an automated, through hole assembly workstation, incorporating robots and automated visual inspection systems, to populate PCBA's with through hole components. The robotic and visual inspection systems must be developed with significant flexibility in mind, to be utilized in multiple locations throughout the facility. The workstations will require a main control computer, with a friendly user interface (UI), to choreograph the operation of the entire workstation. This includes controlling robots, conveyor systems, PCBA feeder systems, and visual inspection systems, as well as monitoring a variety of sensors. The main control application will be required to log every aspect of the production process, provide critical feedback to operators, and create many standard reports used by production for time studies, efficiency and yield analysis.

Anticipated Best Outcome:

Development of:

- Bare PCB feeder system
- Part Binning and feeder systems
- Robotic pick and Place system
- Automated conveyor system
- Automated Visual inspection system
- Main control software application (PC based)
- Hardware development for motor control and sensor interfacing

Best outcome for this project is the development of flexible subsystems that can be utilized as standalone systems as well as incorporated in any configuration as needed throughout the factory.

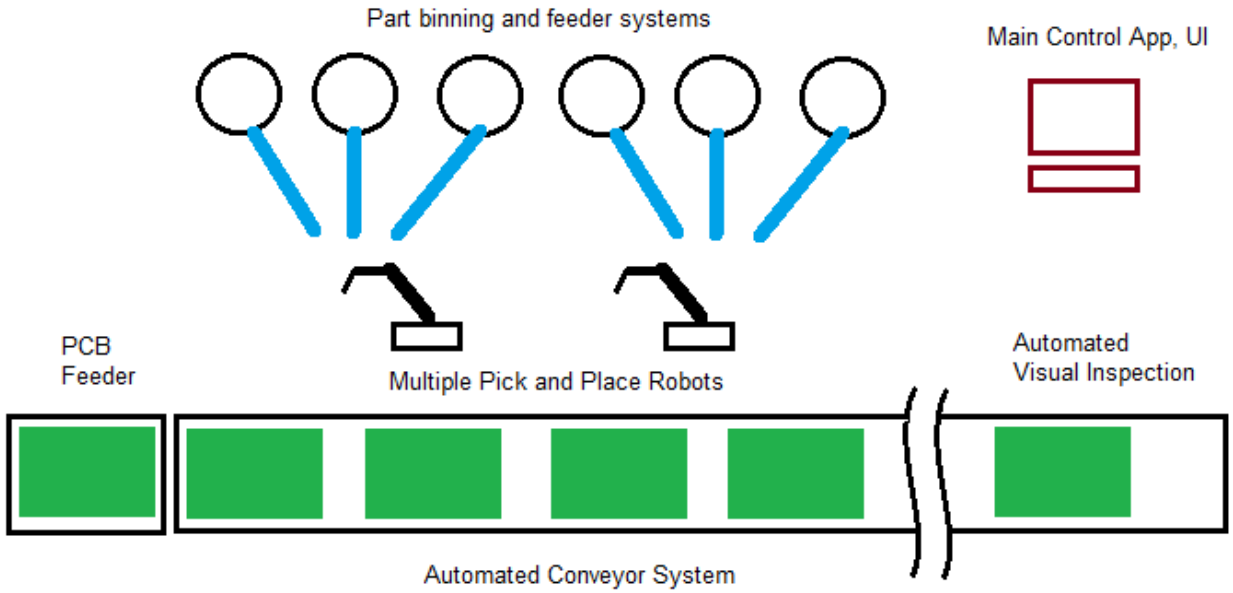
Project Details:

Primary project involves development of a fully functioning workstation for a PCBA known as the 'Field Wiring Panel'.

The Robotic PCBA assembly workstations will be composed of many smaller subsystems. This includes:

- Part bin feeders
- Pick and Place robots
- Custom end-effector (gripper) design
- Automated Optical Inspection systems
- Custom conveyor systems
- Main control PC application development
- Microcontroller hardware and firmware development

Block Diagram:



Hardware/Electrical Tasks:

PCB Feeder subsystem (Mechanical/Electrical/Firmware)

- Servo/Stepper Linear Motor driven lift table with motor drive controller
- Mechanical design and construction, 3D printed components
- Sensors

Automated conveyor subsystem (Mechanical/Electrical/Firmware)

- Servo/Stepper Motor driven conveyor with motor drive controller, solenoid stops
- Servo/Stepper Motor driven PCBA lift and stabilizers
- Mechanical design and construction, 3D printed components
- Sensors

Part sorting, binning and feeder subsystem (Mechanical/Electrical/Firmware)

- Custom designed?
- COTS (Commercially Available Off The Shelf)?
- TBD

Pick and Place Robot sub system (Mechanical/Electrical/Firmware)

- MecaDemic 500
- UR3
- Custom cartesion
- Other TBD

Firmware/Software/Computer Tasks:

Main Control Application subsystem (Software)

- Windows based graphical application
- Communication requirements to subsystem controllers
- Safety and fault detection
- Diagnostics features

Motor Controller, sensor, actuator hardware interface (Electrical/Firmware)

- Motor controller hardware/firmware development
- Various sensor interfacing development
- COTS?
- Custom designed?
- TBD

Automated Visual Inspection sub system (Software)

- COTS?
- Custom designed (OpenMV, OpenCV, other)
- TBD

Composition of the Team:

1 Electrical Engineer & 2 Computer (CPE) Engineers

One CPE can focus on microcontroller hardware and FW development while the other can focus on developing necessary programming skills of the MecaDemic 500 and UR 3 robots.

Additionally, significant effort will need to be applied to AOI development. **(preference will be given to those who can also contribute to the mechanical aspects of the project**)

Skills Required:

Electrical Engineering Skills Required:

- Electrical Schematic/PCB CAD
- Mechanical CAD
- Microcontroller, motor controller design
- Power supply design requirements
- Analog sensor (optical, inductive) interfacing design
- Designing Opto-Isolator circuits

Computer Engineering Skills Required:

- Electrical Schematic/PCB CAD
- Mechanical CAD
- Micro controller FW development
- Schematic/PCB CAD
- Understanding of various communication protocols (RS232, RS485, ethernet, SPI, I2C)
- Windows PC application development (Python, C++, C#, other?)
- AOI concepts and programming

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

This project will allow for the fully automated assembly of one of our higher volume boards. This could potentially result in recurring annual savings of approximately $120,000 per year.

Broader Implications of the Best Outcome on the Company's Industry:

The application outlined in this project description is merely the tip of the iceberg. There is a myriad of applications throughout our factory and in other factories where we could leverage this automated assembly approach.