Cobot

Optimization of a Cobot Loading System

ELECOMP Capstone Design Project 2018-2019

Sponsoring Company:

Hexagon Manufacturing Intelligence
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Company Overview:

Hexagon Manufacturing Intelligence, formerly known as Hexagon Metrology, is the world leader in quality control solutions for manufacturing. Solutions include hardware, software and services in a broad portfolio of products which include stationary coordinate measuring machines (CMMs) for the automated inspection of manufactured components. Coordinate measuring machines are essentially large precision positioning systems that carry accurate sensors in the x, y, z directions for the dimensional inspection of manufactured components. These machines have specialized controllers and firmware and are programmable through dedicated software. These systems are produced here in Rhode Island at Hexagon's Quonset facility for North America.

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Project Motivation:

In recent years the need to become more efficient in all areas of manufacturing has become paramount due to rising production costs and the availability of skilled labor. This is especially true of the post-industrialized markets, such as in the U.S.A. and Western Europe. Industry's approach to this is to make machines and systems more automated so that higher value activities can be performed by humans. One of the great enablers of automation is intelligent software which is now being developed and implemented at an exponential rate. New products such as AI imbedded robotics are rapidly transforming manufacturing. Robots have now become intelligent enough to be able to safely interact with humans. Collaborative robots, or cobots, have advanced sensors for feeling the forces applied around them and thus work safely in environments where strict OSHA requirements would not allow other systems without expensive shielding, light curtains and other safeguards. This makes such solutions highly adaptable to any environment without the safety costs surrounding traditional automation solutions.

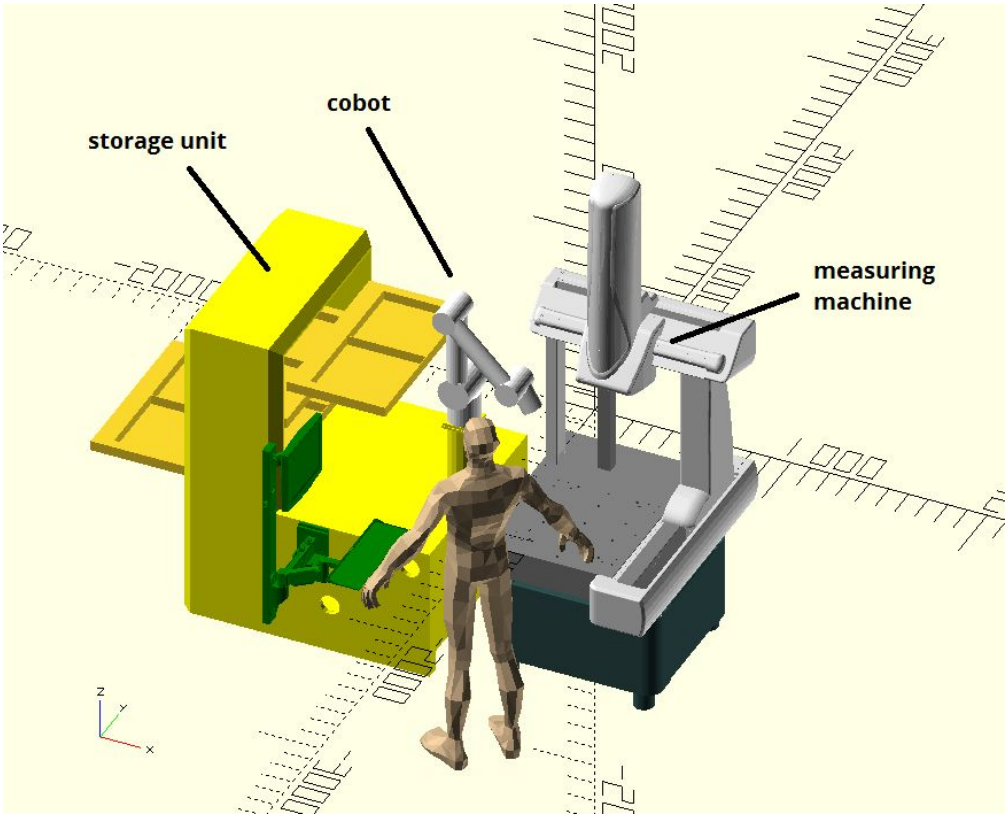
Project Details:

This is a proof-of-concept project which involves the programming of a cobot (collaborative robot) to pick components from different storage pallets built into an integrated loading cell. The Cobot will pick components and place them onto a measuring machine for inspection and then place them back onto a designated pallet depending the inspection results.

There are two software user interfaces for controlling and developing the solution. One is the embedded software for the cobot, which enables routines to be written for the pick and place operations, the other is the cell management software which is an internally developed product written in Python. The cobot software has a user friendly interface and will not need much customization once the routines are learned by the cobot. The cell management software supervises

and coordinates the actions of the various subsystems, such as the cobot, part storage unit and measurement machine. For this reason, the cell management software is one of the main development points, although the integration of other electromechanical subsystems will also be required for teaching the cobot and adding controls to other aspects of the system.

For the cell management software, a UI needs developed so that the work for the cobot to load the measurement machine can be efficiently planned and scheduled by a user without recoding it. This might involve a graphical interface with a method for the user to organize the pallet layout and components being queued for inspection, for example. As for teaching the cobot, a simplified software tool is required to redefine the pallet based on known part reference locations. Some suggestions to aid this process have been to incorporate laser pointers or targets so that the new layouts can be taught more quickly by eliminating precise learn moves to each component.



Above: typical layout for a cobot between a storage unit and measuring machine

Student Skills Required & Division of Work

It is envisioned that two students will work on this project, one computer engineer with electrical engineering background and another computer engineer. The ideal candidates will have some programming background in Python and have worked with some form of robotics, either as a hobbyist or through some other experience. The programming will require some basic understanding of I/O, error handling, creation of GUIs and possibly multithreaded processes. The electronic/electrical design aspects will include some working knowledge of controlling solenoids, laser targeting using simple laser pointers, barcode readers and possibly robot integrated cameras. The ability to design simple holding fixtures and creating 3D printed prototypes would also be helpful but not required.

The division of work should be such that both students can contribute in some way to all major aspects of the project but with emphasis on their strengths or skill sets for the various subtasks. For example, one student could focus on GUI development, while the other focuses on cobot part alignment set up. One student could work on integration of relays in the cell management software for locking out loading pallets while another student works with the cobot and laser pointers to improve setup methods.

The tasks and scope of work can be summarized in development phases as follows:

Computer Engineer:	**Computer + Electrical Engineer:**
Semester I ● Architecture overview. ● Testing of existing software design. ● Creation of layout templates using existing methods ● Text or command line interface for testing purposes **Semester II** ● Integration of hardware/electromechanical components using the modules developed by student #2 in the main software ● GUI for layout manipulation ● Test results: Gage R&Rs for several layouts (TBD)	**Semester I** ● Learning the cobot interface ● Linking to the cobot interface through external software calls ● Electrical & mechanical Integration of control components Semester **II** ● Linking to the cobot interface through external software calls ● Electrical mechanical Integration of sensing and control components/ sw module creation ● Test results: Gage R&Rs for several layouts (TBD)

Deliverables Summarized

- GUI for creating custom pallet layouts
- Simplified procedure for teaching the cobot the new layout without recoding the routines on the cobot software
- Integration of any sensors or electromechanical mechanisms needed to implement the solution.

The Best Outcome is creating a GUI in the cell management software that enables a user to create custom pallet layouts for any type of components along with a corresponding procedure to easily setup the cobot routines for picking and placing from the that custom layout.

Anticipated Best Outcome's Impact on Company's Business:

The creation of a software that makes it easy for anyone to setup and modify their automation solution will not only increase sales but reduce training and support requirements for what is now a very specialized field.

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

Productization of a ready-to-use cobot automation cell for manufacturing will be very disruptive if it truly doesn't require any expert setup or training for a first-time user. Broader implications of this solution will be to produce more products like it for other types of manufacturing operations beyond measuring systems which is our core business. Opportunities for automation in other areas will expand our business.