Application: PLC and Automation

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Date: 01/01/2018

Description of the Lab activity

- Brief description of the lab activity and task given to you

  The task was using LJ create software, create a programmable logic control simulator using methods like truth tables, logic statements, flow charts, Grefcet diagrams and defining the inputs and outputs. Therefore, it was decided, the exercise was to create a ladder logic control program. The program would control two of the air lock doors, two inner-door and one outer door. Because each door has their own unique infrared beam sensors, which will be activated if other individual user beams comes with contract with the beams sensor. The exercise is to program these scenarios in LJ Create.

- The exercise out put

  These are the exercise outputs received when the scenarios were implemented and tested in Simulation Mode on LJ create.

  1. When the beam infrared sensor 1 was broken, cylinder piston was latched on for 0.2 seconds after the beam infrared sensor 1 was broken and cylinder piston would keep on latching on until the beam infrared sensor 2 breaks.
  2. When the beam infrared sensor 2 was broken, cylinder piston was latched on for 0.2 seconds after the beam infrared sensor 2 was broken and cylinder piston would keep on latching on until the beam infrared sensor 1 breaks.
  3. If both beam infrared sensors are broken, then both cylinder pistons would stay in its place and doesn't extend.
  4. If both beam infrared sensors are broken for more than 10 seconds, then both cylinder pistons retract from its positions.

- Challenges

  There were many challenges that I faced during this task. It was when learning to use LJ create for the first time, coming from a computer science student, I mostly work with programming languages, however It was nothing like that and much more complex than I thought therefore learning it from scratch was a tough challenge. The toughest was when I was trying to alter the parameters for the beam infrared sensors so that they matched with the parameters of the constraint set, couple of times I miss matched the parameters and it was so much time consuming to fix them up because I had to do it all over again because something else went wrong in the process. However, it was also a pleasant challenge because I enjoyed doing it and some of the elements can be implemented into my computer science modules.

The product/production life cycle

- Where in life cycle and how can it be integrated with the previous and following step in the life cycle

  PLC and Automation can be integrated in different stages of the previous steps in the product/production life cycle. It is going to involve different participants in different roles. **The operational performance-speed of product flow, inventory levels, information regarding the manufacture of components and subsystems, and quality-across the whole network throughout the product/production life cycle is changed.** This means there is integration between design and manufacturing at the product development stage.

  In an environment in which constant product innovation and speed to market must go hand in hand with stringent product quality requirements-in today's world, that means most manufacturing sectors, from automotive to medical devices-the ability to consider the manufacturing options early in the product development stage is of huge benefit. This should not only involve considering the technology required, the cost, and so on, but also include an analysis of how changes to the design may deliver worthwhile benefits in terms of manufacturing. (Christian, 2013)

- The common characteristic that describe the application

  Typically, PLCs have been best suited for machine control, machines which operate in both simple and high speed. The common characters between PLCs (Programmable logic controllers) and Automation, PACs (Programable Automation Controllers) are:

  - Program execution Scans
  - Limited Memory
  - Focus on discrete I/O with on/off control

  On the other hand, a PAC is geared more toward complex automation system architectures composed of many PC-based software applications, including HMI (human machine interface) functions, asset management, historian, advanced process control (APC), and others. A PAC is also generally a better fit for applications with extensive process control requirements, as PACs are better able to handle analog I/O and related control functions. (Numatic Engineering , 2018)

- Identify important attributes which affect the application, for example format of information sharing

  Attributes that affect PLC and automation are:

  - I/O, Servos, Size of Memory, Communications, Compatibility to HMI, Format and Speed. (Iman, 2011)

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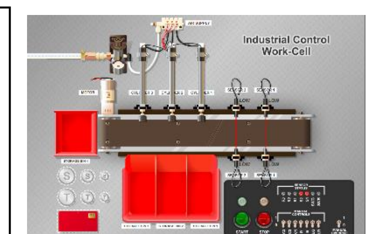

Benefits to industry

- Identify the issue this application could improve

  PLC and Automation are used for control and automation job in a single machine & it increases up to full automation of manufacturing/testing process in a factory or industry. (Mushtaq, 2013). The PLC is something of a workhorse in the automation industry. In the 47 years or so since they were first developed, the PLC has not only changed the way assembly lines are controlled and sequenced, but they've also made the manufacturing process much more efficient.

  "The PLC was created to simplify assembly line processes and make them more productive,". "Before the PLC came about, manufacturing control was operated by specialist hardware such as relays and drum sequencers. This meant that if there was a technical failure, or even a necessary upgrade, it would be cost and time intensive to attend to." (Getting the best out of PLCs, 2015)

  In conclusion, Using PLC and Automation increases flexibility and speed. There has been developments in the systems in recent years, more advanced machines and processes. The latest PLCs provide flexible and advanced operating systems that make integrating new devices into the system and instruction sets much easier. PLC processor or within special function cards to perform tasks such as very high-speed control and synchronization. With FPGAs, suppliers can quickly provide custom or specialized functionality at lower costs. Programmers no longer has to determine the exact target while still in the software development stage, and can instead choose the optimal PLC target platform after all code is written and tested. This can cut cost substantially because the developer no longer has to select a more expensive PLC up front to provide a margin of performance and I/O capacity, but can instead right-size the PLC for the specific application. It also decouples the hardware and software engineering tasks to some extent, allowing these activities to happen more independently, and even concurrently in some cases, reducing required development time. (Natsui, PLC Developments Increase Flexibility and Speed, 2012)

- How it will impact on the product/production life cycle

  PLC and Automation have major impact on the product/production life cycle. **It will improve manufacturing**, The core manufacturing processes (e.g., machining, robotic operations) can be simulated in significant detail using specific technologies like work-cell design and simulation software that allows users to develop, simulate, optimize, validate, and program multidevice robotic and automated manufacturing processes. Automation engineers create full-action simulations of complete manufacturing cells and systems within a three-dimensional environment. In this way, the processes can be optimized, and ideas for improved manufacturing ability fed back to design.

  It will optimize facility operations, including information regarding the manufacture of components and subsystems in the environment, it becomes possible to review and assess the manufacturing side of the picture early in the product's life. Therefore, highly relevant to automation. First, given the cost of most automated production facilities, designing the automation systems with a view to maximizing throughput is a key consideration; but second, there is usually a trade-off between cost and throughput on the one hand and flexibility in terms of product variety on the other. The ability to experiment with different automation configurations in the context of the anticipated new product flow is therefore of huge value, not only in terms of consideration of the manufacturing process early in the design phase for a given product, but potentially in terms of optimizing the facility across a range of products. (Christian, 2013)

Reflection and conclusion

- Reflection on how the application can impact on industry 4.0 and the digital engineering environment

  The current manufacturing automation environment of Industry 4.0 demands high-performance PLCs enabled with secure enterprise connectivity and HMI. Making PLCs ready for Industry 4.0 is fraught with new challenges, requiring grounds-up PLC redesign. The major challenges confronting PLC designers include:

  - High-performance control - Smart-manufacturing environments require PLCs to process instructions, service interrupts, and support integrated HMI at speeds faster than ever before. This need has led to the use of more powerful processors with higher MIPS and multiple cores, resulting in high cost and higher power consumption penalties.
  - Connectivity - Deterministic M2M connectivity between disparate machines requires support for multiple Industrial Ethernet protocols within a single PLC system. Enterprise connectivity demands application interoperability frameworks such as OPC-UA.
  - Secure communications - PLCs connected outside the factory network and to the enterprise are vulnerable to cyber-attacks, making security a significant concern.
  - Cross-platform interoperability - Choosing the wrong processor or ASSP can be an expensive error. Functional interoperability between diverse systems requires standardized operating systems running on non-proprietary processor cores.
  - Future proofing - With an ever-evolving connectivity and interoperability environment, changes in market requirements are more frequent, leading to software and hardware changes.

  System-on-Chip (SoC) FPGAs, which combine a processor and FPGA fabric on a single chip, present a unique alternative for overcoming today's PLC design challenges.

  - High-performance control—SoC FPGAs can off-load the PLC's processor by implementing high-performance algorithms and HMI in the hardware fabric. This will offer faster hardware acceleration at lower cost and power consumption than conventional processors
  - Connectivity—FPGAs can implement multiple Industrial Ethernet protocols simultaneously on a single device by instantiating ready-made intellectual property (IP) cores.
  - Secure communications—Open SSL encryption, implemented in the FPGA fabric, provides up to 4X acceleration over processor-based implementations. This encryption enables faster, more secure enterprise communication channels.
  - Cross-platform interoperability—With an integrated processor, SoC FPGAs offer a scalable roadmap using an industry-standard processor.
  - Future proofing—Designers can reprogram the FPGA fabric to incorporate hardware changes, avoiding major redesign of entire systems.

  In Conclusion, the demand for additional features, precision, and connectivity on the factory floor has driven this increasing integration. It has been sustained by PLC component cost reductions and the availability of higher performance processing engines. In general, the evolution of PLC functionality has followed the industrial automation demand curves of features, performance, and lower power. Following that trajectory, the demands of Industry 4.0, to a large measure, it will drive future PLC architectures to keep growing and potentially bringing more investments from big companies. This will have a big impact on both industry 4.0 and the digital environment. (Roy, 2015)

- Implementation requirement hardware

  Distributed control- instead of using one PLC to control operation of a machine integrating robotic manipulators and multiple actuators, real-time control is distributed by the architecture to the individual subsystems. Allowing each of the PLCs in the network to react to each other – or externally generated events such as last-minute changes to customer orders – improves response times as well as overall operational efficiency.
  Digital signal processing - A 32-bit processor based on ARM or a similar architecture can provide the core computing power for the PLC.
  Deterministic networking - EtherCAT and other network technologies support advanced deterministic networking, which, in turn, supports real-time distributed control algorithms
  Miniaturisation - In addition to the ongoing trend towards distributed control is that of continuing miniaturisation. This must be balanced to allow for ease of installation and maintenance once installed.
  Isolation- isolation on the daughter-boards needs to be in place to provide additional protection against overcurrent and overvoltage situations (leonie, n.d.)