Industrial Automation and Process Monitoring using Artificial Intelligence

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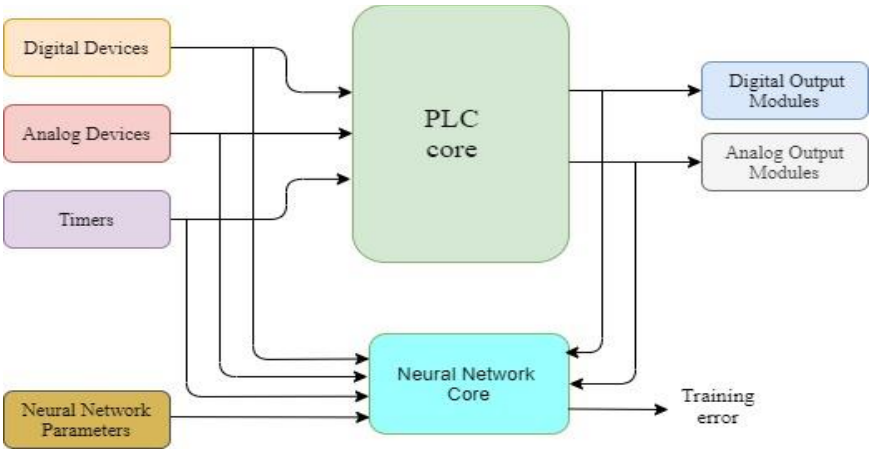
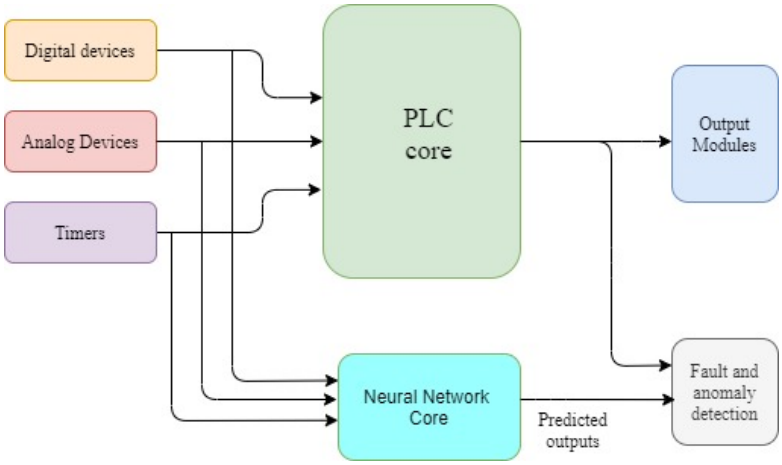
Artificial Intelligence (AI) have a wide range of applications in various fields, such as computer vision, natural language processing, gaming, robotics, and monitoring complex systems. One of the widely used branches of AI is neural network (NN). In industrial automation, neural network is capable of monitoring manufacturing processes, error and fault detection, and even predictions. NN can be merged with Programmable Logic Controllers (PLC) to improve the fault tolerance and error detections accuracy in automation process and control. While PLC programs are tested in the simulated environment before they are implemented in the automation system, this does not guarantee their error-free operations in real-time under time-varying condition where unpredicted external sources of perturbation are likely to inference with the processes. As an example, in 2011, the Stuxnet virus interfered with the operation of Siemens' PLC in one of the Iranian nuclear power plant facilities and destroyed 984 uranium enriching centrifuges.

In this project, students will create an industrial process control platform, become familiar with PLC control and automation and develop AI-based monitoring module to enhance the resiliency of the underlying control systems. The module will be integrated in the system to report the issues to operator or correct the problem in real-time on the fly by directly communicating with the corresponding PLC.

The block diagram of the training system is illustrated in figure below. As shown the values of PLC's I/O ports, timers, and critical variables during the execution of the program can be used to train a neural network and prepare it to monitor the system. A NN-based system monitor learns the characteristics of the automation system using PLC's port values and internal variables during the training.



A successfully trained neural network can detect a malfunction or abnormal behavior in the automation system when the outputs generated by the PLC is different from the expected outputs generated by neural network (see figure below). The abnormal behavior of an automated system could have been caused by intrusions in which the PLC code has been altered by external entities, hardware faults, malfunctions on PLC's I/O ports, or mishandling of the system by the operators. Addition of AI-based monitor to the automation system provides an additional layer of security and helps the system run more safely. The neural network's prediction capability can alert the operators if abnormal behavior in the system starts to take place before it is too late to recover.



In this project, in the first phase, students develop a typical industrial control process using a PLC and transducers. They will practice PLC programing and automation control in their small-scale industrial platform. In the second phase, they create a model to introduce perturbation in the process simulating some probable form of interferences in the factory setting. Students in the final phase work on their AI algorithms and integrate into the system to create automated intelligent process control. The key component of this project is the NN-based algorithm and a plug and play AI-enabled module that monitor the control system performance to increase its robustness and efficiency.

Requirement: Knowledge in control process and systems such as PID, familiarity with artificial intelligence and programing skills.