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Analysis of Arduino Uno Application on Control System Based on Industrial Scale

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Abstract. This research analyses the use of Arduino Uno as a controller, replacing the industrial based controller on the oil and gas industry with the plant: one of the control loops in the Refinery Fuel Oil Complex I PT. Pertamina (Persero) Refinery Unit IV Cilacap, Indonesia. Research is done by making a simulation plant using industrial-scale instrumentation with the Arduino Uno as the controller, and compare the results with the controller for the actual plant. The result is Arduino Uno is able controlling industrial-scale plant-based instrumentation for one control loop that was tested and was able to eliminate the difference between Process Variables and Sets Points at different control modes are proportional to industrial class controllers by using the Proportional, Integral and Derivative (PID) algorithms together with the combination.

1. Introduction
At this time, the world of technology is developing rapidly in all fields. With the rapid advancement of science and technology today, much available equipment that can work automatically using a digital control system. Application of automatic control system technology is vast, ranging from household items such as room temperature control system, up to the level of process automation industries such as oil and gas processing.

Arduino Uno is a microcontroller board open-source platform that is widely used and widely recognised by students, especially for students studying electrical engineering material control system, both in lectures and lab work [1-2].

Previous studies have shown that an Arduino-based PID controller application can be used to control a process automatically [3-6]. Arduino Uno makes it easy for students to learn digital PID control in real-time, some PID control parameters can be changed easily, and responses can be observed directly [7].

Previous studies have shown that an Arduino-based PID controller application can be used to control a process automatically [8-9]. In this study, we will discuss the application of an Arduino-based PID controller to control vessels level automatically but use hardware in the form of industrial-scale instrumentation equipment to examine possibilities the use of Arduino as an alternative to the control system in industrial.

2. Materials and Methods
2.1 Material
Arduino Board, compressor, Current to Voltage Converter module, Voltage to Current Converter module, Level Transmitter Honeywell ST700 Series, PWM to Voltage Converter module, Smart Valve Positioner Azbil AVP301, Regulator lock, software Intouch Wonderware, Honeywell Experion Station and Software Arduino IDE.

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2.2 Methods
Prepared a control simulation that reflects operational in the Industry. The plant is set to be controlled with an Arduino-based controller with PID control. To be compatible with industrial instrumentation, the control, actuator and adjust to the industry standard through the conversion of the required signal that is the conversion of voltage to current and current to voltage instrumentation current signals 4-20mA ISA-50.00.01-1975 (R2012). For testing the application of Arduino as a controller in the industry, it is tried in one control inserted through the control room to control in one of the control loops.

3. Results and Discussions
The working principle of this control system is to create a plant or process that is equipped with industrial-based instrumentation, with a fluid level control system as a control loop representing industrial processes. This control system can be controlled centrally through the HMI (Human Machine Interface), with the actual level, must be controlled automatically through the controller following the setpoint specified by the operator. After the control system is complete, calibration will be performed so that all parameters obtained are accurate following the actual conditions, then proceed with the tunning controller to get a stable system response according to the set point.

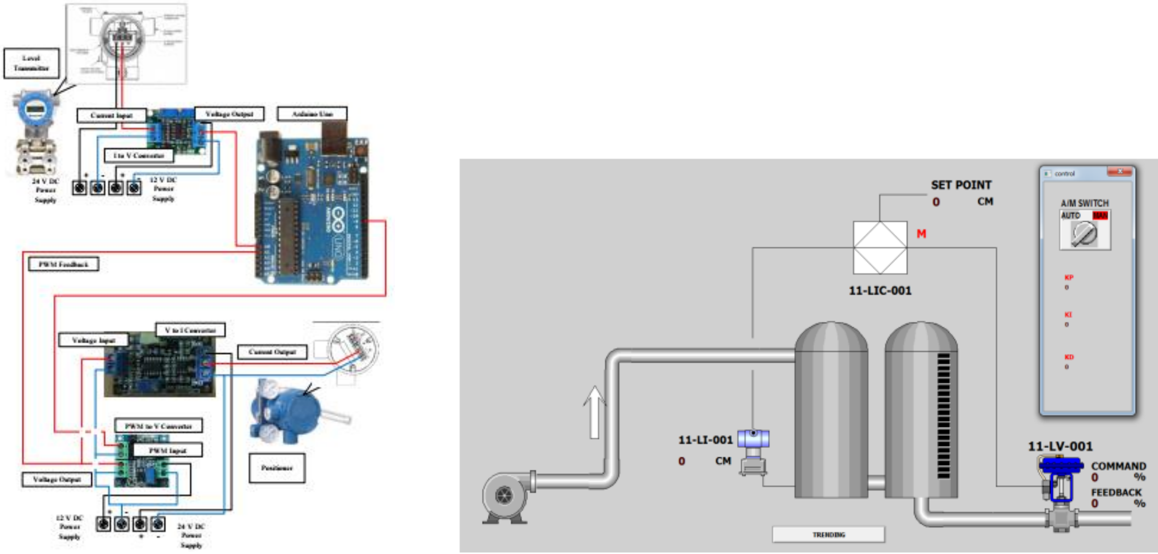

Figure 1. Arduino-based control system simulation and HMI Display

First of all, after the power on the system, The level transmitter will read the fluid level available in vessels. The level transmitter sends a 4-20mA signal (according to the standard signal used by industry) which is equivalent to 0-100% fluid level that will be accepted by current to voltage converter. Here the signal is 4-20mA converted to 0-5V DC which is connected directly to analogue input Arduino. Arduino that works as the controller will execute the system controlling according to parameters determined by the operator through HMI. Execute the controller here to control the same PV value with approaching the SP value (corresponding to tuning parameters).

Response from The controller is the output signal produced by Arduino in the form of a PWM pulse Comparable to 0-100% openings valve. Because Valve works using pneumatic power, the signal PWM is converted to 0-5V DC by PWM to Voltage Converter module. Then this voltage converted currents between 4-20mA to be accepted by the positioner as the final control element. This positioner will regulate valve openings pneumatically from 0-100% is proportional to the 4-20mA signal accepted by positioners. This control system works simultaneously and continuously in the loop closed.

The control loop is divided into two modes. Manual mode: operators are given access to set the output value in %. Comparable to 0-100% of the control valve opening. Auto mode: the controller will

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fully control output. Operators are given access to the Kp, Ki, and Kd parameters to set the controller response. This industrial-based Instrumentation control system simulation facility for the Arduino application analysis facility on the industrial-based instrumentation-based control system aims to answer two questions: How is the response based Arduino control system to controlling industrial-scale instrumentation equipment? Can the Arduino be used on industrial scale control systems? To answer the two questions above, testing is needed using the simulation facility that has been made, and then an analysis will be conducted to conclude. The testing stages to be carried out are: Manually testing the loop control simulation equipment to determine plant characteristics and tuning control loop to get the best response from the plant, conducting controlled trials in industrial processes.

Simulating changes in the parameters of the microcontroller tuning and analysing the response. The controller made with Arduino integrated with the original plant (according to the control valve specifications), i.e. laver 11V1 (with Tag No. control 11LIC010A) at the Refinery Fuel Oil Complex I, PT. Pertamina (Persero) Refinery Unit IV Cilacap (Figure 2).

Figure 2. Arduino integration with DCS

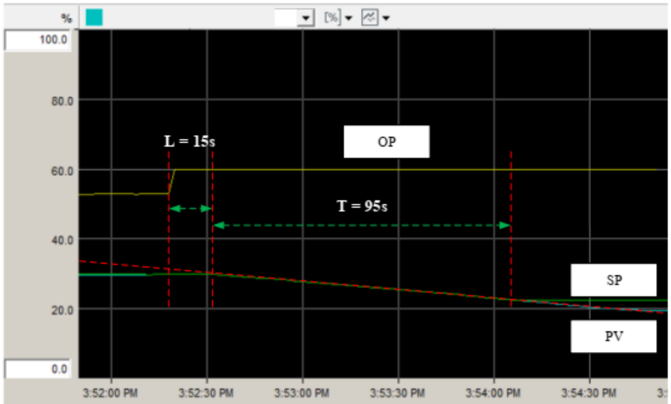
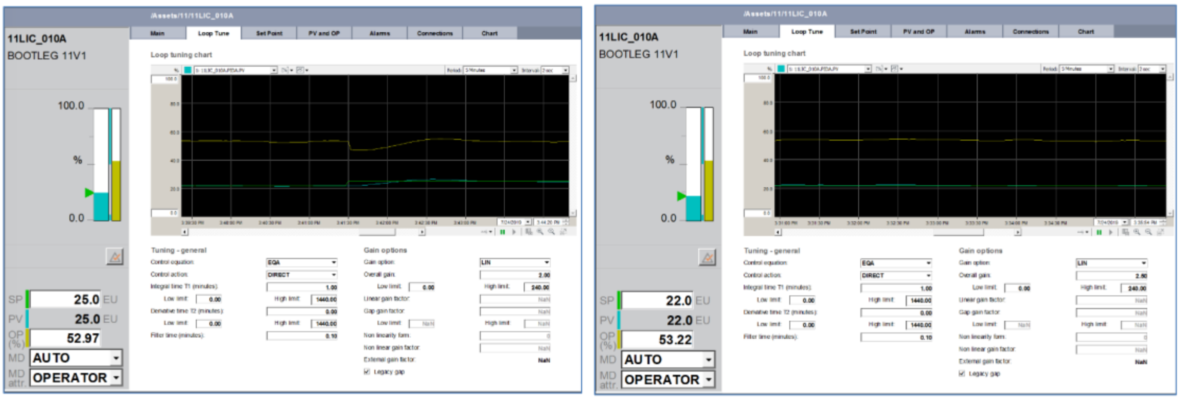


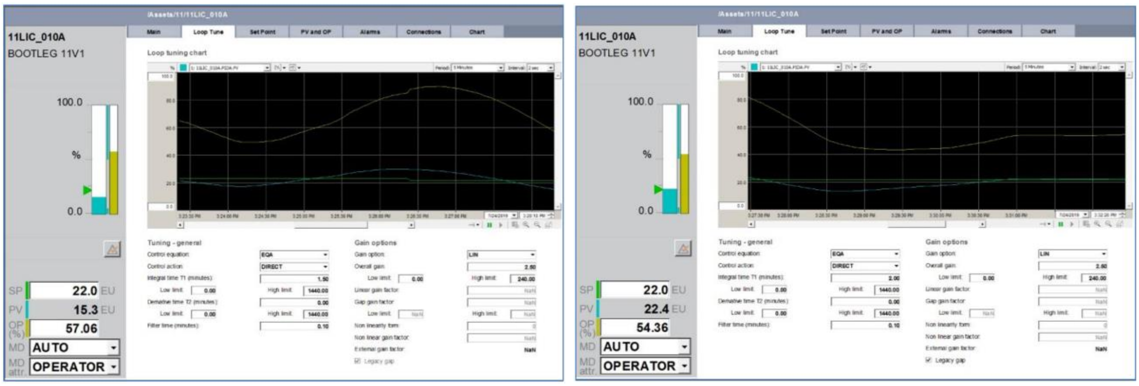
Figure 3. Transient response controller

With Modbus communication connected to the computer, access points can be sent through the controller to the DCS Honeywell Experion PKS station so that the controller can be tuned with the Ziegler-Nichols method or manually input through the station. After Arduino is installed into the real plant, the tuning is then performed using the trial and error method to determine the effect of changing the tuning parameters to the stability of the system. The process is still using the same plant, namely the control system level 11LIC-010A on 11V1 Refinery Fuel Oil Complex I PT. Pertamina (Persero) Refinery Unit IV Cilacap. The following is Arduino's response in handling industrial-scale control with different tuning parameters.



(a) (b)

Figure 4 Controller response to industrial plants a. (P = 2; I = 1; D = 0) b. (P = 2.5; I = 1; D = 0)



(a) (b)

Figure 5 Controller Response in Industrial Plants a. (P=2.5; I=1,5; D=0) b. (P=2.5; I=2; D=0)

4. Conclusion

The results of the study concluded as follows: Arduino-based control system can handle the process of industrial-scale control. Arduino technically can be used in industrial-scale control systems. The only constraint is the Arduino does not have the features Safety Instrumented Level (SIL) it should be added yourself. Arduino can be used to control the industrial process after going through the calibration process using industry-standard calibration equipment with high accuracy.

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