# Modification of Control Oil Feeding with PLC Using Simulation Visual Basic and Neural Network Analysis

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**ABSTRACT**

The oil feeding system is an oil distribution system used in engine lubrication by flowing it directly to the engine parts to be lubricated through pipes. In addition, it is also a raw material for the production process by collecting the oil first in the storage tank, then weighing it on the oil scale before use in the production process. The current control is still using the conventional model. The operating system is still manual, and the absence of identity and damage information makes it difficult for the engineer to troubleshoot. The research method is to modify the oil feeding system control using PLC (Programmable Logic Controller) and Visual Basic to display process information. This process uses the Neural Network (NN) method. The simulation results show that the PLC program and visual basic software can be connected properly. The speed of the data transfer test connection that can be obtained is 32 ms. The prediction process of the oil feeding system using the backpropagation algorithm Neural Network and the activation function, which uses the binary sigmoid function (logsig) with the 17-10-1 architecture having very good performance getting the MSE value below the error value of 0.001 maximum epoch 961 and hidden layer 10 with an MSE value of 0.00099915.

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## 1. INTRODUCTION

The rapid development of technology has helped humans do their jobs more efficiently. Updating each machine is the application of science and industrial research that is continuously carried out to obtain quality and efficient products in the production process. The company PT Gajah Tunggal must optimize its machine work system to make this happen. The tire manufacturing process goes through long stages. In between the process stages, there is a mixing stage that produces compounds. The compound is a raw material in the manufacture of tires produced from a mixture of natural rubber, synthetic rubber, carbon black, oil, and other chemicals ground into sheets. This mixing process takes place in a mixer machine. In mixing materials such as natural rubber, synthetic rubber, and chemicals, it is weighed on the weighing conveyor after weighing all of these materials into the mixer machine with oil. The results come out through the roll die into compound sheets. In mixing materials such as natural rubber, synthetic rubber, and chemicals, they are weighed on the weighing conveyor after weighing all these materials into the mixer machine with the oil. The result comes out through the roll die into compound sheets.

Furthermore, the compound sheets are pulled by a pull-out conveyor to enter the solution bath containing promol fluid. Then proceed to the drying process on the cooling rack, and in the final process, the sheets are stacked. From the series of processes above, some problems exist in controlling the oil feeding system. The oil feeding system is an oil distribution system used in engine lubrication. Its works by channeling it directly to the machine that wants to be lubricated through pipes and as a raw material for the production process, collecting the oil first in the storage tank and then weighing it on the oil scale before use. In the production process. The current control is still using the conventional model. The operating system is still manual, and the absence of identity and damage information makes it difficult for the engineer to troubleshoot.

From the series of processes described, there were several problems found in the control of the oil feeding system. The current control still uses conventional models. The operating system is still manual, and there is no identity and damage information on the system, making it difficult for engineers to troubleshoot. Based on the above problems, a solution can be proposed by modifying the control using PLC and Visual Basic.

The PLC program was divided into an engine, control, and customizing program [1-4]. The PLC automatically develops the corresponding acceleration and deceleration operating curves according to the displacement. A fuzzy PID self-tuning control method is used to control the speed and steering of the stepping motor accurately, and an IIR digital filter is designed to reduce the interference from sea waves. The simulation results show that the stepping motor responds quickly, the speed of the stepping motor is stable, and the data acquisition time is reduced based on the proposed algorithm [5-9]. The construction of the campus automatic settlement system should fully consider the consumer management subsystem, the library monitoring subsystem, the student attendance monitoring subsystem, and the computer monitoring subsystem [10-11]. To Present modern PLC technologies and standards, they highlight their MAC sublayer characteristics and provide a detailed comparative analysis of PLC MAC protocols in the context of current and emerging PLC applications. Finally, we identify future trends within the scope of the MAC sublayer for PLC systems intending to stimulate additional research efforts on PLC MAC design [12-13]. The suggested concept is experimentally validated by both virtual and real commissioning in industrial conditions. The aspect of energy efficiency of the heat source control systems is also discussed, and for assessment of the energy supply performance, the energy error index is proposed [14-16]. Therefore, we designed the final assignment to wash the oil pan machine using the PLC to communicate with the mist collection. Using the mist collection can prevent the steam back into the water and dripping to the part that is already dry and littering the part. Using this new washing machine increases efficiency because the process of spraying the wind manually can be removed, and the cycle time down by 65.4 from initially 100.4 seconds to 35 seconds [17-22]. The final assignment of washing the oil pan machine using the PLC is to communicate with mist collection. Using the mist collection can prevent the steam back into the water and dripping to the part that is already dry and littering the part. The last part is devoted to examples of programming for different Boolean functions and simple control algorithms. All programs are written using the Ladder Diagram language [23-26].

The final result of this research is to design a conventional oil feeding control system to become a more automatic system. PLC is used as a controller and programming using Visual Basic.Net software, which can be connected to display information on a computer screen. The author is interested in modifying the conventional oil feeding system using PLC and Visual Basic to display process information from all explanations.

## 2. METHOD

Overall, the theories from the previous research were used as the basis for data processing and tool testing. The results obtained indicate that the tool made can work using the Visual Basic program. It is then sent via a serial communication circuit to the PLC with several components, namely RS-232 cable, Relay, Serial Port, and socket. PLC used is PLC LG KG80S. PLC is the controller for the monitoring system, and Visual basic is used to display compressor parameter data which PLC processes all data. From this research, the data results in a compressor pick-up time, which is 99% faster or 196 seconds than the old method. From this research, the results of the monitoring system can monitor line conditions in real-time and can increase the accuracy of recording downtime by 3.01% of the total number of machine working hours for one month. PLCs that can control the Building Automation System (BAS) equipment include Air Conditioners (AC), lights, and sockets in a room whose settings are adjusted through the time setting in the programming available on the PLC itself. The PLC used is the Omron Zen PLC with a monitoring system using Visual Basic 6.0. Monitoring goes well, and all building equipment controls can run automatically [27-30].

Fig. 1 describes a special form of microprocessor-based controller that uses program memory to store instructions and implements order, timing, counting, and arithmetic functions. It was first developed in 1969. The main advantage of using PLC is that the control system can be changed as needed without changing the basic components of the controller. Because it is very flexible to various control systems, it becomes cost-effective.

Fig. 2 explains the flowchart. MCB supply voltage 220 VAC for PLC and Power supply 24 VDC in On state. Then the Toggle Switch power is turned on to provide a 24 VDC source at the PLC's COM output terminal. After that, the ready push button is pressed to give an input signal to the PLC that the system is ready to operate. PLC will process the input signal according to the program that has been made. The process results are downloaded to the PLC CPU, where the output is an indicator light ready to light up. The ready indicator light illuminates, providing information that the system is ready to operate.

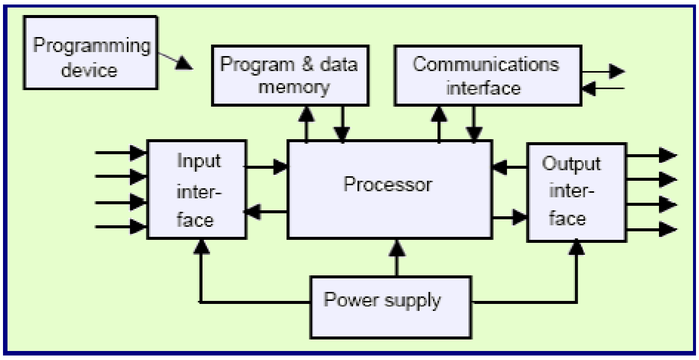


Fig. 1. PLC System

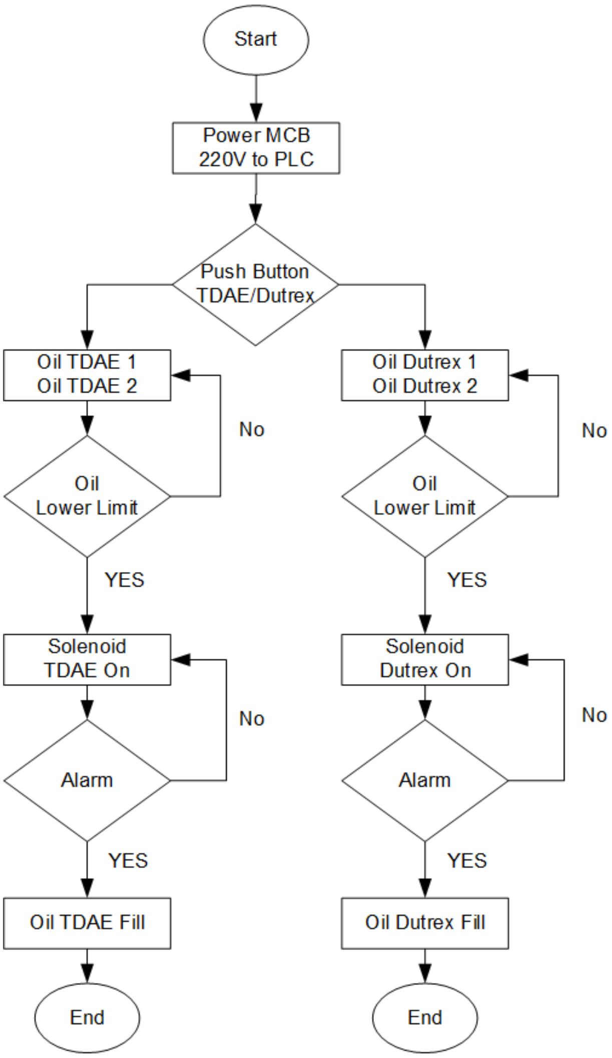


**Fig. 2.** Flowchart

In the system flow, the user can be faced with choosing the pump that will be used in the visual basic .NET software. The oil feeding system has two types of oil used, TDAE oil and Dutrex oil. Both types of oil are used together. So the user only chooses which pump to use. For the flow of the TDAE pump system, there are 2 pump options. Users only need to select pump 1 or 2. When pump 1 is selected, the next step is to press the push-button for pump TDAE 1. Likewise, if pump 2 is selected, then the push button pump TDAE 2 is pressed. Then the level sensor will read the oil level in the reservoir. If the tank is still full, the pump will not operate if the oil level is minimum. The level sensor will provide an input signal to the PLC. The signal from the level sensor will be processed according to the program that has been made, and the output will turn on the pipe solenoid valve so that the oil filling line to the tank is open. After the pipe solenoid valve operates, the system will first read whether there is an alarm. If there is an alarm, it is necessary to check first, and then the alarm reset push button is pressed to remove the alarm information. After that, the selected pump will operate until the oil transferred to the tank reaches the maximum level, and the level sensor reads the max signal. For Dutrex oil filling system flow is the same as TDAE. The process will operate until the oil level is full.

## 2.1. Workflow Design

In Fig. 3, the tool block diagram is divided into input, process, and output blocks. There are control devices included in the block.

Block input: Devices or equipment included in the input block, namely the TDAE Push Button Oil Pump, Dutrex Push Button Oil Pump, Push Button Ready, Push Button Reset Alarm, Oil Tank Switch Level, and Auxilary Contact Relay. Each input device controls the oil feeding system and sends signals to become input signals to the PLC.

Process blocks: The device that is included in the process block is Mitsubishi FX2N 32MR PLC. PLC functions to receive incoming input signals, then based on a program created with GX works 2 in the form of a ladder diagram programming language. After that, the PLC issues the process resulting in an ON or OFF signal sent to the output block.

Output block: Devices or equipment included in the output block, namely Relays and Indicator Lamps. The device receives the PLC process resulting in a voltage of 0 VDC or 24 VDC.

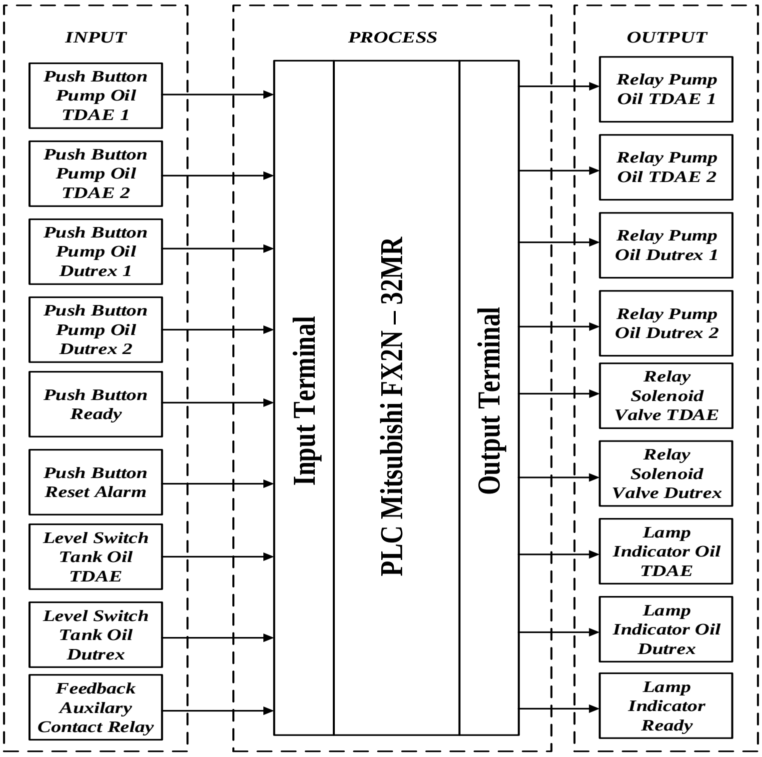

**Fig. 3.** Block Diagram

The oil feeding system control design aims to create or design an oil feeding system control using a PLC as a controller and create a program with Visual Basic.Net software and connect it to a PLC computer to display information on a screen. It makes it easier to operate and troubleshoot if there are problems with both hardware and software. In this design, there are several materials used. Table 1 is the technical specifications for the design of the oil feeding system.

**Table 1.** Technical Specifications

| No | Name | Description |
|---|---|---|
| 1 | Voltage supply | 220 VAC 50/60 HZ |
| 2 | Power Supply | 24 VDC |
| 3 | PLC | FX2N - 32MR Mitsubishi Supply 220 VAC |
| 4 | MCB | 2A 1 Pole |
| 5 | Push Button | Momentary NO |
| 6 | Relay | MY4N Omron |
| 7 | Limit switch | 1 NO 1 NC |
| 8 | Toggle Switch | NO |
| 9 | Pilot Lamp | 24 VDC |
| 10 | Cable Duck | 32x45 |
| 11 | Mounting Rail | 1 fuction |
| 12 | Cable Terminal | CBR 100 Black TEND |

The hardware design in question is the control panel design layout and the Oil Feeding System control circuit design using the Mitsubishi FX2N 32MR PLC, as shown in Fig. 4.

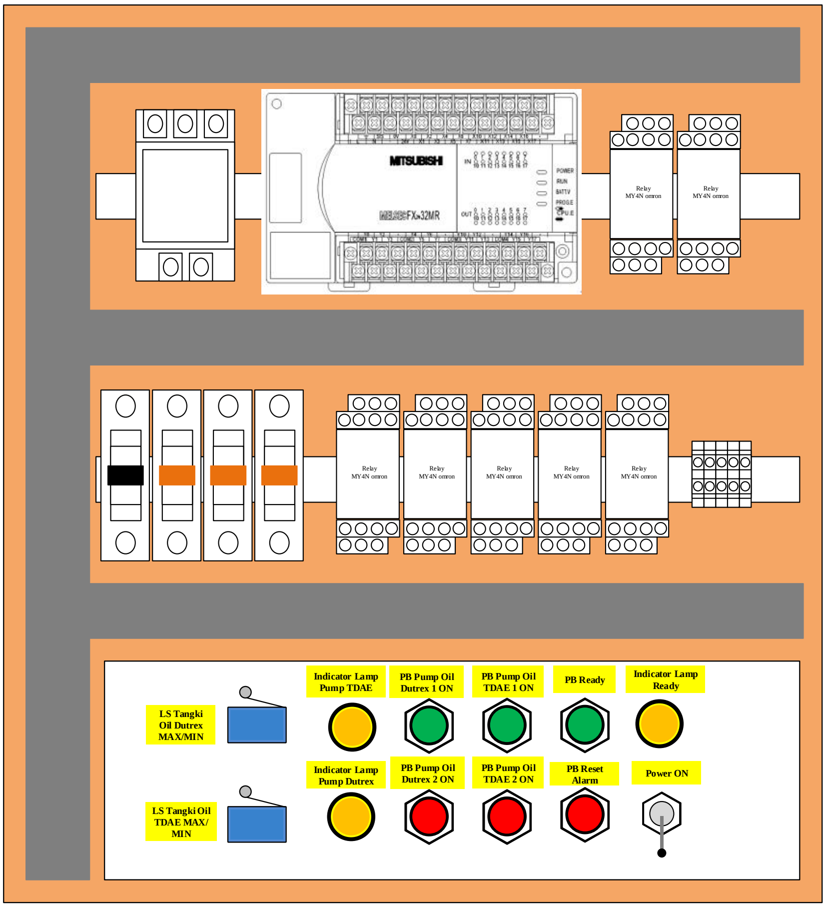


**Fig. 4.** Control Panel Layout

The design of the input terminal control circuit contains a circuit drawing or wiring diagram for the input equipment used. According to the technical specifications, the FX2N PLC uses a voltage of 220 VAC for Run conditions and for signal input using the common sink type. The wiring diagram can be seen in Fig. 5.

The design of the control circuit output terminal contains a circuit drawing or wiring diagram for the output equipment used. According to the technical specifications of the output equipment used, the working voltage used is 24 VDC, so in this design, a 24 VDC power supply is used to supply voltage to the output equipment, namely Relays and Pilot Lamps. The wiring diagram can be seen in Fig. 6.

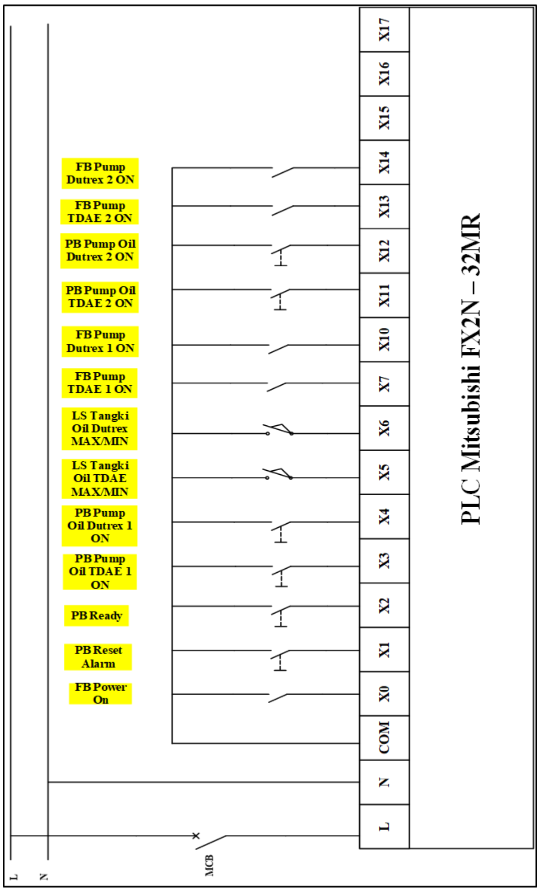


Fig. 5. Wiring diagram terminal input

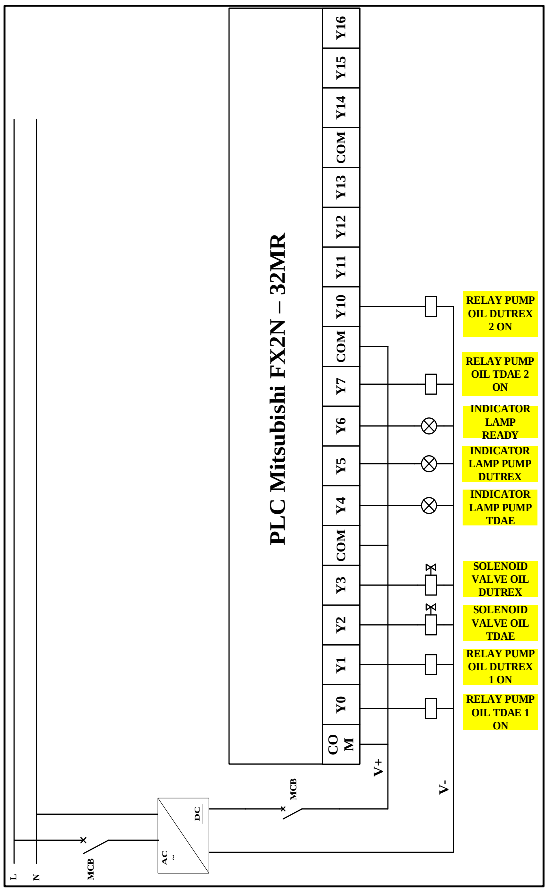


Fig. 6. Wiring diagram terminal output

All parts included in the hardware and software configurations run with the operating system to complete the various requirements of the PLC-based and Visual Basic.Net oil feeding control systems are shown in Fig. 7.

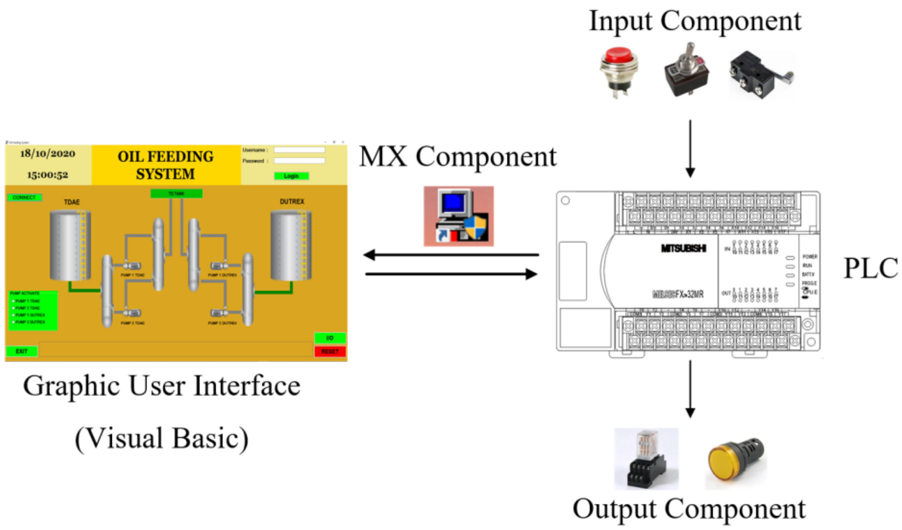


**Fig. 7**. System Configuration

## 3. RESULTS AND DISCUSSION

The whole set of this tool consists of two devices shown in Fig. 8. Including the PLC control panel, which is used for simulation, and the Visual Basic monitor display on the laptop as the user interface. The two devices are connected with a serial cable to transmit data from the PLC control panel to the laptop to be displayed on a Visual Basic monitor.

**Fig. 8.** PLC Control Panel

The visual basic monitor display on a laptop as the user interface of the oil feeding system has several forms. The first is the main screen form which contains the main view of the oil feeding process. Wherein this form, the user can select the pump he wants to use. In addition, this menu contains the login menu to activate the main mode function. The display of the main screen form can be shown in Fig. 9.

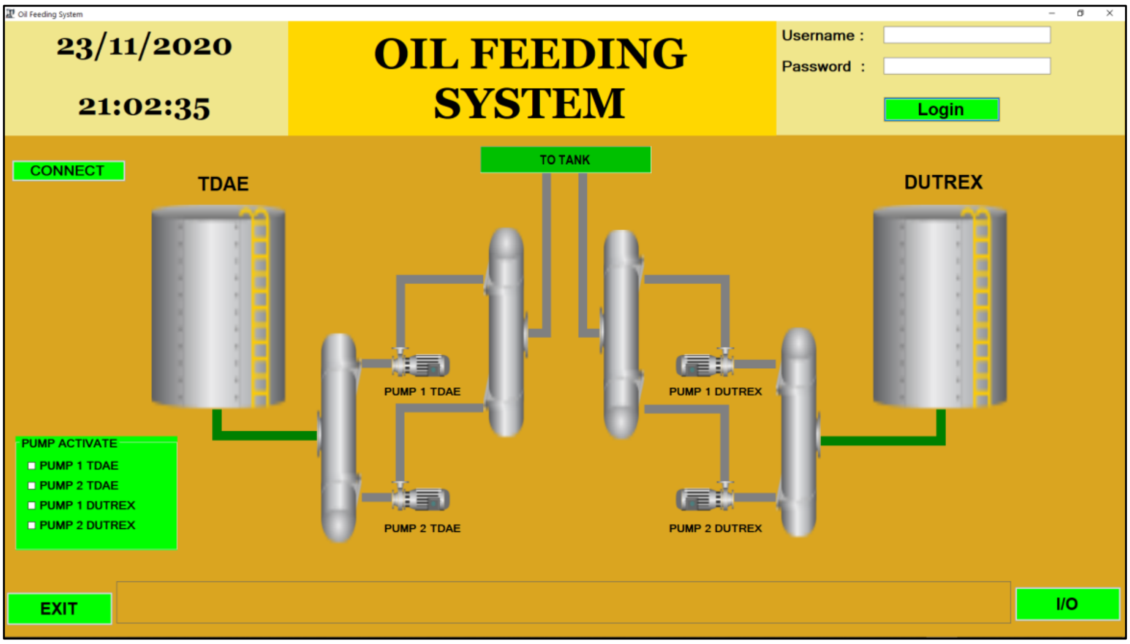


**Fig. 9.** Main Screen oil feeding system

Furthermore, there is a tank screen form. This form contains the follow-up process flow from storage (main tank) to storage tanks. The display of the tank screen form can be seen in Fig. 10. Then the third is the I / O list form. This form contains the condition or status of the currently active input and output equipment to make monitoring easier. Fig. 10 is a display of the I / O list form.

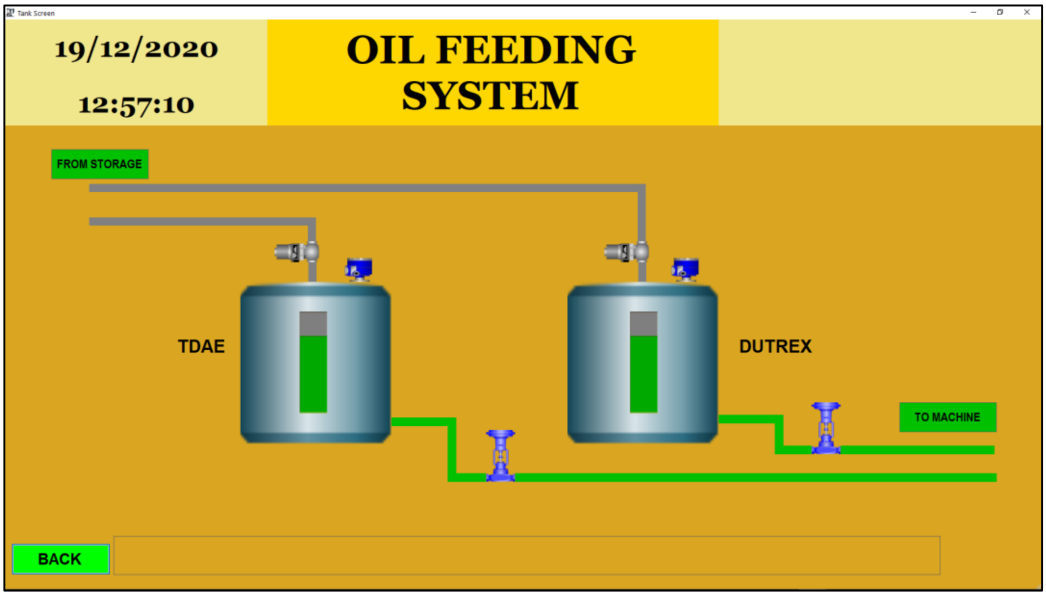


**Fig. 10**. Form tank screen

### 3.1. Testing With Neural Networks

In this stage, the neural network system is given input in the form of initialization parameter values. The number of input layer cells consists of 17 inputs in Table 2. The value of the variable is determined between 0 and 1 according to the input conditions. The number of hidden layer cells is searched based on trial and error by changing the learning constant and the hidden layer continuously until the best configuration is obtained, namely the smallest number of epochs.

**Table 2**. Input Neural Network

| No | Initialization | Description |
|---|---|---|
| 1 | X1 | RESET ALARM |
| 2 | X2 | PB READY |
| 3 | X3 | PUMP OIL TDAE 1 ON |
| 4 | X4 | PUMP OIL DUTREX 1 ON |
| 5 | X5 | LS TANGKI OIL TDAE MAX/MIN |
| 6 | X6 | LS TANGKI OIL DUTREX MAX/MIN |
| 7 | X7 | FEEDBACK PUMP TDAE 1 ON |
| 8 | X8 | FEEDBACK PUMP DUTREX 1 ON |
| 9 | X9 | PUMP OIL TDAE 2 ON |
| 10 | X10 | PUMP OIL DUTREX 2 ON |
| 11 | X11 | FEEDBACK PUMP TDAE 2 ON |
| 12 | X12 | FEEDBACK PUMP DUTREX 2 ON |
| 13 | X13 | FEEDBACK POWER ON |
| 14 | X14 | VB CHECK BOX TDAE 1 |
| 15 | X15 | VB CHECK BOX DUTREX 1 |
| 16 | X16 | VB CHECK BOX TDAE 2 |
| 17 | X17 | VB CHECK BOX DUTREX 2 |

The number of outputs consists of 2 patterns: oil feeding system run and oil feeding system off. The details can be seen in Table 3 and are as follow

Learning rate ($\alpha$) = 0.5
Maximum error = 0.001
Maximum Age = 1000
Activation Function = Logsig.

**Table 3**. Target initialization and prediction

| No | Initialization | Prediction |
|---|---|---|
| 1 | 1 | Oil Feeding System Run |
| 2 | 0 | Oil Feeding System Off |

In testing with the nervous network system, 10 sample data were given to assess the condition of the oil feeding pump to be trained as a learning process. To get the output value, The first step to take is to determine the input matrix and target matrix, as shown in Table 4.

**Table 4**. Input and target matrices

| No | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 | X15 | 16 | X17 | Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 3 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 4 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 5 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| 6 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 7 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 8 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 9 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 10 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

Next, determine the formula of the feedforward neural network by setting the activation function between the hidden input layer using logsig (binary sigmoid). The activation function from the hidden layer to the output using the logsig (binary sigmoid) activation and the network training function using the training function. Then the experiment was carried out with Matlab on Fig. 11 and Fig. 12. The MSE value for network training that has been completed is 0.00099915, achieved at 961 iterations, as shown in Fig. 12.

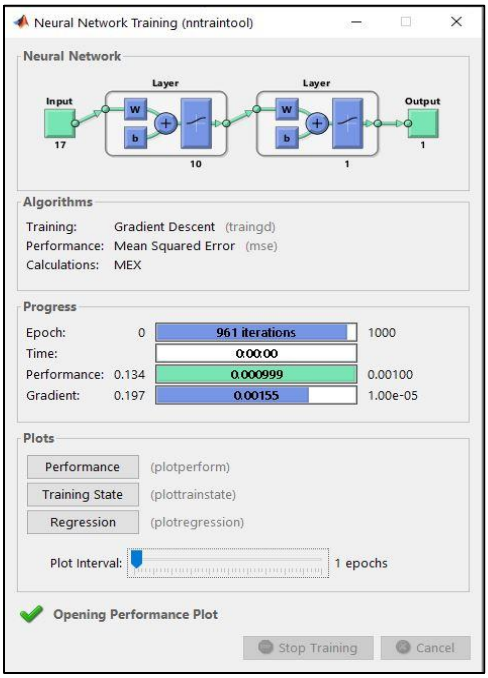


**Fig. 11**. Network Training Process

In the training process, this neural network will stop if the iteration has reached the maximum limit of 1,000 iterations, or the training will stop if the MSE (Mean Square Error) is below the target error. Here, it is known that the target error is 0.001. With the training, it can be seen that the output is in accordance with the target where the actual output value is taken, which is worth 1. The parameters for the actual output assessment with the activation function are:

$$Y = \begin{cases} 1, & If\ \ y \geq 0.5 \\ 0, & If\ \ y < 0.5 \end{cases} \tag{1}$$

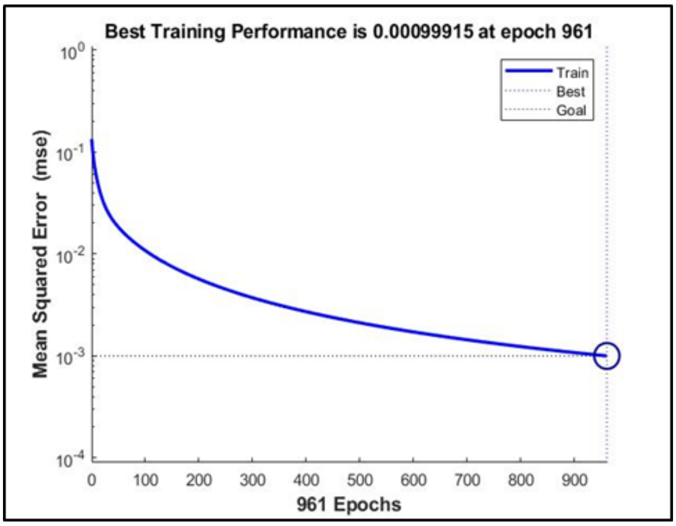


**Fig. 12.** MSE Results on Network Training

The results of the neural network's actual output values with predetermined predictions can be seen in Table 5. The test results show that the oil feeding system prediction process using the backpropagation algorithm with 17-10-1 architecture has a very good performance with an MSE value below the error value. 0.001 with a maximum epoch of 961 and hidden layer 10 with an MSE value of 0.00099915.

**Tabel 5.** Output Value

| No | Output Value | Actual Output | Target | Accuration |
|---|---|---|---|---|
| 1 | 0.987826932 | 1 | 1 | Correct |
| 2 | 0.033464869 | 0 | 0 | Correct |
| 3 | 0.050163124 | 0 | 0 | Correct |
| 4 | 0.953893694 | 1 | 1 | Correct |
| 5 | 0.980724176 | 1 | 1 | Correct |
| 6 | 0.03465905 | 0 | 0 | Correct |
| 7 | 0.959279745 | 1 | 1 | Correct |
| 8 | 0.007378034 | 0 | 0 | Correct |
| 9 | 0.016971729 | 0 | 0 | Correct |
| 10 | 0.022536788 | 0 | 0 | Correct |

## 4. CONCLUSION

The modified design of the oil feeding system control has been made, and the stability of the performance of the oil feeding system with various actuators is running well. Based on the actuator on-off test results, the actuators work according to the program that has been made. The test results of the system design carried out on the PLC program and visual basic software can be connected properly. The buttons in the visual basic software can provide input signals to the PLC via a USB cable connection. The speed of the data transfer test connection that can be obtained is 32 ms. Then the error testing uses the neural network method for the prediction process of the oil feeding system. The backpropagation algorithm and the activation function, which uses the binary sigmoid function (logsig) with the 17-10-1 architecture, have a very good performance getting the MSE value below the error value, 0.001 maximum epoch 961 hidden layers 10 with an MSE value of 0.00099915.

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