MONITORING AND CONTROLLING TRAINER OF AUTOMATIC GRAIN DRYER MACHINE BASED ON PLC AND SCADA

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Abstract— Grain drying is currently still using the traditional method of drying with solar thermal. One of the obstacles to rice production in Indonesia is the problem of the grain drying process. So far, Indonesian farmers still carry out traditional drying, only relying on the solar thermal to dry their grain, so that during the rainy season they will troubled in the drying process. Therefore, a trainer for a grain dryer machine with a small capacity is made so that it can be controlled by PLC and monitored using SCADA. The test results obtained that the weight of the grain before the 1000 gram test was tested with a drying time of 90 minutes, for the water content before drying was 18% after entering the drying process for 90 minutes, the weight of the grain became 927 grams and the water content after drying was 12.5%. At every 10 minutes the average weight loss of grain after the drying process is 5.9 grams and water content is 0.5%.

Keywords— *PLC, SCADA, Grain Dryer Trainer*

1. Introduction

Majority of grain drying In Indonesia still uses conventional methods, namely drying under direct sunlight, but this cannot be done during the rainy season or limited land, then a tool appears to dry rice, one type of grain dryer is by using the vertical drying method. . The operational cost of conventional grain drying is still high because it still uses a lot of human labor in the process. Therefore, it is necessary to automate the tool as well as the process of monitoring several parameters such as temperature, humidity, current and voltage.

In the previous activity, the researcher had written a scientific article in a national seminar SNPPM d1 Jakarta State University regarding the Design of a Vacuum Air System Grain Dryer for the Sido Rukun Farmer Group Association (Gapoktan) in Sidomulyo Village, Adimulyo District, Kebumen Regency. In this research, researchers will conduct research on the Design of Control Panel for Automatic Grain Dryer Based on PLC. This research is in line with the Strategic Plan and Roadmap of Semarang State Polytechnic research. One of the flagship research fields of the Semarang State Polytechnic, namely INTERNET OF THINGS (IOT) FOR SMART – LIVING is very closely related to the research to be carried out. This research is also in accordance with the road map for the superior development of the Electrical Applied Bachelor study program, namely Automation in the Electrical field.

The problems to be studied in this research are formulated as follows:

a) Designing a control panel on the grain drying process
b) Designing monitoring of grain dryers
c) Making control and monitoring of automatic grain drying process.

2. Literature Review

In Drying using a machine that does not depend on the weather is needed to be an alternative solution to the problem of drying grain. Controlling temperature, moisture content and appropriate humidity is the key in the drying process using this dryer. Therefore , the application of sensor and dryer technology with low operating costs is very important.

The grain dryer made is as shown in Figure 1 as follows:

Figure 1. Grain Dryer Tool

Researchers have conducted research in 2016 regarding the Design of Telemetring Systems in Real Time of Electricity Quantity Data in the Semarang State Polytechnic Electrical Workshop Building. The description of previous research, namely the Design of Telemetring Systems in Real Time, Data on Electricity Quantities in the Workshop Building as shown in Figure 2 as follows

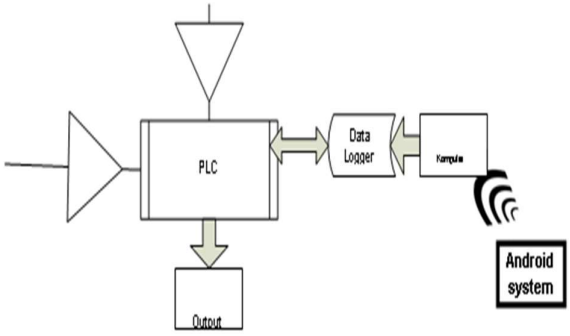


Figure 2. Electrical Power Monitoring design diagram (source: syahid, 2016)

Researchers have carried out community service in 2020 making rice dryers with on-off control not yet using PLC as the controller. The controller created in the previous activity is as shown in Figure 3 below:PLC functions and uses are very vast, in practice PLC can be divided in general and in particular. In general, the PLC function is as follows:

Figure 3. Design and Construction of On Off drain Dryer Control Panel (source: syahid, 2020)

3. Research Method

The steps taken to achieve satisfactory results in this research are described in the following methods:

3.1 Hardware Design

The tools and materials used in the design of the trainer system for the automatic grain dryer based on PLC and SCADA are :
PLC Modicon TM221CE24R, Relay,
Push Button, Selector Switch, Proximity Switch, Pilot Lamp, Screw Conveyor, Limit Switch, RTD PT 100, DC Motor, Blower Fan, Steam Solder, Temperature Control STC-1000, Bucket Elevator, MCB, and Power Supply.
System Block Diagram

The design of the trainer for automatic grain dryers based on PLC and SCADA has the following block diagram :

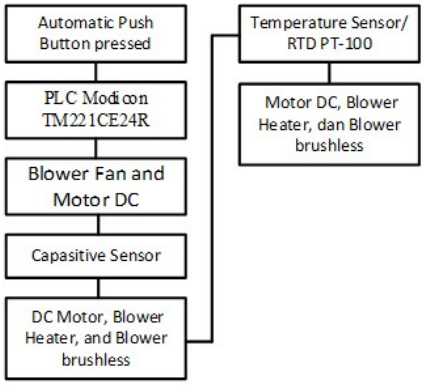
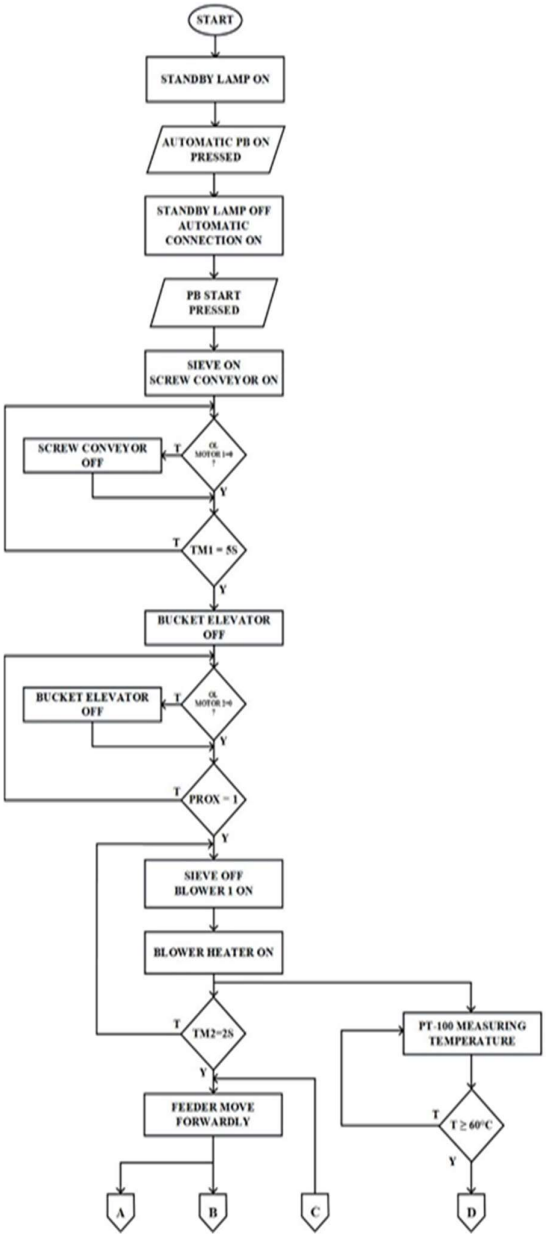


Figure. 4 Grain dryer Trainer Block Diagram

3.2 Software Design

This software design or software is a tool used to create programs or animations, here are several tools or devices used such as the EcoStruxure Machine Expert Basic program which functions to create PLC control programs and Vijeo Citect (SCADA) which are usually made for monitoring or for monitoring. create animation programs. The following will be given an explanation of the stages of making the program starting from the flow diagram to the steps of making animation

A. Automatic Flowchart:



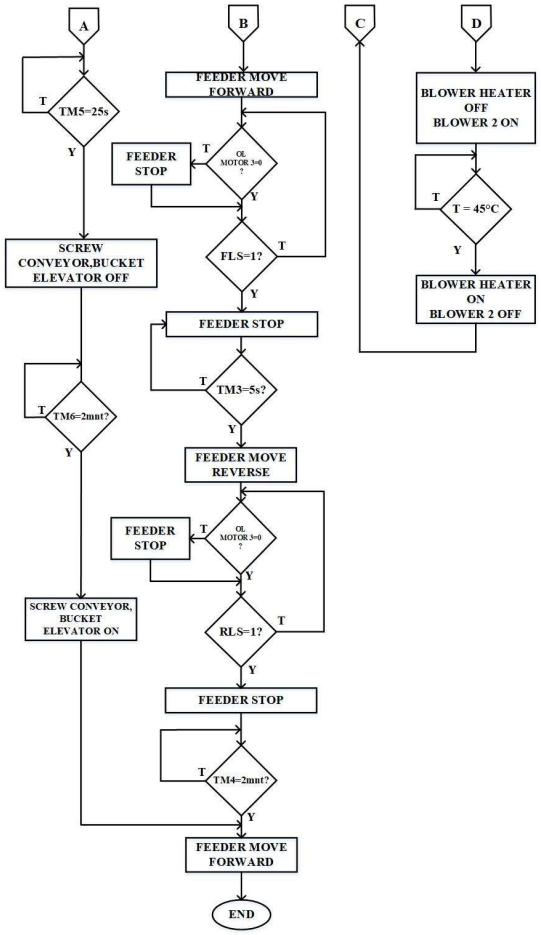


Figure 5. Automatic Flowchart

For the automatic work process, when PB_ON Automatic is pressed, the system will work automatically. When the circuit works automatically, the load will work sequentially. When PB START is pressed, the sieve and screw conveyor will work simultaneously. After 5 seconds when the Sieve and screw conveyor start working, the Bucket Elevator starts to work. Bucket Elevator serves to transport grain into the reservoir. At the top of the reservoir there is a proximity switch to detect the height of the grain in the reservoir. When the grain is full in the reservoir, the proximity switch will detect the grain and start working. When the proximity switch works, the sieve will stop working, blower 1, and blower heater will start working. When the blower heater is working, the PT100 temperature sensor will also measure the temperature in the reservoir. If the temperature in the reservoir reaches 60°C, then the blower heater will turn off and blower 2 will turn on. Blower Heater will turn on and blower 2 will turn off again when the temperature in the reservoir reaches = 40°C. After 2 seconds when the blower 1, and the blower heater is running, the feeder will start moving forward. After 10 seconds while the feeder is moving forward, the screw conveyor and bucket elevator will stop working. When the feeder moves forward and presses the limit switch 1, the feeder will stop. After 5 seconds later, the feeder will move backwards. When the

feeder moves backwards and presses the limit switch 2, the feeder will stop. After 2 minutes later, the feeder will move forward again, screw conveyor and bucket elevator will work again.

B. Manual Flowchart :

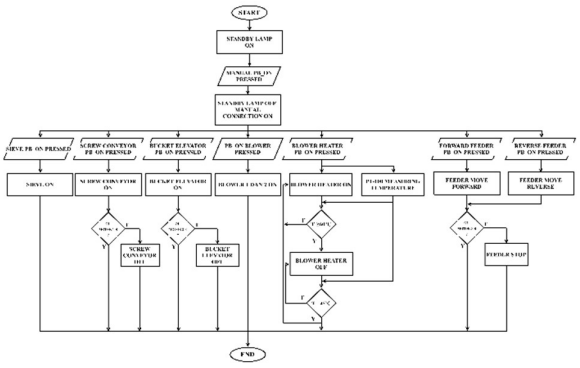


Figure 6. Manual Flowchart

For the manual work process, when PB_ON Manual is pressed, the system will work manually. When the circuit works manually, all loads can be turned on without having to be sequential. When PB_ON Sieve is pressed, Sieve will work, when PB_ON Sieve is released then Sieve will stop. When the PB_ON Screw Conveyor is pressed, the Screw Conveyor will work, when the PB_ON Screw Conveyor is released, the Screw Conveyor will stop. When PB_ON Bucket Elevator is pressed, then Bucket Elevator will work, when PB_ON Bucket Elevator is released then Bucket Elevator will stop. When PB_ON Blower is pressed, blowers 1 and 2 will work, when PB_ON Blower is released, Blowers 1 and 2 will stop. When the PB_ON Blower Heater is pressed, the blower heater will work, when the PB_ON Blower Heater is released, the blower heater will stop. When the blower heater is working, the PT-100 temperature sensor will also measure the temperature in the reservoir. If the temperature in the reservoir reaches 50°C, the blower heater will turn off. Blower Heater will turn on again when the temperature in the reservoir reaches = 40°C. When the PB_ON Forward Feeder is pressed, the feeder will move forward, when the PB_ON Forward Feeder is released the feeder will stop. When the PB_ON Reverse Feeder is pressed, the feeder will move backwards, when the PB_ON Reverse Feeder is released the feeder will stop.

4. Result and Analysis

The picture of the hardware and monitoring Grain dryer Trainer system can be seen in Figure 7 and figure 8.

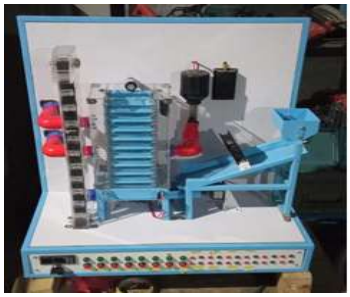


Figure 7. Grain dryer Trainer

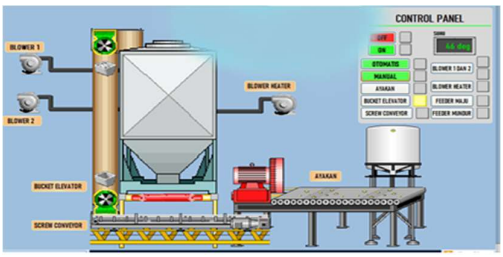


Figure 8. Monitoring Grain dryer Trainer

The results of testing the data of the rice dryer trainer as table 1 and table 2

Tabel 1. Grain Weight Data

No	Grain weight before drying	Grain weight after drying	Drying Period (minutes)
1	1000 g	1000 g	0
2	1000 g	980 g	10
3	1000 g	977 g	20
4	1000 g	970 g	30
5	1000 g	960 g	40
6	1000 g	957 g	50
7	1000 g	951 g	60
8	1000 g	937 g	70
9	1000 g	933 g	80
10	1000 g	927 g	90

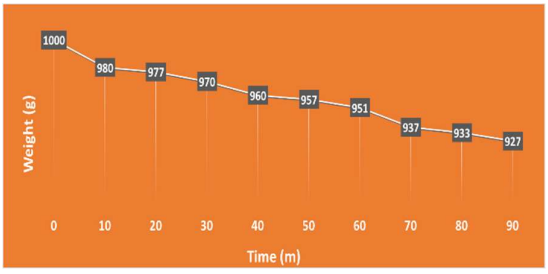


Figure 9. Grain Weight Chart

Tabel 2. Water Content Data

No	Water Content before Drying	Water Content after Drying	Drying Period (minutes)
1.	18%	18%	0
2.	18%	18%	10
3.	18%	17,5%	20
4.	18%	16,5%	30
5.	18%	16%	40
6.	18%	15,5%	50
7.	18%	14,5%	60
8.	18%	13,5%	70
9.	18%	13%	80
10.	18%	12,5%	90

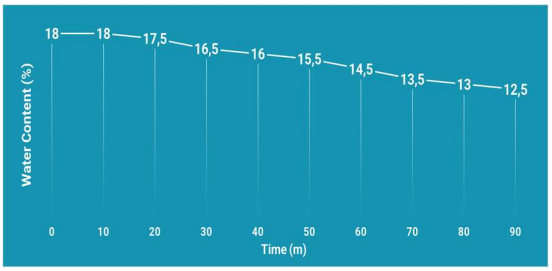


Figure 10. Water Content Chart

The data is obtained every 10 minutes of the drying process sequentially. After doing some test data, the following results were obtained :

1. In the first 10 minutes of drying, the water content has not changed, only the weight has decreased by 20 grams.
2. During 20 minutes of grain drying, the moisture content was reduced by 0.5% from 18% to 17.5% and the weight was reduced by 3 grams.
3. At 30 minutes of grain drying, the moisture content was reduced by 1% from 17.5% to 16.5% and the weight was reduced by 7 grams.
4. At 40 minutes of drying, the moisture content was reduced by 0.5% from 16.5% to 16% and the weight was reduced by 10 grams.
5. At 50 minutes of grain drying, the moisture content was reduced by 0.5% from 16% to 15.5% and the weight was reduced by 3 grams.
6. At 60 minutes of grain drying, the moisture content was reduced by 1% from 15.5% to 15% and the weight was reduced by 6 grams.
7. At 70 minutes of grain drying, the moisture content was reduced by 1% from 14.5% to 14% and the weight was reduced by 4 grams
8. At 80 minutes of grain drying, the moisture content was reduced by 0.5% from 13% to 12.5% and the weight was reduced by 4 grams.
9. At the end of the grain drying time, 90 minutes, the water content was reduced by 0.5% to 12.5% and the weight to 927 grams.

5. Conclusion

Based on the research " Monitoring and Controlling Trainer of Automatic Grain Dryer Machine Based on PLC and SCADA" it can be concluded as follows:

1) The hardware test results show that the PLC module and trainer of the automatic grain dryer machine can run well.
2) The results of the SCADA software test function for monitoring the work process of the grain dryer trainer can run well.
3) The test results obtained that the weight of grain before the 1000 gram test was tested with a drying time of 90 minutes, for the moisture content before drying 18% after entering the drying process for 90 minutes the weight of the grain became 927 grams and the water content after drying was 12.5%.
4) At every 10 minutes the average weight loss of grain after the drying process is 5.9 grams and water content is 0.5%.

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