Design an Automatic Flour Packing System with the Programmable Logic Controller System

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Abstract

To facilitate marketing so it is necessary to organize the packaging / packaging process. One of the production activities in terms of filling and packaging flour still uses human labour and it takes 2 workers for producing 100 sacks of flour in 3 hours in a 20 kg package. The manual method used by the workers can prove that it takes a long time to process the flour filling and packaging. After observing the problems experienced by workers, therefore the authors took the initiative to create a device that can carry out the filling and packaging process of flour automatically by utilizing a PLC (Programmable Logic Controller) as a controller, proximity optical sensors as packaging detectors in the filling place, load cell sensors. as a detector for the weight of flour to be weighed and the weighing result is displayed on the LCD. Packages that have been filled with 2 kg of flour will be carried by a conveyor for the packing process using a sewing machine. From the test results, it is found that the filling process of flour weighing 2 kg is displayed on the LCD and also the packaging process takes 20 seconds.

Keywords: loadcell sensors, PLC (Programmable Logic Controller), proximity optic

Abstrak

Untuk mempermudah pemasaran maka perlu diadakan pengemasan/proses pengemasan. Salah satu kegiatan produksi dalam hal pengisian dan pengemasan tepung masih menggunakan tenaga manusia dan dibutuhkan 2 orang pekerja untuk memproduksi 100 karung tepung dalam waktu 3 jam dalam kemasan 20 kg. Cara manual yang digunakan oleh para pekerja dapat membuktikan bahwa proses pengisian dan pengemasan tepung membutuhkan waktu yang lama. Setelah mengamati permasalahan yang dialami oleh pekerja, maka penulis berinisiatif untuk membuat suatu alat yang dapat melakukan proses pengisian dan pengemasan tepung secara otomatis dengan memanfaatkan PLC (Progammable Logic Controller) sebagai pengontrol, sensor proximity optical sebagai pendeteksi pengemasan pada tempat pengisian, sensor sel beban. sebagai pendeteksi berat tepung yang akan ditimbang dan hasil penimbangan ditampilkan pada LCD. Paket yang telah diisi dengan 2 kg tepung akan dibawa oleh conveyor untuk proses packing menggunakan mesin jahit. Dari hasil pengujian diketahui bahwa proses pengisian tepung terigu seberat 2 kg ditampilkan pada LCD dan juga proses pengemasan membutuhkan waktu 20 detik.

Kata kunci: loadcell sensors, PLC (Progammable Logic Cntroller), proximity optic

1. Introduction

One of the biggest things after the processed product is marketing. To facilitate its marketing, it is necessary to arrange the product in such a way that it is easy to distribute. One of the most important product arrangements is packaging, packaging according to certain sizes and shapes so as to facilitate the preparation and transportation of the product. Packaging is a way of providing appropriate environmental conditions for foodstuffs and thus requires greater thought and attention to develop environmentally friendly packaging.

One of the activities in production is the filling and packaging process, it is mentioned by adding the weight of the flour and the accuracy of the filling. Based on observations in Gampong Kumbang Punteut, to be precise on Jalan Alue Raya, Blang Mangat District, Lhokseumawe City, to fill and package sago flour it takes 2 workers to produce 100 sacks of flour with 3 hours in 20 kg packs. It is proves that it takes a long time for workers to fill in packaged flour.

The difficulty in this production process can be analyzed that the process of filling and packing flour into packaging is done manually which causes a lot of time used. Therefore, the author takes the title design an automatic flour packing system with the programmable logic controller system using a PLC which can facilitate various kinds of difficulties in the process.

Due to the continuous advancement of technology, especially in the industrial sector, programming technology was created using a logic control system known as the Programmable Logic Controller. This solution can make it easier for workers to fill in the field.

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Due to the continuous advancement of technology, especially in the industrial sector, programming technology was created using a logic control system known as the Programmable Logic Controller. This solution flour packing automatically.

Based on the above background, the formulation of the problems that will be discussed in this project are: Designing the system packing flour automatically using PLC. The use of load cell sensor as a sensing weight of 2 kg flour. The results of weighing flour are displayed on the LCD.

2. Theory

2.1 PLC (Programmable Logic Controller)

PLC (Programmable Logic Controller) is a programmable logic control which is an electronic command designed to be able to operate digitally by using memory as a storage medium for internal instructions to carry out logic functions, such as counter functions, process sequence functions, timer functions, arithmetic functions, and other functions by programming it. PLC is the same as a microcontroller but here the PLC has got standardized as an industrial controller.

2.1.1 Based on the name, PLC has its concept as follows:

a. Programmable
   Shows the ability in memory terms to store programs that have been created that can easily be changed in function or use.
b. Logic
   Demonstrates the ability to process input arithmetic and logic (ALU), which is to perform operations comparing, adding, multiplying, dividing, subtracting, negating, AND, OR, and so on.
c. Controller
   Demonstrate the ability to control and regulate the process so as to produce the desired output.

2.1.2 In general, the PLC function:

a. Sequential Control
   PLC processes the binary signal input into output which is used for technical processing purposes in a sequential manner, here the PLC keeps all steps or steps in a sequential process taking place in the right order.
b. Plant Monitoring
   The PLC continuously monitors the status of a system (eg temperature, pressure, altitude) and takes the necessary action in connection with the controlled process (eg value has exceeded the limit) or displays the message to the operator.

2.1.3 Whole PLC System:

a. Central Processing Unit (CPU)
   Consists of a microprocessor as the brain of the PLC, memory as a program storage device and a power supply equipped with a rectifier circuit that converts alternating current (AC) to direct current (DC). Overall CPU can be seen in Figure 1.

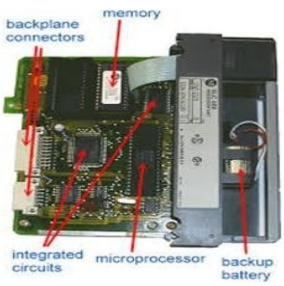

Figure 1. CPU

b. Model Power Supply (Power Supply)
The PS provides DC voltage to various other PLC modules in addition to additional modules with a total current capability of around 20A to 50A, which is the same as an integral lithium battery (which is used as memory backup).
c. Modular input
The input module is used to receive signals from the peripheral sensing unit and provide settings signal, termination, isolation, or input signal state indicator. The signals from the peripheral device will be scanned and the state will be communicated through the interface module in the PLC.
d. Modular output
The output module activates a variety of devices such as hydraulic, pneumatic actuators, solenoids, motor starters, and a display of the status of the connected peripheral points in the system. Other output module functions include conditioning, terminating and isolating existing signals. The activation process is of course carried out by sending relevant discrete and analogue signals, based on the nature of the PLC itself which is a digital device.

2.1.4 PLC Programming Language

In PLC programming, there are several programming methods used by PLCs to operate. Common methods of choice include programming methods with ladder logic diagrams, mnemonic (statement lists), and function block diagrams. The choice of this method is intended so that users can easily program according to their preferred programming skills or methods. Based on the International Standard IEC- 61131-3, there are 5 types of PLC programming languages.

a. Ladder Diagram
This programming is one method that is very commonly used. This method is practical and quite easy to understand. This diagram itself consists of two vertical lines that represent power. The circuit components are then connected as horizontal lines which are rungs. The component in question is placed between the two vertical lines.
b. Function Block Diagram / Function Plan
This programming language focuses on the relationship between input and output variables in the form of block diagrams and within these blocks there are certain functions.
c. Structure Text
This programming language includes a high-level language which is used for a number of complex procedures using standard language to state conditions from different steps. The language used is similar to the Pascal programming language.
d. Mnemonic / statement list
This programming language includes a low-level language, which is this programming uses variable statements (letters) as input and is very effective for small applications where there are standard commands.
e. Sequential Function Chart
This programming language is created with a chart system that presents each step into a relationship - transitional relationship. The chart already contains a sequence of steps, transitions and branching.

2.2 PLC (Progammable Logic Controller) OMRON CPM1A

The PLC used is the Omron brand PLC type: CPM1A 30CDR - D - IV, this type number has the following code meaning:

- CPM1A = This series has serial communication and peripherals
- 30 = total input and output, usually I / O = 60%: 40%
- C = CPU unit
- D = 24VDC sensor input

Figure 2. PLC OMRON CPM1A

For programming software, there are two software that can be used, namely: SYSWIN software, the software is an old product. CX-Program software is the latest software from Omron. CX-PROGRAMMER is a tool that is integrated in the plcomron software, all of which are summarized in the CX-ONE software which contains CX-PROGRAMMER, CX-SIMULATOR, CX-DESIGNER, etc. CX- PROGRAMMER is software that operates under the Windows operating system.

2.3 Optical Proximity Sensor

The optical proximity sensor consists of two main modules, namely emitter and receiver. In the case of the diffuse sensor, it is built into one housing system. The emitter of the diffuse sensor emits a pulsating red light that is within the visible spectral range. The object to be detected reflects is the part of the light emitted. This light is detected by the semiconductor device in the receiver which is also built into the sensor housing and causes a change in the switching state. The object to be detected can be reflective, matt, transparent or opaque. All is needed as proportion of light high enough to be reflected directly or diffusely. Operational switching distance may vary with use potentiometer. The Proximity sensor has a PNP output, that is, the signal line is switched to a positive potential in the switched state. The switch is designed as normally closed contacts. The load connection occurs between the signal output from the proximity sensor and the load. The switching status is indicated by a yellow LED. The sensor is protected against polarity reversal, overload and short circuit

Figure 3. Optical Proximity Sensor

Infrared light is used in most optical sensors. To make light sensing systems easier, most optical distance sensor light sources shine infrared light on and off at a fixed frequency. The light sensor circuit is designed so that light which does not pulsate at this frequency is rejected

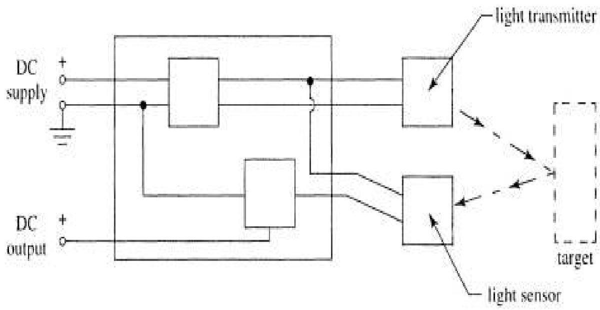

Figure 4. Optical Proximity Sensors Diagrams

The light sensor in optical proximity sensors is usually a semiconductor device such as a diode, which produces a small current when light energy strikes, or more commonly a phototransistor or photo-Darlington which allows current to flow if light is on. Early light sensors used photoconductive materials which became better conductors, and thus allowed current to pass through, as light energy hit them. Sensor control circuit is also required. The control circuit may have to match the pulsing frequency of the transmitter with the light sensor. Control circuits are also often used to power output circuits at a certain light level. Light beam sensor that generates voltage or a current proportional to the received light level is also available.

Through beam type sensors are usually used to signal the presence of objects blocking light. If they have an adjustable level of diversion, they can be used, for example, to detect whether a bottle is filled by the amount of light passing through the bottle or not. The retroflected type light sensor has a transmitter and receiver in the same package. They detect targets that reflect light back at the sensors. A retroreflective sensor that focuses on recognizing targets within a limited range is also available.

2.4 Motor DC

DC motor is an electromechanical device that converts electrical power into mechanical power with a current source as the supply of electrical energy. In general, a DC motor consists of a stationary part and a moving part. The stationary part is called the stator and the moving part is called the rotor. The stator is a field coil in the shape of a shoe pole to produce a magnetic field. The rotor is an anchor coil with a conductor winding (coil) to induce emf (electromotive force) on the conductor which is located in the anchor grooves. The air gap allows the anchor to rotate in a magnetic field.

The working principle of a DC motor is based on a current-flowing conductor placed in a magnetic field that conducts it will experience a force. This force will cause torque which will cause mechanical rotation so that the motor will rotate. This DC motor will receive a direct current source from the grid which is then converted into mechanical energy in the form of a rotation that will be used by other peripherals.

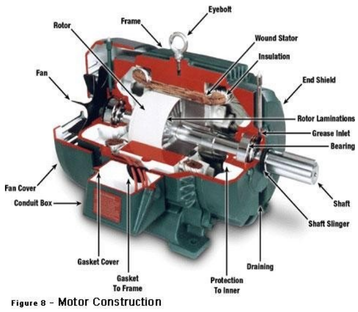

Figure 5. DC Motor

2.5 Methods

Mechanical design aims to determine how a tool will be made. In this mechanical design, there will be a part of the overall system of the control system for the flour packing process automatically using a PLC as a controller. In an automatic control system, of course, there are various kinds of manipulations of electrical circuits that are carried out to achieve the input or output requirements to be achieved, the manipulations carried out include various kinds of components used by assembling each of these components with various complex considerations and calculations. In this electrical design discusses a series of circuit manipulations that are applied to this system.

3. Results and Discussion

After making hardware and software, the author needs to test and analyze the tools that have been made, whether the tools can work in accordance with the functions and test planning that were previously carried out separately then combined in a control system that has been designed. The test data obtained will be analyzed to be used as a reference in drawing conclusions.

3.1 Software Testing

Software testing is done by simulating a program in the Cx-Programmer software with simulation features without having to be connected directly to the PLC. Simulations are carried out repeatedly to check that the ladder program is correct and to get the accuracy of the program in controlling the hardware, after that the program is transferred to the PLC and run in monitoring mode so that every step of the instructions on the ladder can be directly observed with the hardware response.

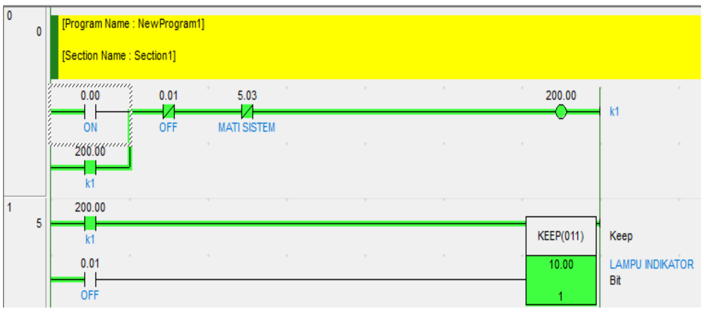

Figure 6. Ladder Start - Stop Simulation

Figure 10 above shows a ladder start-stop simulation, when the ON button is given logic 1, it will activate address 200.00 as a digital output, output 200.00 will activate a rung filled with address NO 200.00. In the next rung the child contact NO 200.00 will activate the indicator light with the output address 10.00. When the system is active, actuator 1, namely the conveyor motor, will work by bringing the object to the filling process. In actuator 1 there is 1 proximity optical unit which functions as a sack detector right under the valve, as shown in the following 11:

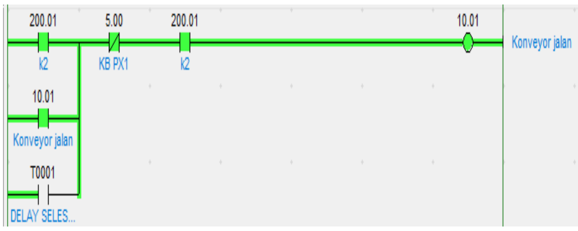

Figure 7. Ladder Conveyor Simulation

When proximity 1 is active, the conveyor motor will be OFF, then the motor valve will open until it hits the limit switch 1 (open limit), and the motor valve turns off when it has filled the flour according to the setpoint, which is 2kg until it hits the limit switch 2 (closed limit). As shown in Figure 12.

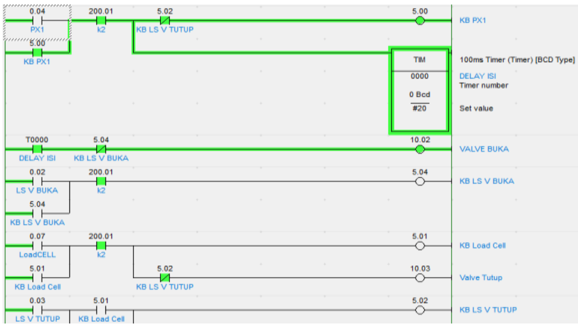

Figure 8. Flour Filling Ladder Simulation

3.2 Hardware Testing

Hardware testing is to find out whether the system that is being made is functioning properly and in accordance with the planning specifications, therefore it is necessary to do hardware testing. DC motor testing is done to determine the working voltage output of the DC motor and to find out whether the motor can work according to planning or not. In this system, in general, there are 2 types of actuators, including a DC motor that is used for conveyors and a DC motor that is used for valves, as for the test results of a DC motor as shown in Table 2.

3.2.1 DC Conveyor Motor

In Table 2, the test results of the DC motor power window test based on measurements using a multimeter are carried out in 2 conditions, namely when the motor is active at 9 volts and 0 volts when the motor is non active.

Table1. Data on Motor Test Results on Conveyor Actuators

DC Motor Power Window 1	Motor Condition	Voltage (V)
Conveyor	Active	9 Volt
	Non Active	0 Volt

3.2.2 MotorDCValve

Actuator testing to open and close the valve by utilizing the DC motor rotation power windows. The stress results obtained can be seen in Table 3

Table 3. Data on the results of motor testing on valve actuators

No	Actuator	Voltage In Motor Condition		
		Non Active	Active	
			Left	Right
1	DC Motor power window Valve	0 V	11.97	11.95

Based on the test results as in Table 3 in this test, the power windows motor works to open and close the valve. In this process, the power windows motor is given an input voltage of 12 volts so that it can work normally.

3.3 Overall System Analysis

The first step to operate this design is to get supply from the control panel. On the panel there are 2 buttons and 1 indicator light, namely the ON button to activate the system, the OFF button to turn off the system and an indicator light that functions as a sign that the system is working.

Initially the packaging is placed on top of the container so that the packaging is open so that it is easy when the flour is filled then placed on the conveyor, after that the ON button is pressed then M1 (conveyor motor) will move the conveyor and bring the packaging to the filling process for 5 seconds, when Proximity 1 detects the packaging then the conveyor will stop right below the valve, proximity 1 which detects the presence of packaging, then M2 will actuate the valve and open the valve until it reaches the opening limit (LS1) then the flour will be filled into the package of 2 kg if the timer is set for 10 seconds, during the flour filling takes place under the package there is a load cell sensor which functions as a weight detection sensor. If the flour is filled with a weight of 2 kg, M2 will rotate to the left regarding the cap limit (LS2) and the weighing result will be displayed on the LCD in grams. After 2 kg of flour is filled with a delay of 10 seconds for M1 (conveyor motor) to move again, Proximity 2 will detect the packaging for the packing process, and when Proximity 2 detects a package, the sewing machine will turn on and perform the sewing process. When the sewing process is complete, Proximity 3 will detect the packaging and the conveyor will stop when the packaging is detected by Proximity 3, then this system will remain ON before pressing the OFF button. This system can also work repeatedly. The process of filling flour with a weight of 2 kg is displayed on the LCD and also the packaging process takes 20 seconds. Proximity working voltage in general when active is 23.87 volts. The working voltage of the valve drive motor being opened is 11.95 Volts and when closed is 11.97 Volts and the working voltage of the conveyor drive motors is 9 Volts.

4. Conclusion

Based on the results of testing and analysis on an automatic flour packing system using a Programmable Logic Controller, it can be concluded that: (1) The I / O address allocation data in PLC memory must be synchronized with the external I / O address allocation data, so that the system can work according to instructions from the operator to produce the expected device performance; (2) Proximity Optic sensor works as a switching and also to detect the presence or absence of packaging. Proximity 1 as a packaging detector during the filling process, Proximity 2 as a packaging detector during the sewing process and Proximity 3 as a packaging detector to indicate that the system is OFF; (3) A strain gauge is a strain sensor that converts strain into resistance, then with a Wheatstone Bridge circuit it is converted to voltage but because the voltage generated is very small (milli Volt scale) an amplifier circuit is needed so that the strain gauge sensor can become an actuator; (4) The change in voltage of any given load is almost proportional. The greater the weight of the load, the greater the stress and the change in the magnitude of the stress of each load tends to be constant; (5) The output voltage on the HX711 amplifier module when given a load gradually tends not to change when measuring several times.

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