PLC based Automatic Oil Filling Machine

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Abstract--- The main aim of this project is to provide a low cost automated oil filling system. The present system will provides a great deal of applications in the field of low cost automation, especially in mass production industries where there are large number of components to be processed and handled in a short period of time and there's need for increased production.

Keywords: automatic oil filling machine, PLC, hardware, low cost automation.

I. INTRODUCTION

India is fast developing industrially. The industrial growth, particularly during the last decade, has been considerable. This growth, of course, is not free from the attendant problems. In a country like ours, which has mainly an agricultural based economy, the industrial development is very likely to change the existing conditions.

In our country, one can come across factories with outdated and inefficient technology and also factories with modern and highly sophisticated technology. The main reason for the latter is the fact that the latest technological developments from the already developed countries have been transplanted is worthwhile to remember that the technological advancement that has taken place in the developed countries has been, achieved in stages, depending upon the changed conditions and requirements. For example many of the developments in industrially more advanced countries require minimum labor force because of the fact that increasing wages, shortage of skilled labor force and lower Productivity have made the older technologies inadequate to meet the demands, inefficient, and uneconomical.

A. Low Cost Automation

Low Cost Automation (popularly known as LCA), is the introduction of simple pneumatic, hydraulic, mechanical and electrical devices into the existing production machinery, with a view to improving their productivity.

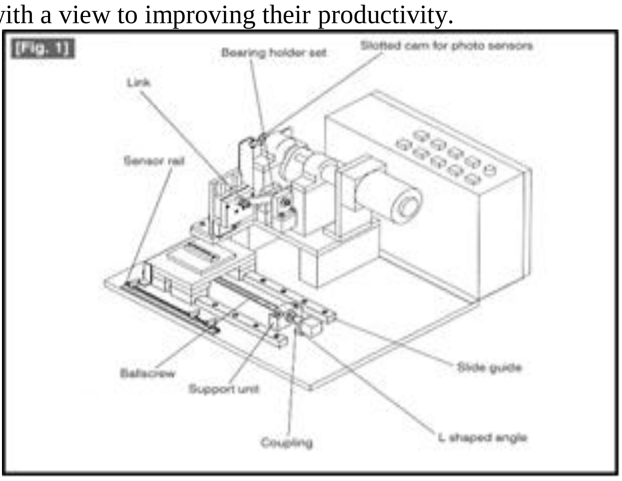

Fig. 1: Automation

This would also enable the operation of this equipment by even semi-skilled and unskilled labor, with a little training. This will involve the use of standardized parts and devices to mechanize or automate machines, processes and systems. Utilizing a human being as a source of energy is an inefficient method, in addition to being boring and monotonous to the worker.

The aim of the project is to fill oil to three different height compressors. This type of filling is used in many industries. By this process, we are able to fill the different classes of objects. With the advent of liberalization and globalization, it is necessary that industries explore method of enhancing automation.

B. History of PLC:

Before the PLC, control, sequencing, and safety interlock logic for manufacturing automobiles was mainly composed of relays, cam timers, drum sequencers, and dedicated closed-loop controllers. Since these could number in the hundreds or even thousands, the process for updating such facilities for the yearly model change-over was very time consuming and expensive, as electricians needed to individually rewire relays to change the logic.

Digital computers, being general-purpose programmable devices, were soon applied to control of industrial processes. Early computers required specialist programmers, and stringent operating environmental control for temperature, cleanliness, and power quality. Using a general-purpose computer for process control required protecting the computer from the plant floor conditions. An industrial control computer would have several attributes: it would tolerate the shop-floor environment, it would support discrete (bit-form) input and output in an easily extensible manner, it would not require years of training to use, and it would permit its operation to be monitored. The response time of any computer system must be fast enough to be useful for control; the required speed varying according to the nature of the process.[1]

In 1968 GM Hydra-Matic (the automatic transmission division of General Motors) issued a request for proposals for an electronic replacement for hard-wired relay systems based on a white paper written by engineer Edward R. Clark. The winning proposal came from Bedford Associates of Bedford, Massachusetts. The first PLC, designated the 084 because it was Bedford Associates' eighty-fourth project, was the result.[2] Bedford Associates started a new company dedicated to developing, manufacturing, selling, and servicing this new product: Modicon, which stood for Modular Digital Controller. One of the people who worked on that project was Dick Morley, who is considered to be the "father" of the PLC.[3] The Modicon brand was sold in 1977 to Gould Electronics, and later acquired by German Company AEG and then by French Schneider Electric, the current owner.

One of the very first 084 models built is now on display at Modicon's headquarters in North Andover, Massachusetts. It was presented to Modicon by GM, when the unit was retired after nearly twenty years of uninterrupted service. Modicon used the 84 moniker at the end of its product range until the 984 made its appearance.

The automotive industry is still one of the largest users of PLCs.

C. Programming:

Early PLCs, up to the mid-1980s, were programmed using proprietary programming panels or special-purpose programming terminals, which often had dedicated function keys representing the various logical elements of PLC programs.[2] Some proprietary programming terminals displayed the elements of PLC programs as graphic symbols, but plain ASCII character representations of contacts, coils, and wires were common. Programs were stored on cassette tape cartridges. Facilities for printing and documentation were minimal due to lack of memory capacity. The very oldest PLCs used non-volatile magnetic core memory.

More recently, PLCs are programmed using application software on personal computers, which now represent the logic in graphic form instead of character symbols. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. The programming software allows entry and editing of the ladder-style logic. Generally the software provides functions for debugging and troubleshooting the PLC software, for example, by highlighting portions of the logic to show current status during operation or via simulation. The software will upload and download the PLC program, for backup and restoration purposes. In some models of programmable controller, the program is transferred from a personal computer to the PLC through a programming board which writes the program into a removable chip such as an EEPROM or EPROM.

D. Functionality:

The functionality of the PLC has evolved over the years to include sequential relay control, motion control, process control, distributed control systems and networking. The data handling, storage, processing power and communication capabilities of some modern PLCs are approximately equivalent to desktop computers. PLC-like programming combined with remote I/O hardware, allow a general-purpose desktop computer to overlap some PLCs in certain applications. Regarding the practicality of these desktop computer based logic controllers, it is important to note that they have not been generally accepted in heavy industry because the desktop computers run on less stable operating systems than do PLCs, and because the desktop computer hardware is typically not designed to the same levels of tolerance to temperature, humidity, vibration, and longevity as the processors used in PLCs. In addition to the hardware limitations of desktop based logic, operating systems such as Windows do not lend themselves to deterministic logic execution, with the result that the logic may not always respond to changes in logic state or input status with the extreme consistency in timing as is expected from PLCs. Still, such desktop logic applications find use in less critical situations, such as laboratory automation and use in small facilities where the application is less demanding and critical, because they are generally much less expensive than PLCs.

II. PROGRAMMABLE LOGIC CONTROLLERS (PLC)

PLC can be defined as a digital electronic device that uses a programmable memory to store instructions such as logic, sequencing, timing, counting and arithmetic to control of a PLC was to directly replace electromechanical relays as logic elements machines or processes. The purpose substituting instead a solid digital computer with a stored program, able to emulate the interconnection of many relays to perform certain logical tasks.

Fig. 2: PLC

A Programmable Logic Controller, PLC or Programmable Controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a hard real time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.

A. PLC Software

Bosch Rexroth IndraLogic PLCs are used to build PLCs programming in Ladder logic. IndraWorks is the carrier system for integration of the Bosch Rexroth engineering tools. Rexroth IndraLogic is based on the CoDeSys technology of Smart Software Solutions (3S). IndraLogic 1.32 is based on CoDeSys version 2.3, service pack 4. IndraLogic puts a simple approach to the powerful IEC 61131-3 language at the disposal of the PLC programmer. The IEC 61131-3 international standard defines four PLC languages: ladder logic, sequential function charts, function blocks, and a text language. By far, ladder logic is the most prevalent language. The ladder logic symbology was developed from the relay ladder logic wiring diagram. In order to explain the symbology, simple switch circuits will be converted to relay logic and then to PLC ladder logic.

Fig. 3:PLC

B. *Hardware*

A PLC can be defined as a digital electronic device that uses a programmable memory to store instructions such as logic, sequencing, timing, counting and arithmetic to control machines or processes. It is a software based instruments and hence it can be programmed using an easy-to- learn programming languages.

Many PLC configurations are available, even from a single vendor. But, in each of these thereare common components and concepts. The most essential components are as shown in figure:

1) Power Supply

This can be built into the PLC or be an external unit. Common voltage levelsrequired by the PLC (with and without the power supply) are 24Vdc, 120Vac, 220Vac.

2) CPU (Central Processing Unit)

This is a computer where ladder logic is stored and processed.

3) I/O (Input/Output)

A number of input/output terminals must be provided so that the PLC canmonitor the process and initiate actions.

4) Indicator lights

These indicate the status of the PLC including power on, program running, anda fault. These are essential when diagnosing problems.

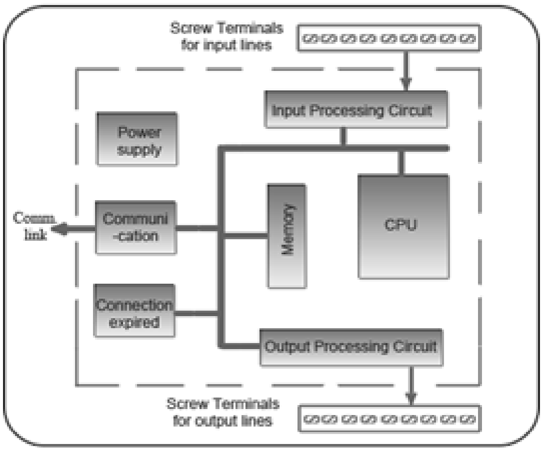

Fig. 4: illustrates the system components of a PLC

C. *Programming the PLC*

PLC is programmed by means of a programming device. The programming device is usually detachable from the PLC and it can be shared between the different controllers. Different devices ranging from simple teach pendent type devices to special programmed keyboards and CRT displays are adopted.

Most of programming methods used today for PLCs are based on the ladder logic diagram. There are various approaches for entering the program into the PLC.

1) Ladder diagram based

Ladder logic was originally a written method to docu of relay racks as used in manufacturing and process control. Each device in the relay rack would be represented by a symbol on the ladder diagram with connections between those devices shown. In addition, other items external to the relay rack such as pumps, heaters, and so forth would also be shown on the ladder diagram. See relay logic. Although the diagrams themselves have been used since the days when logic could only be implemented using switches and electromechanical relays, the term 'ladder logic' was only latterly adopted with the advent of solid state programmable logic.

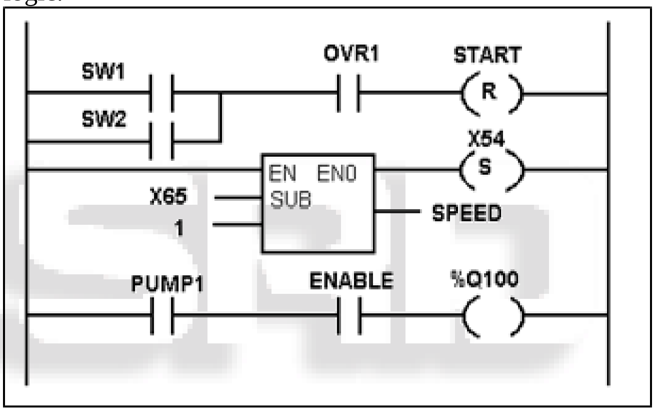

Fig. 5: Ladder Diagram

D. *Advantages And Disadvantages Of PLC*

- PLCs are more reliable and faster in operation
- They are smaller in size and can be more readily expanded.
- They require less electric power.
- They are less expensive when compared to electromechanical relays for the same number of control functions.
- Hard-wired electromechanical relays lack flexibility. For instance, when system operation requirements change, then the relays have to be rewired.
- PLCs have very few hardware failures when compared to electromechanical relays.
- Special functions such as time-delay actions and counters can be easily performed using PLCs.
- *Flexibility:* One single Programmable Logic Controller can easily run many machines.
- *Correcting Errors:* In old days, with wired relay-type panels, any program alterations required time for rewiring of panels and devices. With PLC control any change in circuit design or sequence is as simple as retyping the logic. Correcting errors in PLC is extremely short and cost effective.

- *Space Efficient:* Today's Programmable Logic Control memory is getting bigger and bigger this means that we can generate more and more contacts, coils, timers, sequencers, counters and so on. We can have thousands of contact timers and counters in a single PLC. Imagine what it would be like to have so many things in one panel.
- *Low Cost:* Prices of Programmable Logic Controlers vary from few hundreds to few thousands. This is nothing compared to the prices of the contact and coils and timers that you would pay to match the same things. Add to that the installation cost, the shipping cost and so on.
- *Testing:* A Programmable Logic Control program can be tested and evaluated in a lab. The program can be tested, validated and corrected saving very valuable time.
- *Visual observation:* When running a PLC program a visual operation can be seen on the screen. Hence troubleshooting a circuit is really quick, easy and simple.

III. IDENTIFICATION OF EXISTING PROBLEM

A. *Problem Definition*

The problems that were persisting in the field of filling machine were identified and noted down. They are as follows.

- Manual inspection is slower and inaccurate practice in mass production.
- The rate of production was affected due to the use of manual inspection systems.
- Comparatively low quality assurance to the customers
- Sometimes in special environments which are dangerous and not conductive for human operation

B. *Objective*

- Achievement of low cost automation.
- Increase in production rate.
- Quality of product high.
- Reduction in skilled man power.

IV. ELECTRIC CIRCUIT AND WORKING

A. *Electric circuit of working of cylinder with magnetic sensor*

When the material is placed under the capacitive sensor B0, a signal will flow through K1 and actuate the Y1. This will cause the cylinder 1 to extend. Push button S0 must be in ON condition. Depending on the height of material placed under the cylinder the magnetic switch mounted on the cylinder will on. The three magnetic sensors B1, B2 and B3 are mounted on the double acting cylinder. B1 is on when the large size component is placed, the piston inside the cylinder will be at TDC. B1 and B2 will be on when the medium size component is placed and the piston will be at middle of cylinder. All the three sensors will be on when the smaller on is placed the piston will be at BDC. Depending upon the actuation of three sensors the timer and LED will works.

B. *Electric circuit of working of two ultrasonic sensor*

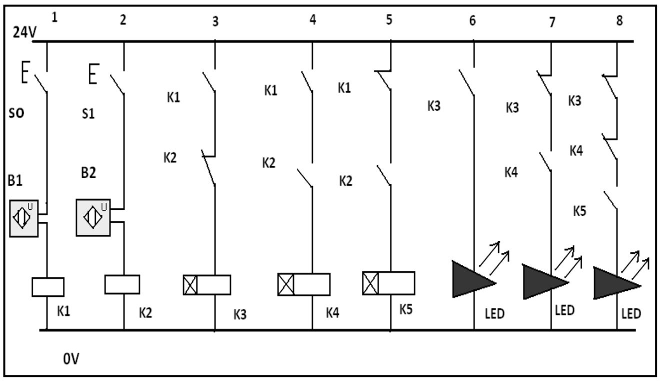

Fig. 6: Electric circuit of working of two ultrasonic sensor

- Case 1: B1 ON, B2 OFF for small height.
- Case 2: B1 and B2 both ON for medium size.
- Case 3: B1 OFF, B2 ON for large height.

SO and S1 are the push button should be in ON condition. When the material is placed under the sensor, depending on the height of the material, a signal will be sent. B1 and B2 are two ultrasonic sensor depending upon the material placed below the B1 and B2 are two ultrasonic sensor depending upon the material placed below the sensor the timers and LED will work. If the sensor B1 is ON then K1 actuate and timer K3 will ON, B2 should be in OFF condition. B1 and B2 both ON then the timer K4 will ON. Similarly when B1is OFF and B2 is ON then timer K5 will ON. Use of ultrasonic sensor is more efficient than the use of cylinder with magnetic sensor. Since in the case of cylinder with magnetic sensor is the contact type of inspection to find the height it may damage the product. So we are inspecting by using ultrasonic sensor which is non contact type of inspection.

C. *Schematic*

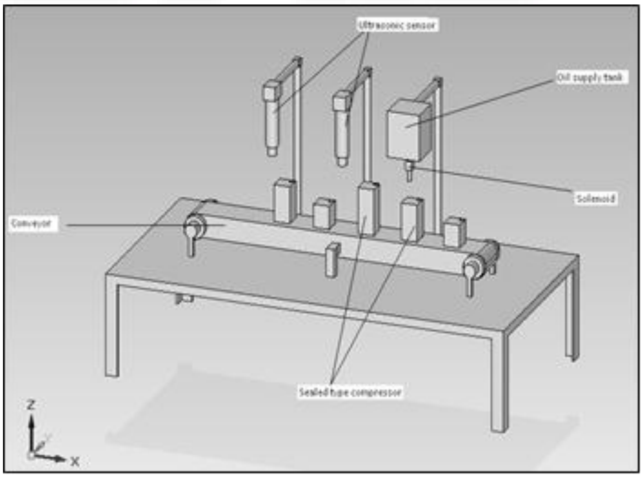

Fig. 7: Diagram of Solid Model

Fig. 7 represents the table solid model done using Solid Edge V19 software

V. PRINCIPLE OF WORKING

- Placement of material onto the system- manually or through a conveyor system.
- Height inspection of materials using an ultrasonic sensor.
- Filling of inspected material is done by oil tank through the solenoid valve.

- The material movement is through a conveyor system driven by a motor.

The automatic oil filling machine is made up of six parts: height detection part (ultrasonic sensor), solenoid valve control part, oil supply tank, belt conveyor, sealed type compressor to which oil has to be filled, and a programmable logic controller which controls the whole machine. Components used

- Belt Conveyor
- Ultrasonic Sensors
- Solenoid valve control part
- Oil supply tank
- Programmable Logic Controller

VI. CONCLUSION

This paper illustrates the applications in the field of low cost automation, especially in mass production industries where there are large number of components to be processed and handled in a short period of time and there's need for increased production

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