

A Review of Automated Profile Cutting Machine Using PLC

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Abstract— Global competitions and technological advances are forcing manufacturers, designers and engineers to constantly innovate new product manufacturing strategies in reducing product development cost and time. Contemporary manufacturers have the option of selecting optimum technologies or processes to suit their manufacturing environment. CNC is one in which the functions and motions of a machine tool are controlled by means of a prepared program containing coded alphanumeric data. This technique is basically used for industrial application. This paper presents that how to work profile cutting machine by using PLC technique.

Keywords— CNC, Profile cutting machine, Alphanumeric data, PLC

I. INTRODUCTION

One of the key objectives in durable goods-manufacturing is to create faster industrial processes throughput by eliminating the needs for off-line quality control and part inspection. Nowadays, as automation, high performance machining and labour savings are introduced in machining of discrete component designing, prototyping and manufacturing, it is desirable to reduce the time and the manpower for inspection, and have an intelligent and real-time quality control of the products. Great savings of both time and labour during the inspection process can be realized in the machining of discrete components through gains in automation, information technology and high performance machining.

The major goals and objectives of our project is to integrate strategic process optimization concepts and intelligent controls in high speed machining, creative thinking and solutions-based applications, machine tool calibration, on machine quality control, precision metrology applications into the existing engineering curriculum through the development and implementation of learning modules that will simulate industry approach to product development

cycle that is design, analysis, prototyping and improvement into selected required coursework in each engineering discipline [1].

II. DESCRIPTION OF PROFILE CUTTING MACHINE

Automated equipment and good shop layout normally improves speed, precision and quality regardless of which type of fabrication is performed. Further, blending mechanical assemblies with computer controls lends flexibility and consistency to fabrication operations. Sometimes the perception of high cost associated with automation in general is not warranted. Various companies have successfully adopted low-cost technologies to improve their profitability. The machine should be adaptable to more automation or future changes when need arises [2].



Fig. 1- Profile Cutting Machine [3]

Profile cutting is a process that is used to cut steel and other metals of different thicknesses (or sometimes other materials) using a torch. In this process, a gas (oxygen, air, inert and others dependant on material) is blown at high speed out of a nozzle; at the same time an electrical arc is formed through that gas from the nozzle to the surface being cut, turning some of that gas to profile. The profile is

hot enough to melt the metal being cut and moves fast enough to blow molten metal away from the cut [4].



Fig. 2 - Profile Cutting Performed by an Industrial Robot [5]

In recent years, PC-based control technology has become a widely used industry practice. Benefits include faster design cycles, lower downtime using diagnostics and simulation tools, increased productivity and decreased maintenance costs. Moreover, open system designs that use standard hardware and operating system software minimize cost, permit system scalability, and ensure future performance enhancement. However, hardware-based CNC systems still dominate the world of machining control [6].

III. TYPES OF CUTTING MACHINES

A. Mechanical cutting

Mechanical cutting is in many cases very economical and versatile. Aluminum can be worked with common machine tools found in most fabricating shops. Aluminum is often compared with wood because the same tools work for both materials and at roughly the same cutting speeds. The main difference lies in that aluminum demands more power to maintain the cutting speeds. Even at high cutting speeds lubricants or coolers are not needed [7].

B. Plasma cutting

The plasma arc cutting process is a highly productive method of cutting aluminum and is experiencing rapidly growing application. Cuts can be made from thick foil thickness up to 200 mm although cutting in these thicknesses causes extreme noise levels that have to be taken into consideration when considering the suitability of the process. The trend today is that more simple and inexpensive machinery is used, making plasma cutting a realistic alternative to other cutting methods. Plasma cutting is a melting process, compared to flame cutting which is a combustion process [7].

C. Laser cutting

Laser cutting is today a well established process in industry. There are essentially two types of lasers used in profile cutting - the CO₂ laser and the Nd: YAG laser. The CO₂ laser is the most commonly used. The laser medium is a mixture of gases (CO₂, He, N₂). The Nd: YAG laser is a solid state laser which means that the laser active medium is a solid and the Nd: YAG laser does not consume any laser gases. The cutting of aluminum with CO₂ lasers is considered difficult due to the high reflectivity and high thermal conductivity of the metal. Anodized aluminum is easier to cut due to the enhanced laser light absorption in the thick surface layer of aluminum oxide. It is also easier to cut aluminum alloys than pure aluminum [7].

D. Water-jet cutting

Water jet cutting exists in two variants, pure water jet cutting and abrasive water jet cutting. Pure water jet cutting can be used for a variety of non-metallic materials but in order to cut metals an abrasive is added to the water jet. Special pumps are used to achieve the high pressures needed. The water pressure can be up to 400 bar [7].

E. CNC cutting

CNC refers to a computer that is joined to the NC machine to make the machine versatile. Information can be stored in a memory bank. The programmer is read from a storage medium such as the punched tape and retrieved to the memory of the CNC computer. Some CNC machines have a magnetic medium (tape or disk) for storing programs. This gives more flexibility for editing or saving CNC programs [8].



Fig. 3 - Profile Cutting With A CNC Machine [9]

IV. PROFILE CUTTING MACHINE IMPLEMENTED BY PLC

The block diagram of proposed model is shown in below figure-4.

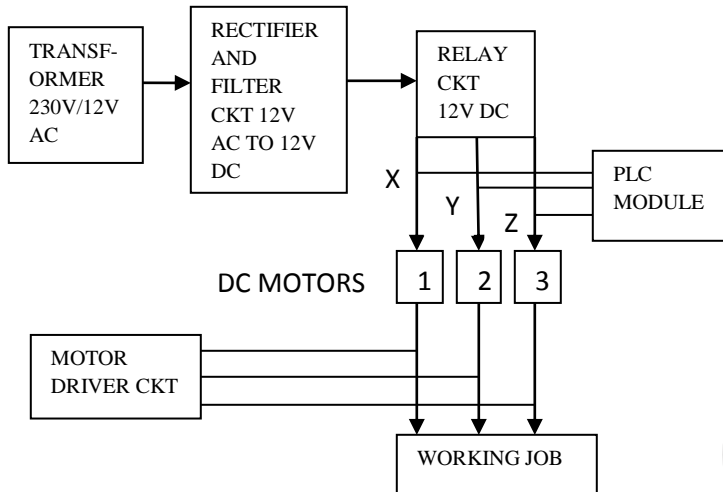


Fig. 4 - Block Diagram of Profile Cutting Machine Using PLC

This block diagram describes the various sections which are following as below:

A. Transformer

A transformer is an electrical device that transfers energy between two or more circuits through electromagnetic induction. Commonly, transformers are used to increase or decrease the voltages of alternating current in electric power applications.

A varying current in the transformer's primary winding creates a varying magnetic flux in the transformer core and a varying magnetic field impinging on the transformer's secondary winding. This varying magnetic field at the secondary winding induces a varying electromotive force (EMF) or voltage in the secondary winding. Making use of Faraday's Law in conjunction with high magnetic permeability core properties, transformers can thus be designed to efficiently change AC voltages from one voltage level to another within power networks.

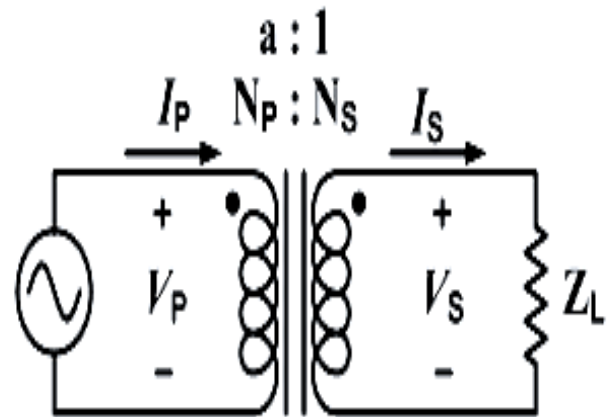


Fig. 5 - Circuit Diagram of Transformer [10]

B. Rectifier and filter circuit

- **Rectifier circuit** – A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification. Physically, rectifiers take a number of forms, including vacuum tube diodes, mercury-arc valves, copper and selenium oxide rectifiers, semiconductor diodes, silicon-controlled rectifiers and other silicon-based semiconductor switches. Rectifiers have many uses, but are often found serving as components of DC power supplies and high-voltage direct current power transmission systems. Rectifier circuits may be single-phase or multi-phase (three being the most common number of phases). Most low power rectifiers for domestic equipment are single-phase, but three-phase rectification is very important for industrial applications and for the transmission of energy as DC (HVDC).

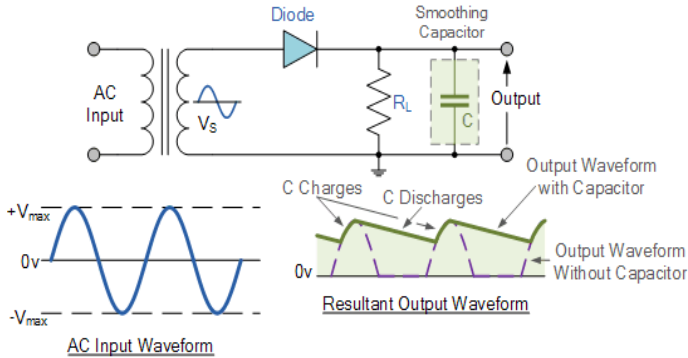


Fig. 6 - Rectifier Circuit and Waveforms [11]

➤ **Filter circuit** – Electronic filters are analogue circuits which perform signal processing functions, specifically to remove unwanted frequency components from the signal, to enhance wanted ones, or both. In signal processing, a filter is a device or process that removes from a signal some unwanted component or feature. Filtering is a class of signal processing, the defining feature of filters being the complete or partial suppression of some aspect of the signal. Most often, this means removing some frequencies and not others in order to suppress interfering signals and reduce background noise. Correlations can be removed for certain frequency components and not for others without having to act in the frequency domain.

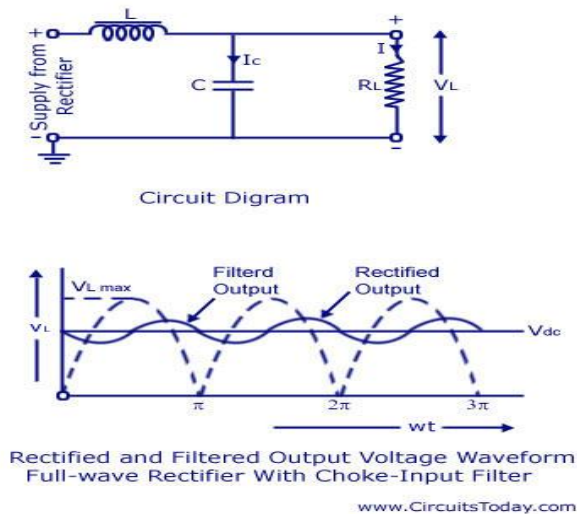


Fig. 7 - Filter Circuit and Waveform [12]

C. Relay circuit

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

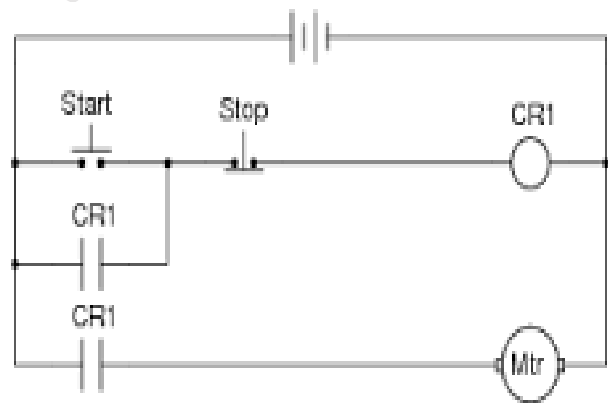


Fig. 8 - Relay Circuit [13]

D. PLC Module

A programmable logic controller or programmable controller is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many machines, in many industries. PLCs are designed for multiple arrangements of digital and analog inputs and outputs,

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 [10].

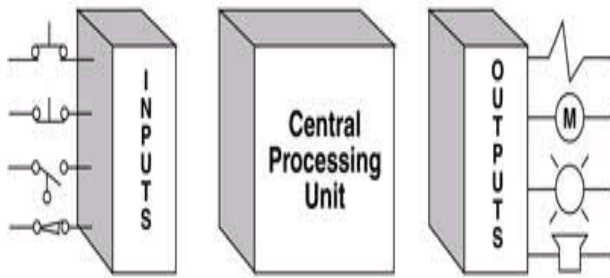


Fig. 9 - Inside of A PLC [14]

The Central Processing Unit, the CPU, contains an internal program that tells the PLC how to perform the following functions:

- Execute the Control Instructions contained in the User's Programs. This program is stored in "nonvolatile" memory, meaning that the program will not be lost if power is removed
- Communicate with other devices, which can include I/O Devices, Programming Devices, Networks, and even other PLCs.
- Perform Housekeeping activities such as Communications, Internal Diagnostics, etc.

The control for the hardware is to be process by the programmable logic controller via the computer. It includes a ladder diagram for programmable logic controller and an actual prototype for the experimentation. The whole system executes the following processes: automation using the programmable logic controller or called as PLC and cutting.[15] ladder Logic is the most commonly used PLC programming language. Ladder Diagram (LD) Traditional ladder logic is graphical programming language. Initially programmed with simple contacts that simulated the opening and closing of relays, Ladder Logic programming has been expanded to include such functions as counters, timers, shift registers, and math operations.

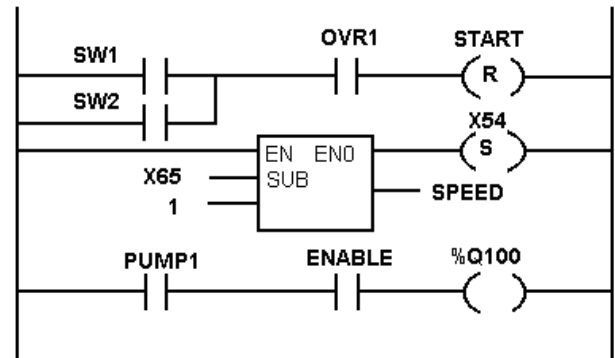


Fig. 10 - Ladder Diagram of PLC Programming [16]

E. DC motor connection

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

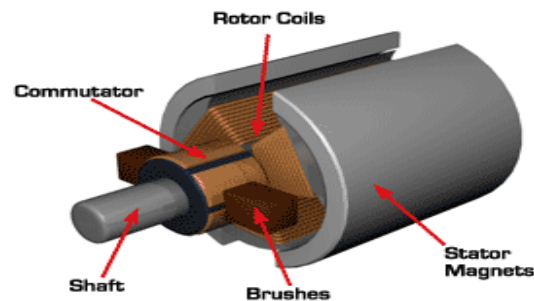


Fig. 11 - DC Motor [17]

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in

drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

F. Motor drive circuit

In electronics, a driver is an electrical circuit or other electronic component used to control another circuit or component, such as a high-power transistor, liquid crystal display (LCD), and numerous others. They are usually used to regulate current flowing through a circuit or is used to control the other factors such as other components, some devices in the circuit.

A Normal DC gear-head motor requires current greater than 250mA. ICs like 555 timer, ATmega16 Microcontroller, 74 series ICs cannot supply this amount of current. If we directly connect motors to the output of any of the above IC's, they might get damaged.

There is a need of a circuitry that can act as a bridge between the above mentioned ICs and the motors. There are several ways of making it, some of them are mentioned below.

- Using Transistor
- Using L293D/L298
- Using relays

G. Working job

In this research paper I have used thermocol as a protocol and with the help of plc programming, profile cutting machine cuts this thermocol in different shapes and sizes.

V. CONCLUSION

In this paper we have presented a design of a system based on PLC that is used for profile cutting in industrial purpose. The proposed PLC system which has been designed to program with particular shape and size, then cutting machine runs according to programming of PLC and cuts the profile with perfection. When the PLC recognizes any increase or decrease in the level of voltage, current or temperature values the unit has been made shutdown in order to prevent it from further damages with the help of relays in the system. The system not only cuts profile but it automatically controls the system and makes perfect shape and size of profiles. This claims that the proposed design of the PLC system makes the profile cutting machine more effective and automated against some key issues. Hence the

machine is made more reliable and highly efficient by means of the proposed system.

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