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Research paper

PLC based automatic grinding system for door frames

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Abstract

Usually in order to smoothen or flatten any surface we generally prefer grinding process, the grinding process can be done in surface area or metal portion in any possible areas or metal portion in any possible area we want. This research work is on automation, since automation can be done for grinding of door frames. This idea gained inertest is due to the increasing demand of door frames for the customers in huge amount of production rates. There are several methods to grind the door frames either it can be done by humans (man-made), because normally grinding is a process which is being done manually by humans and we also have several methods other than manual grinding techniques. By automation using "programmable logic controllers" (PLC) which can overcome the traditional relay logic controllers, the door frames can be preferably grinded in a fraction of seconds and production rates to gets higher. Since we use (PLC) being the industrial tool, it performs the step-by-step sequence combined by both mechanical and electrical parts. In this paper, the proposed (PLC) based grinding automation is performed and finally compared with the conventional methods being used before grinding process and validated by using real time status obtained.

Keywords: *Automation; Grinding; Programmable Logic Controllers (PLC); Relay logic controllers.*

1. Introduction

Since automation is widely used in many industries for over decades, in general automation can be defined as the "automatically controlled" operation of an apparatus, process or system by mechanical or electronic devices that takes the place of human labor [1]. In other words automation or automatic control is the use of various control system for operating equipment such as machinery, process, in factories, boilers, and heat treating ovens, switching ON telephone networks. Since automation consists of many types some of them are Industrial automation and Building automation [2].

2. Industrial Automation

This research work deals with industrial automation for grinding of door frames in automated sequence manner. The traditional relay logic is replaced with the use of programmable logic controllers.

An important aspect to be considered with the evolution of (programmable logic controllers) (PLC) is a tool for automation, which runs the machine automatically and sequentially [3]. Programmable logic controllers are a special computer device used in industrial control system [4]. The programmable logic controllers are used not only for industrial purpose but also in civil applications such as washing machine, elevators working and traffic signals control [5]. It continuously monitors the state of the input device and make the decision based upon a custom program to control the state of the output devices [5].

In the present research work we specifically use PLC because it reduces the panel wiring and there is no complexion in machine automated process[7]. For this present work, PLC programming software is used as it is adapted for the control of manufacturing process in grinding by using "ladder logics" in programming software [8]. Therefore PLC's are better way in designing the control panel as well as in auto running sequence of the machine [9].

The proposed area of using PLC's in grinding process has gained interest due to demand from the customer leading to high production rates [10] compared to using traditional relay logic controllers (or) man made grinding techniques. In existing scenario, grinding of door frames is first executed on human intervention (man made grinding). Secondly they were executed based on traditional relay logic controllers (push button). Several disadvantages are there in the present way of door frame smoothening they are:

- grinding done by humans wont able to achieve the smoothness compared to the ones achieved through machines
- The manmade grinding process of door frames cannot make the surface of the metal to its finest finish.
- Sometimes due to some heavy load from humans, the metal part gets collapsed.
- So, the production rate falls down due to the improper grinding finishes.
- Using relay logic controllers leads to problems like having huge number of wirings to it, manually operated by humans and consumes more time for higher production rates.

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3. Electrical Diagram

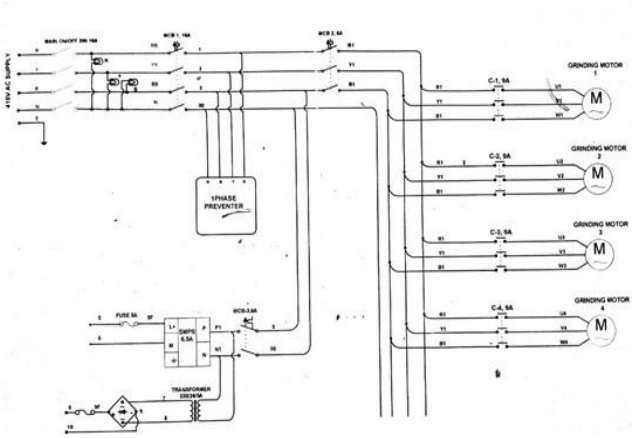


Fig. 1: Electrical diagram of the system

From the above mentioned electrical diagram of figure 1, first the supply comes on from SMPS 6.5A, and with the help of transformers, more load can be taken because of the rating (230-24V) and a rectifier is also fixed in the transformer to convert the alternating current to direct current because all the components in the control panel works under 24V DC. So from SMPS the connection goes on to the MCB-3,6A the connection mainly goes from main MCB to sub MCB's, when 415V AC SUPPLY is switched "ON" R, Y, B (red, yellow, blue) is in "open contact" as mentioned in the diagram, furthermore 1 phase preventer is provided for safe running of motors which overcomes the disadvantage reverse phasing or unbalanced supply.

And the connection goes on to MCB 2 by ferruling R, Y, B wires the R1, Y1, B1 are connected to four contactors placed in the control panel. A contactor is placed because of the continuous running process of the motor since we don't want control the speed of the motor. For continuous grinding purpose we have installed 4 contactors for 4 motors placed in it. When a supply comes into contact with the each contactor it opens the switch to flow the current to the specified motors fixed at each corners.

4. Block diagram

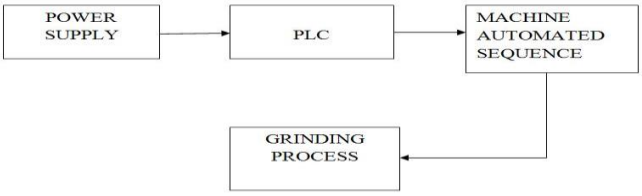


Fig. 2: Block diagram of the system

From the above mentioned block diagram of fig 2, the Programmable logic controllers, play a major role because the automated sequence are controlled by the logic controllers and desired output is achieved in its finest way for perfect grinding of door frames. First power supply SMPS converts AC to DC, because the whole panel works under DC current. Since logic controllers runs under DC current once the PLC gets active when supply comes to it, the "automatic machine sequence" starts. Thus on repeated grinding process the door frames gets finished to its fullest.

5. Mechanical and Electrical portions

Automation is a process of both mechanical and electronics. The mechanical portion has to be done first for the stability check up. And the whole prototype is being made to coincide with electronics working module. In mechanical portion we also use encoders and proximity sensors to calculate counting and distance between the door frames to get grinded.



Fig. 3: Mechanical Portion



Fig. 4: Electronics portion (Control panel)

In electronics portion the main task is to create a whole working control panel for automation, which makes the machine to work on its automated sequence. There are several components for designing of control panel. We use 1. PLC (Programmable Logic Controllers) 2. SMPS (Switch Mode Power Supply) 3. MCB (Miniature Circuit Breaker) 4. VFD (Variable Frequency Drive) 5. TB (Terminal Blocks) 6. Transformers 7. Relays 8. Contactors. In fig. 4, the whole control panel is designed for the automated sequence.

6. Flow Chart and Ladder logic:

The programming part of the research work uses both normally open and normally closed contact switches. The real input represents the sensors, switches, PLC, etc., and the real outputs are represented by motors, pumps, lights, timers, etc., Apart from the above, we use timers to carry out the next sequential order of process. The main function of a timer here is to keep an output ON for specific length of time. Example to grind the door for 10 seconds. The DELTA PLC model:28 SV is used and ISP software that works both on ladder logic and functional block helps in interfacing the system with that of the PLC.

In machine auto sequence, the first portion is done by loading the job where the four grinding wheels are placed. In auto sequence, once the cycle starts the sequential order of grinding process takes place. And then the job clamping process takes place, which is done by the pneumatic cylinder when 24V coil supply is being given to the solenoid coil. And by the next sequence, grinding head positioning of four grinding wheels takes place. The grinding head then rapidly comes down to the grinding levels of the door frames at the corner. The grinding wheel is "ON" for grinding of door frames. And by the next step left right oscillation

takes place in place of weaving. And then front back oscillation takes place for weaving.

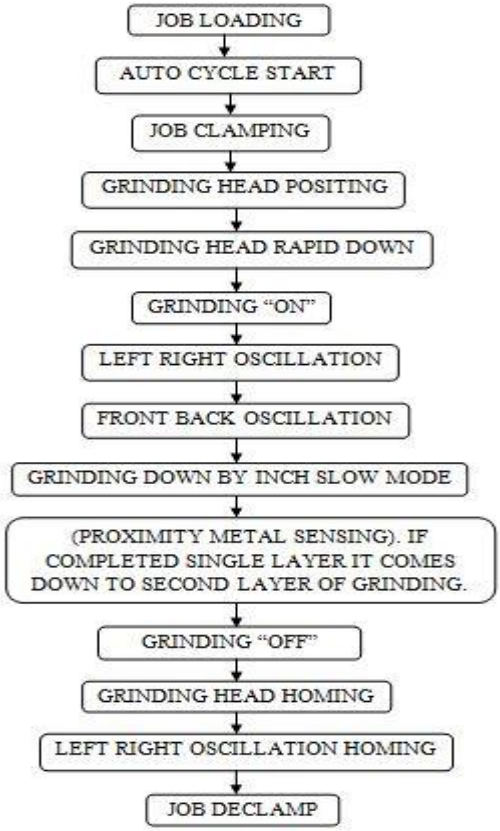


Fig. 5: Flowchart of the machine sequence

This constant weaving of left right, front back oscillation helps in flat grinding process. And by the next sequence the grinding head comes down comes down to the inch slow mode. In this process the grinding head slows down inch by inch and grinds it to perfection. The next sequence is the proximity metal sensing layer. If the grinding is completed for the single layer, it again comes down to the second layer of grinding and by this the grinding portion gets completed fully. And by the next sequence grinding portion gets "OFF". The grinding head automatically goes up to the homing position. The left right, front back oscillation also goes on to their homing position. And finally, once the grinding is perfectly done, motor head and oscillation gets on to their homing positions. The job gets declamp in final automated process.

In this research work, the ladder logic is designed in such a way that it operates through both manually and automatically. The figure 6 below explains the ladder logic sequence for manual grinding process. A series of ladder logic are designed for the process to get grinded manually. These control actions can be controlled by pendent which sends the action to control panel and the required action is done. Thus the operator can adjust grinding positions to whatever process is needed by the operator to achieve the required grinding process. Mainly the automated sequence process is designed because the manual process has fault in it.

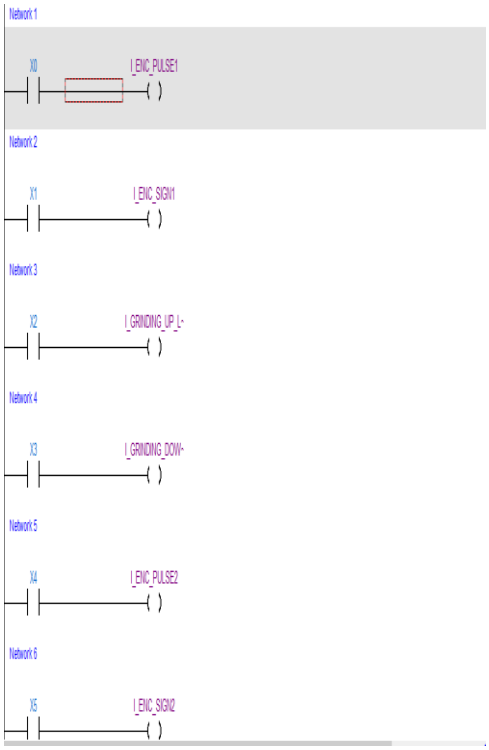


Fig. 6: ladder logic sequence for manual grinding process

7. Simulation results and discussion:

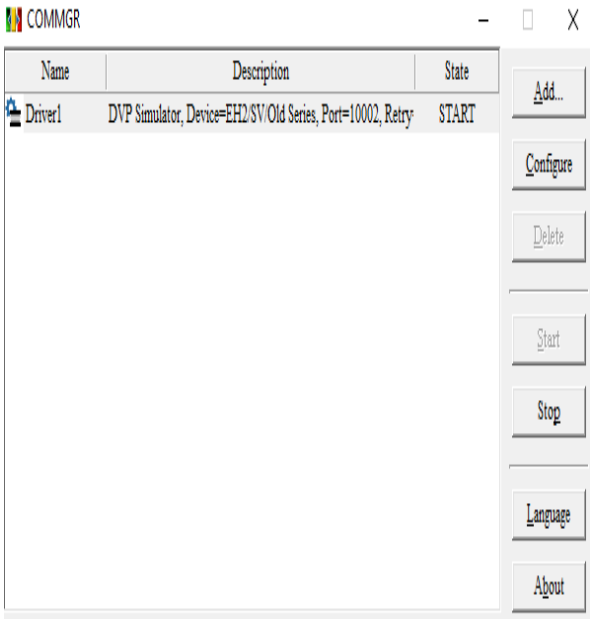


Fig. 7: Desktop icon representing to start the COMMGR software

Once the ladder logic is finished the next important work is to run the sequence or simulate it. To simulate the given program, each PLC has its own communication software to it. The communication software used in DELTA PLC is COMMGR software. We have to click the "START" in COMMGR software and go to the "ONLINE" mode in the PLC and simulate.

On simulation process we can design the ladder logic on our own interest. The outputs running through timers in the output section of the ladder logic is created. And on the input side we check the ladder logic once as the sequence is running. For instance job clamping has certain timer to it after the time is finished in job clamping it switches on to "grinding head positioning" and the sequential order continues step by step.

And now the automated machine sequence comes into place, for designing the automated sequence. Timers are used which carries

the next sequential order step by step. As shown below in the diagram 8 timers are placed at the output section from starting job clamp to job declamp the automated sequence carries with the timers at every instance in the ladder logic used.

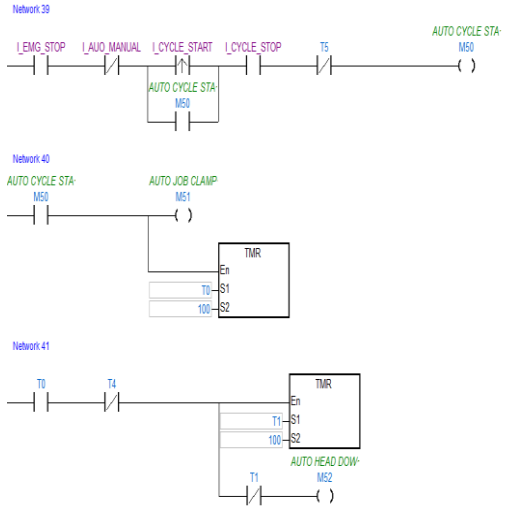


Fig. 8: Automated sequence using timers.

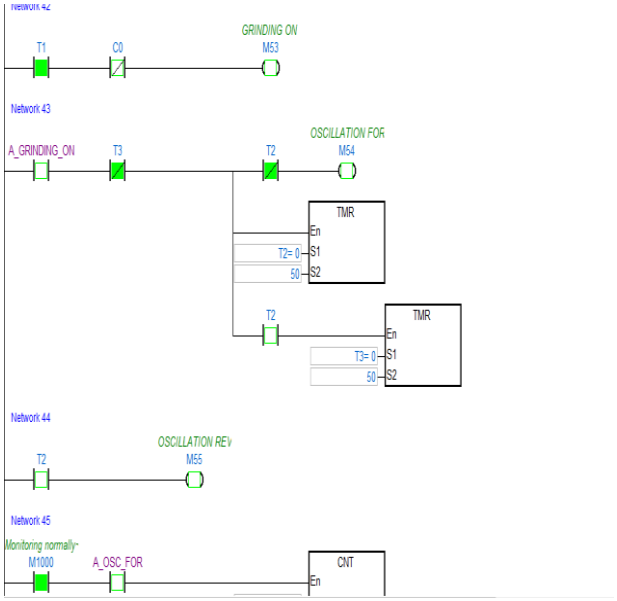


Fig. 9: Simulation by using Communication software.

The below figure 10 explains clearly the head homing portion of the ladder diagram, the homing portion is the last sequence of the ladder diagram coming on to this stage we are almost done with the automated sequence of the machine the above timer exactly shows T5=21 and the required time to be completed to get the homing portion is T=50. Once it completes the full timer level, the homing position is achieved in a perfect manner.

The below figure 11 shows clearly that the grinding down portion of the ladder logic in the sequential order in Network 4, so by then when the timers gets finished off with its grinding down portion it switches on to oscillation right portion by this output module.

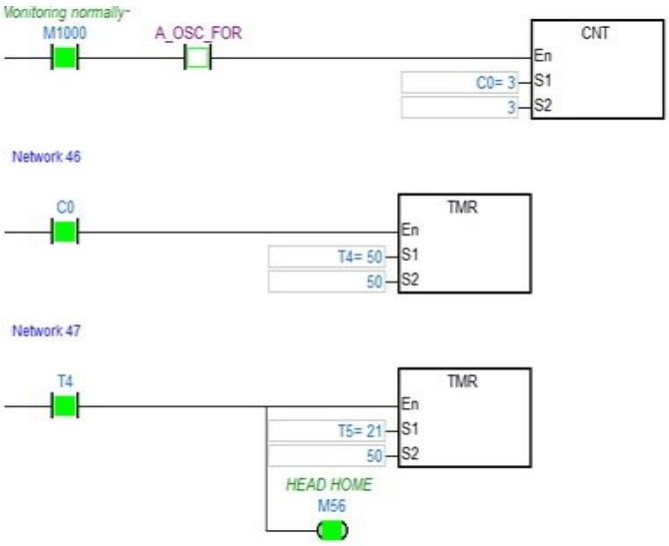


Fig. 10: Simulation of head homing.

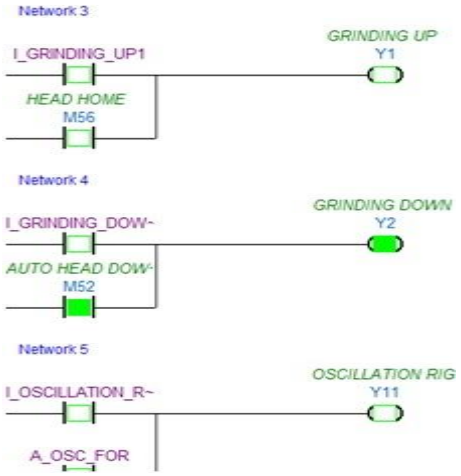


Fig. 11: Simulation of grinding down at the output module.

The figure 12 shows right and front oscillation of the ladder logic as the program is designed in such a way that all front, back, right, left oscillations acts at the same time from the above network first oscillation right and front gets "ON" and the next sequential order gets to its place and a fine grinding process is obtained. And this is how the sequence follows to get its finest grinding techniques.

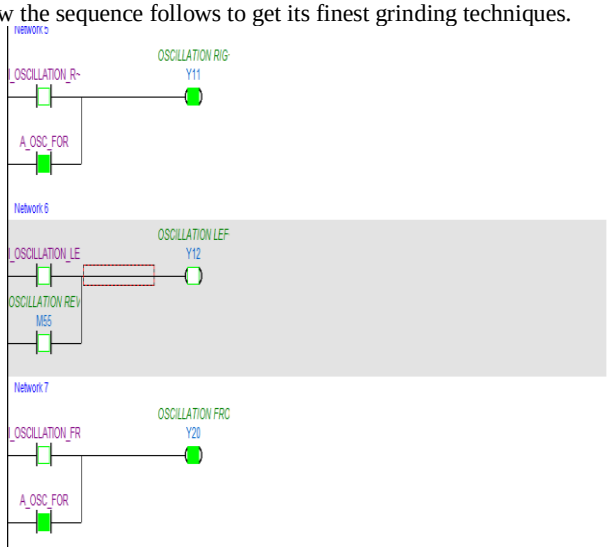


Fig. 12: Simulation of right and left oscillation.

8. Results of Welded Door Frames:



Fig. 13: Picture of welded door frame before grinding

From the above figure 13, it clearly shows the door frames before grinding, the welded part of the door frames, have to be grained at the four corners respectively. The mould like shape appears after the welding is being done for fixture of frames at four corners. These button like shapes have to be grained in order to get a fully mat finished grained shape. As said in above paragraphs the grinding process can be done on any methods but doing automation side to get better results as well as in production rates and customer satisfaction.



Fig. 14: Picture of grained door frame by humans

From the above snapshot the grained door frames by humans clearly shows that the imperfection of smoothening and uneven finishes of the metal surface. And sometimes due to over pressure by humans during grinding the metal surface tends to break its layers. And humans also take much time in producing a single door frame. So, these disadvantages are more concerned towards the customer. Because of this the production rates fall down because of hand- made grinding process.



Fig. 15: Picture of smoothened door frame by PLC

From the above figure 15, the grained door frame is obtained using machine sequence, we can clearly see the result above the grained portion is perfectly finished and without any breakage in the metal portion in edges and doesn't collide with each other. By this method of grinding techniques, we are able to achieve a huge amount production rates and in customer satisfaction on a daily basis of production rates the customer can see a huge amount of profit through automation.

8. Conclusion:

From the above research work it is convenient to observe that as PLC has involved in the smoothening of the door frame, the resultant door frame obtained was having greater smoothness than the manual counterpart. This gained interest amongst various customers due to increasing demands and huge production rates. This method finds a suitable alternative to the traditional grinding techniques using relay logic controllers.

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