International Journal of Research in Engineering, Science and Management
Volume-3, Issue-6, June-2020
www.ijresm.com | ISSN (Online): 2581-5792

Design of the Machine Tending System for Hydraulic Power Press Machine

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***Abstract*: The paper mainly describes the Automation of a loading mechanism. The motivation of this study is the loading and unloading the in power presses cause a large number of workplace amputations. Crush injuries and fractures to the fingers, hands and arms and common injuries. The purpose of the study is to design and development of the 'machine tending system' is to reduce the cycle time of manufacturing and increase productivity by a significant amount. The paper briefly describes about Automation of a loading mechanism. Components of varying sizes are fed through the 'Machine tending system' for the power press machine which completes a particular set of operations and also does the operation of delivering the finished part on to the exit chute, where all the finished parts are stacked. The scope of the project involved designing a part loading from the hopper and delivery sub-assembly, part gripping and loading mechanism, part unloading sub-assembly and finally part delivery sub system. The main elements for the automation are the sensors, PLC, actuators and HMI.**

***Keywords*: PLC; Machine tending; Power press; Hopper; HMI.**

1. Introduction

In this section, a brief about the project which is Development of the machine tending system for power press machine. Introduction to the current scenario and general discussion of the industrial automation and what are the uses of it. It is meant to reduce the operating time of the system with comparison to the manual loading of it. The auto loading of the components helps us in optimized time of loading and unloading of the components for machining and unloading of it. The productivity increases due to faster loading/ unloading and lesser breaks.

Industrial Automation is a broad field among other engineering disciplines. The major activities of Automation system from manufacturing industries and include cycle time improvement, productivity improvement, cost reduction, efficiency improvement. Present technology and economic scenario is marked by increasing competition in almost every sector of economy. The expectations of the customers are on rise and the manufacturers have to design, and produce goods in as many varieties as possible according to demands of the customers. Thus there is a challenge before the industries to manufacture goods of right quality and quantity at right time and at minimum cost for their survival and growth. This demands the increase in productive efficiency of the organization. Automation techniques play a vital role in increasing the productivity. Automation is concerned with the development, improvement, implementation and evaluation of integrated systems of people, knowledge, equipment, energy, material and process. Engineers work to eliminate wastes of time, money, material, energy and other resources. Automation is an engineering approach to the detailed analysis of the use and cost of the resources of an organization. The objective of increasing productivity, reducing time, reducing cost and improvement in efficiency can be achieved using Automation Techniques. Thus, automation helps companies grow and expand. This could reduce the dependency of the company on the operators & also will be able to eliminate 70% of the operators in future. Thus creating a stable system which leads to increase in safety, quality & productivity. Also lot of market survey was done regarding this solution for Power press machine which could be implemented almost everywhere with minimal process change.

2. Literature Review

In this concept robot, several joints are driven by a double drive-train, consisting of typically two gearboxes and two motors. The concept robot is equipped with a linear axis mounted on the tool flange, mainly for improved cycle time performance. The concept robot is inversely installed on a bridge structure established between two adjacent press machines. The inverse installation of the robot does not require any floor space, which makes the press line more compact. A virtual prototype of the concept robot has been developed using 3D CAD design and quantified using multi-body simulations. Gearboxes of critical joints are dimensioned based on the multi-body simulation and based on lifetime design criteria. The developed virtual prototype concludes that it is feasible, based on today's engineering practice, to develop such robot for the ultra-high performance press line automation [1].

This paper initiates a structure for analyzing problems involved in sequencing the operations that must be performed by a robot to tend machines in a cell. The sequence of

operations is shown to be important in determining the feasibility of assigning a robot to tend machines and achieve specified production rates. Various cases, defined by the parameters that describe the system, are identified and analyzed. Optimal sequencing procedures are described for several fundamental cases. Models are developed to prescribe solutions in more advanced cases, and the computational complexity of these cases is defined [2].

The main features of the system include integration of all components on a single, easily movable platform, on-board sensory means ensuring personnel safety in the vicinity of the operating system, as well as an intuitive graphical user and programming interface. Small and medium enterprises (SME) often are faced with varying order volumes and irregular scheduling of machine loads, so automation of manufacturing tasks in this environment requires additional flexibility beyond that of conventional fixed robot installations. Our system manages this requirement through its easy adaptation to a range of tasks, handling order peaks as they occur and complementing manual machine tending, potentially leading to nearly full booking of the robot station. Robotic automation of manufacturing tasks in SME thus increasingly becomes an economically viable choice [3].

Statistics show that good machinists are hard to find and that it will not get any better in the years to come. So they want to get the most value of their skilled machinists. One way of doing this is having the machinists do the programming and the setups, then a robot do the loading and unloading of the parts. The work presents a robot control approach that can leverage the features of the Adaptive Gripper and the precision of the lathe tooling to obtain a flexible and precise robotic machine tending cell. The control uses compliance mode available today on most industrial robot controllers to enable free movement along given tool axis while maintaining constraints on others. Experiments were done on a cylindrical part turned back to back in a lathe. The part precision obtained by the robot was compared by the precision obtained by a human machinist. It is shown that the proposed approach could be used as the basis for flexible and precise robotic machine tending [4].

3. Methodology

The presented mechanism involves following cycles. The main objective of the system Pick and placing of the specimen/component to the hydraulic power press by using different mechanism. Conveyor system for the component loading. Grippers are used to pick the component from the conveyor to the power press/hydraulic press.

In this system it consists of different mechanisms in the different stages in order to perform the operation the main parts are conveyor system, grippers, hopper, base stand. To automate the system.

The process cycles start by operator placing the raw material/component which as to undergo the cold forging or press process. The conveyor system is used to transfer the unfinished component to the system in which the grippers will pick the component. The different type of conveyor can be used in the system depending upon the customer requirement in this system the different conveyor are used belt conveyor, gravity conveyor, bowl feeder. The belt conveyor and the bowl feeder are effective. The gravity-based conveyor is more economical and this conveyor is used due to the component cylindrical in structure.

In this system is based on the rack and pinion mechanism operated by the different stepper motor for different

Axis. As shown in the figure this system consists of X, Y, Z linear axis respectively. It has a total of 6 linear axes and each axis is operated by the rack and pinion mechanism

These mechanisms are driven by the stepper motor because of its precise positioning, speed control, and precise repeatable steps. There are 2 long mountings are plates mounted on the 2 separate stepper motor and each long plates contains 2-jaw gripper and this gripper operated in the y-axis The gripper Simultaneously picks up the component and place it in the die of the hydraulic press at the same time the finished component is dropped to the exit bin. The 2 jaw gripper is attached to the mounting plate are operated mechanically in the y-axis. The complete system is controlled by PLC with HMI screen.

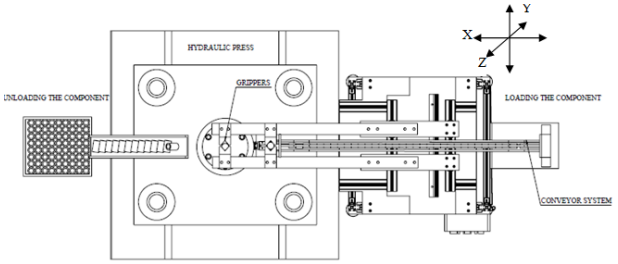

Fig. 1. Schematic representation of machine

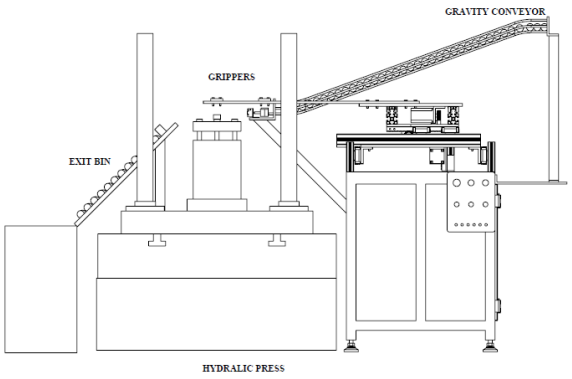

Fig. 2. Schematic representation of mechanism

Fig. 1 shows the machine layout. Fig. shows the draft view of side view of the machine. Fig. 3 show the rack and pinion mechanism, comprising with pneumatic system all the tools and mechanism are operated by the stepper motor provided for each axis. As shown in the figure the operator loads the component at the loading point and gravity based conveyor rolls the component to the picking point the rotary actuator is provided

in order to change the orientation of the component the gripper pick and the place the component to the die at a same time it picks and place the component from the die to the exit bin.

In this system it consists of different mechanisms in the different stages in order to perform the operation. The main parts are conveyor system, grippers, hopper, and base stand and to automate the system. The complete system is controlled by PLC with HMI screen.

4. Sequence of Operation

- *Step 1:* Operator will place the component to gravity conveyor.
- *Step 2:* Due to gravity the component will rolls uniformly.
- *Step 3:* The component moves to picking point of rotary actuator.
- *Step 4:* The rotary actuator rotates component 90°.
- *Step 5:* The 2 jaw Gripper picks up the component and moves forward.
- *Step 6:* The Gripper places the component to die.
- *Step 7:* At the same time the gripper drops component to exit bin.
- *Step 8:* Again Operator will manually load the component and the cycle repeats.

5. Requirements

1. *Base assembly:* The base assembly is where all the parts are mounted it should design in such as that capable of withstanding loads.
2. *Gripper assembly:* In this system it consists of 4 grippers which all are act simultaneously.
3. *Axis assembly:* this assembly consist of the rails and guide and also the motor is mounted on to it in order to move in the particular axis
4. *Detection system:* the sensor and actuator used in the system for the feedback component empty alert, also increases the efficiency of the system
5. *Electrical:* the electrical system is required to operate the system it includes various electrical components.

Table 1
Morphological chart

	Opt 1	Opt 2	Opt 3
Hopper assembly	Belt Conveyor	Gravity conveyor	Chain conveyor
Gripper assembly	Pneumatic gripper	Electric gripper	Mechanical linkages
Loading & unloading mechanism	Pneumatic Cylinders	Servo motor	----------

6. Conclusion

The system is made very reliable and more reduced the overall cost is shown in the above chapter. The system is simple to install and it hardly takes few mins to assemble the entire system over the rigid gantry support made up of aluminium frames. The aluminium frames are easy to assemble with the gusset and the t-nuts. Strong base plate is used to mount the aluminium structure over it. The frame supports maximum rigidity with minimum vibration in the system. The system is made reliable since it can be stopped in intermediate position and change the stroke length as per our new requirement. Since the entire system is mounted over the frame assembly with the adjustments in the positions of the axes and hopper we can use this auto loading in Hydraulic press machines with similar jobs.

Gravity feeding magazine is used as it doesn't require any axis to feed components which in turn reduces the cost of the system. The hopper is placed at an angle so that the components roll down one by one. Due to an optimized and pre-analysed design, space consumption and cost of investment is made very less as per the requirement. For operating this system, skilled operator is not required, and if it is necessary to change the component of different length for operation, one just needs to adjust the gravity feed mechanism for the free flow of the components, and there are no modifications to be done in programming and logic side.

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