

# Research on Automatic Discharge System of Stamping Line Tail

Jiangang Yi<sup>1,\*</sup>, Wen Bo<sup>1</sup> and Zibo Wang<sup>1</sup>

<sup>1</sup> School of Electromechanical and Architectural Engineering, Jiangnan University, Wuhan 430056, China  
469883553@qq.com

**Abstract.** The automatic discharge system of stamping line tail is an important part of automatic logistics production line, which can solve the problem of disorderly placement and management of end workpieces. In this paper, an intelligent automatic discharge system for stamping line tail is proposed, focusing on the design of horizontal discharging mechanism, vertical lifting mechanism and conveying mechanism. Through reasonable selection and calculation analysis, the mechanism composition of each part is given. On this basis, the key components are modelled and simulated by finite element method.

## 1. Introduction

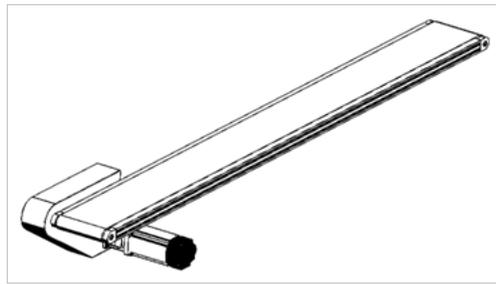
The automatic production line is mainly divided into automatic feeding at the beginning of the line, automatic transfer of semi-finished products between the lines and automatic discharging at the end of the line. The improvement of automation and flexibility of stamping line can not only optimize the rhythm of production line, but also avoid the faults of production line workers in high-tempo production operation and improve the productivity and safety of production line. The traditional tail discharging process of stamping production line mainly depends on manual control, which is difficult to meet the needs of high-speed, flexible and intelligent production. At present, foreign factories have begun to use intelligent logistics warehouse transport robots to achieve material transportation in stamping production line. China's research in this area is relatively backward. Therefore, this paper proposes a flexible automatic discharging system for stamping line tail, discusses its composition scheme and mechanism, and uses it to improve production efficiency and production safety.

## 2. System Composition

In stamping production line, compared with manual handling, the safety and efficiency of automatic palletizing by manipulator are very high. Therefore, the designed discharging system is used in conjunction with the parallel manipulator on the production line. The discharging system includes conveying mechanism, transverse discharging mechanism and vertical lifting mechanism.

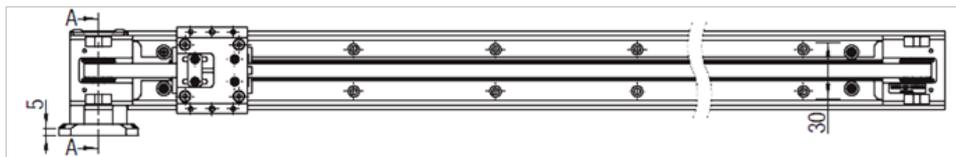
Because of the lower weight of stamping parts, the load on the conveyor is smaller. Therefore, flat belt conveyor can be used for conveying mechanism. Because flat belt conveyor has the characteristics of simple structure and low design cost, it is more suitable for small load workpiece transportation, which has higher flexibility and simpler control mode. In addition, the various parts of flat belt conveyor have been standardized, suitable for mass production, so that the design and manufacture cycle can be greatly reduced. The conveyor is used to transport the workpiece produced from the stamping line to the grasping position of the parallel manipulator, providing a platform for grasping recognition of the parallel manipulator, as shown in Figure 1.



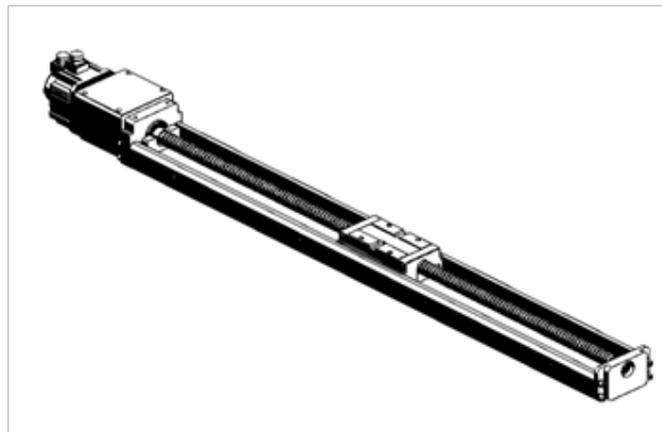


**Figure 1.** Conveyor Mechanism

The transverse discharging mechanism is used to realize the rapid delivery of the workpiece. The trajectory is high-speed reciprocating motion. Considering the load weight of the stacked workpiece and the stability of high-speed transmission, the reciprocating high-speed linear module composed of synchronous belt drive and linear guide is selected. Using medium-load linear guide can make the life of linear high-speed module in a longer state. Selecting smaller high-torque synchronous pulley and synchronous belt can reduce the manufacturing cost and the size of the overall mechanism. By installing synchronous belt base fittings with slider of linear guideway, high efficiency and high speed linear motion can be guaranteed. The slider holder needs to pass through the loose and tight edges of the synchronous belt, so it needs to be designed.



**Figure 2.** Transverse Discharging Mechanism

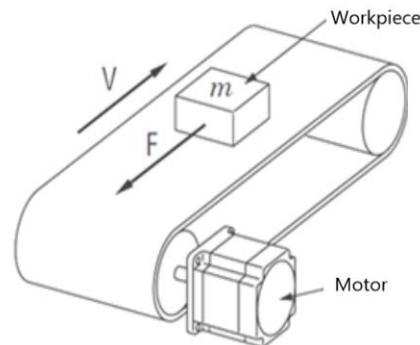


**Figure 3.** Vertical Lifting Mechanism

The function of vertical lifting mechanism is lifting tray. After the manipulator grabs the workpiece on the flat belt conveyor, the feature points of the workpiece are identified by the camera, and then the workpiece is put into the pallet. For each workpiece, the motor drives the ball screw to drop one unit vertically, waiting for another workpiece until the tray is full. The tray with full workpiece is sent out by the transverse discharging mechanism. The linear module of ball screw is driven by stepping motor, which can achieve better servo control. Because of the need to achieve multi-point residence and infinite speed regulation, the ball screw nut actuator driven by stepping motor is selected.

### 3. Computational Analysis

Flat belt conveyor has a long conveyor length. In order to maintain the normal operation of the conveyor so that the loose edge of the belt will not slip, it is necessary to set a higher belt tension. Therefore, the conveyor needs to produce higher torque. Ordinary servo motor can not be directly connected with the conveyor driving wheel. Considering the economy of the conveyor, it is necessary to install a reducer before driving the driving wheel. The function of the reducer is to improve the output torque of the transmission shaft and adjust the speed of the motor to a suitable range. According to the output torque of the reducer and the transmission efficiency of the reducer, the minimum output torque required by the motor can be calculated in reverse.

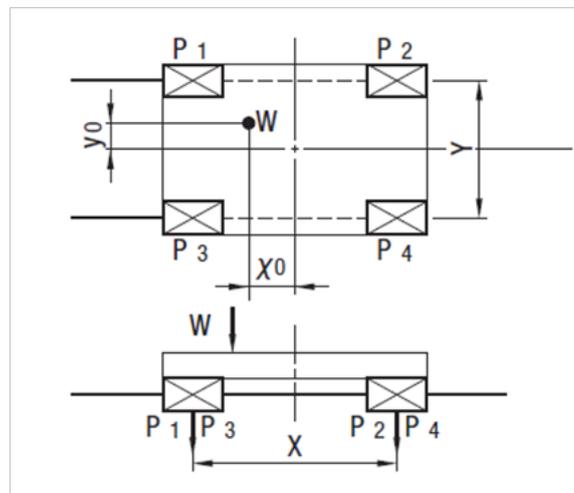


**Figure 4.** Driving Mode

Considering the size of the motor and the conventional installation method, the transmission mechanism is set to be installed in parallel with the bottom external, and the synchronous belt is used to connect the motor power to drive the driving wheel. The motor drives the roller of the conveyor to rotate. The friction provided by the inner side of the conveyor belt makes the belt move in a straight line, and then drives the driven roll on the other side to roll. Because the movement precision required by the conveyor is not high, only light parts can be transported. In the course of running, the slider will be affected not only by the resistance but also by the moment. The direction of the action of the moment varies with the installation mode. Here, the straight-line guide is installed horizontally, and the load can be calculated by Equation (1).

$$P = F + \frac{C_0}{M_C} (F \times L_R) + \frac{C_0}{M_B} (F \times L_Y) \quad (1)$$

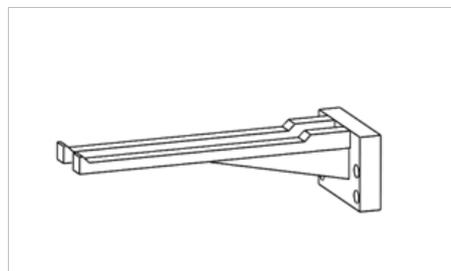
The linear guideway is subjected to the gravity of the loaded object, it also needs linear reciprocating motion, so the position of the centre of gravity and the necessary thrust of the stamping part and the starting, stopping, accelerating and decelerating of the motor drive will cause the load acting on the linear guideway to change, as shown in Figure 5.



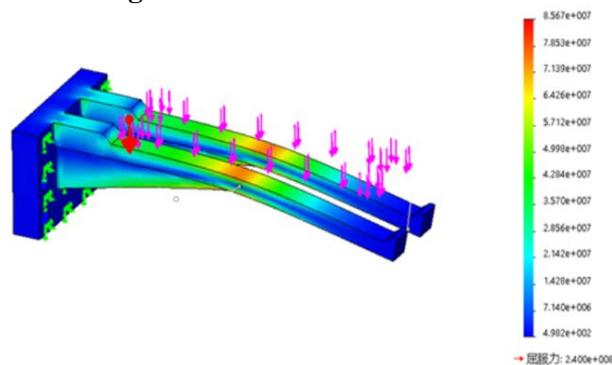
**Figure 5.** Force Distribution on Guideway

#### 4. Design of Slider Connector Bracket

The slider connector bracket is used to fix the bracket. During operation, the bracket lifts the bracket, and after the machine hand locates and identifies the workpiece, grabs the workpiece from the conveyor and transfers it to the bracket. Since the lifting workpiece is a simple load, the bracket can be simplified to a cantilever beam subjected to uniform load, as shown in Figure 6. In order to reduce its deflection, reinforcement is added to the main load-bearing part. In order to ensure that the connector bracket can withstand the maximum load weight and not deform, it is necessary to carry out mechanical analysis.



**Figure 6.** Slider Connector Bracket



**Figure 7.** Finite Element Analysis

According to the operating conditions, it is necessary to calculate the deformation of the bracket at full load. If the deformation is too large, the bottom plate of the load will be inclined, resulting in irregular workpiece. Using finite element simulation software, the bracket model as shown in Figure 7 is established. Deformation analysis in static analysis is selected. Under full load, the bracket is

subjected to the uniformly distributed pressure of the weight and its own gravity. The analysis shows that the maximum stress is located at the end of the reinforcing bar, and the deformation meets the standard. Therefore, the design of the bracket is reasonable and meets the application requirements.

## 5. Conclusions

The automatic discharging system of stamping line tail is an intelligent equipment used to improve automatic palletizing of production line. With the development of manufacturing industry, the demand for automated production is getting higher and higher. The designed system includes vertical lifting mechanism composed of ball screw, horizontal discharging mechanism composed of synchronous belt and conveyor composed of flat belt conveyor. Through the structural design, parameter selection and force analysis of the main components, the transmission scheme and overall structure design of the three mechanisms are given. Finally, the strength of the slider connector bracket is checked by finite element software, and the feasibility analysis of the design scheme is verified.

## 6. Acknowledgements

This work is supported by the Industry-university-research project of Wuhan Education Bureau (Granted No: cxy02), China. The authors also gratefully acknowledge the helpful comments and suggestions of the reviewers, which have improved the presentation.

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