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# Research on Key Technologies for Automated Assembly Equipment of TF Card Slots

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## Abstract

**This study focuses on TF card slots and examines the research status of automated assembly for TF card slots. By analyzing the assembly process of TF card slots, a TF card slot automated assembly line is designed. The assembly line includes automatic screening and feeding of the base, automatic feeding and pressing of the male-female spring, automatic feeding of the buckle, visual inspection of the product, and overall performance testing. The key technologies of automated assembly equipment are analyzed and researched.**

## Keywords

**TF Card Slots; Automated Equipment; Automatic Detection; Precise Control.**

## 1. Introduction

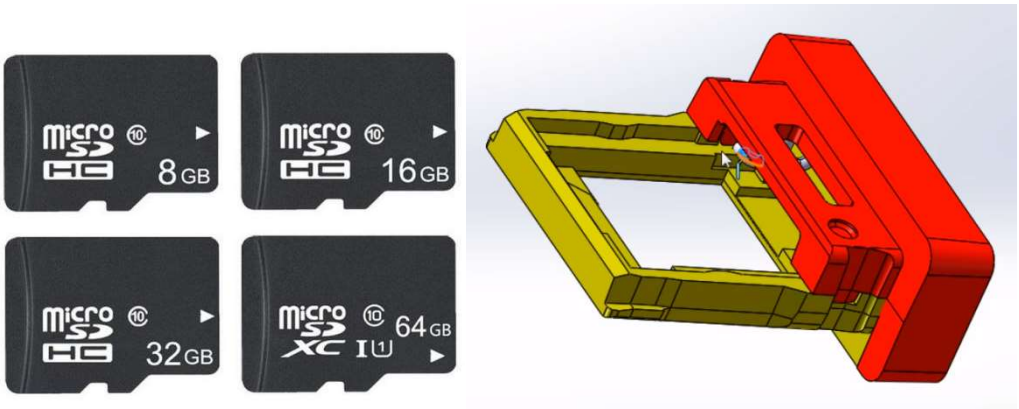


**Figure 1.** TF card and card slot diagram

Electronic connector assembly belongs to labor-intensive industries, and its production requires a large amount of manpower. With the continuous increase in labor costs in recent years, the proportion of labor costs in production costs is growing, making labor savings a top priority for manufacturing companies. Achieving production automation is one of the most effective methods to save labor and reduce costs, and investment in automation equipment can not only save manpower but also greatly improve production efficiency. Therefore, the development and investment in automated assembly equipment are of great significance to electronic connector manufacturers' production and operations.

TF card, also known as microSD, is an extremely small flash memory card, as shown in Figure 1. TF cards are mainly used in mobile phones, but due to their small size advantages and increasing capacities, they have gradually been used in GPS devices, portable music players, and some flash memory drives. Its size is generally 15mm11mm1mm, equivalent to the size of a fingernail, making it one of the smallest storage cards available. Due to these advantages, the application of TF card technology is becoming more widespread, and corresponding assembly equipment for storing and

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connecting TF cards is continuously being developed. However, due to the small size and high assembly accuracy of TF card slots, there are significant technical difficulties in meeting the requirements of batch production. This study aims to design a fully automated assembly and testing equipment for TF card slots.

## 2. Domestic and Foreign Research Status

In the 1970s and 1980s, the computer industry emerged and developed rapidly, leading to significant advancements in the connector industry. Japanese and American manufacturers were the first to develop automated assembly equipment for connectors. With investments from foreign connector manufacturers in mainland China, driven by the consideration of cost reduction, the connector industry in mainland China experienced rapid growth. In the 2000s, Taiwan, Hong Kong, Japan, and Europe further increased their investments in mainland China, resulting in continuous growth in the production value of the connector industry. As a result, the Chinese connector industry started providing products and services to customers worldwide in various industries. The development of the connector industry also drove the rapid development of related automated assembly equipment, with foreign connector assembly technology taking root in China. With the continuous evolution and diversification of connector products, the requirements for connector assembly technology have become increasingly demanding.

Zhang Xingxing from Shanghai Jiao Tong University highlights the necessity of developing automated assembly and testing equipment by introducing the characteristics of SMT series memory card slots and existing production equipment. Based on SolidWorks 3D modeling technology, a narrow VLP SMT DDR3 automatic assembly equipment was designed and developed, including the design of its PLC control system. An Automatic Optical Inspection (AOI) flatness detection system was also developed, capable of automatically detecting and determining the flatness of terminal pins. The equipment was evaluated based on its processing accuracy, product qualification rate, and production capacity, demonstrating its compliance with the design requirements.

Zhang Pan from Wuhan University of Technology designed a control system for a dual-card automatic card dispenser, completed the hardware and software design, and conducted experimental verification using a prototype. The control of the card dispenser's transmission mechanism was optimized by adding detection of the initial angle position, overcurrent, and overheat signals on top of the open-loop control of the stepper motor. When abnormal conditions, such as motor stalling or overheating, occur due to card jams, the drive voltage is shut off, and fault handling measures are implemented, improving control accuracy. The five-segment S-curve speed control algorithm was applied to the acceleration and deceleration control of the stepper motor, achieving good results.

Wang Liwei from the University of the Chinese Academy of Sciences conducted in-depth research on laser cutting technology guided by machine vision positioning for mobile phone SIM card slot cutting. A coaxial vision-guided laser cutting SIM card slot system was designed. The hardware and software components of the system were selected and analyzed, and a working platform was built. The process of solving the intrinsic and extrinsic parameters through camera calibration was derived. The origin of camera distortion was analyzed, and a method for correcting radial distortion was proposed. An improved maximum interclass variance method was used to automatically obtain threshold segmented images. An edge-preserving and denoising adaptive filtering method was employed, and a new line detection algorithm was proposed.

While there has been some research on assembly equipment and detection systems for electronic connectors in China, there has been limited research on automated assembly equipment specifically for TF card slots, especially intelligent production equipment with precise control for electronic connectors. Although there are automated assembly equipment for TF card slots available overseas, there is limited public information on them, and their core technologies are restricted from being shared with China. Therefore, the designed intelligent production equipment for TF card slots based on precise control in this study holds significant importance.

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# 3. Overall Design of the Equipment

## 3.1 Demand Analysis

Currently, the assembly of TF card slots in enterprises is mostly done manually. The operation process involves the following steps: manually installing the base on a fixed fixture, pressing the special-shaped springs to achieve preloading, and then inserting them into the base. Due to the need for preloading and fitting the springs into the base, it takes a considerable amount of time. Additionally, the installation of the special-shaped springs is prone to errors and results in a high rate of defective products. Finally, the latch is placed on the base and pressed using a press machine to complete the installation of the TF card slot. Subsequently, the installed TF card slots are tested by a dedicated person to check their quality.

Currently, it takes approximately 45 seconds for one person to install a TF card slot. With one person working for 8 hours, a maximum of 640 TF card slots can be installed per day. Considering the demand for 6000 TF card slots of this particular model, approximately 9 workers are required for the installation, resulting in high labor intensity, low efficiency, and a high rate of defective TF card slots due to inconsistent installation force applied by the workers. Therefore, there is an urgent need to design a fully automated assembly and testing equipment for TF card slots to replace manual assembly.

Considering the production volume requirements and installation accuracy of the enterprise, the following key technical parameters are proposed:

1) TF card slot dimensions: 22mm*16mm*10mm (fixture logistics need to be changed for assembly of different models of card slots).

2) Automatic assembly speed of TF card slots: 720 pcs/hour.

3) Automatic assembly accuracy of TF card slots: ±0.1mm.

4) Control system and human-machine interface tailored to the practical use, implementation, management, and maintenance of automated equipment.

## 3.2 Equipment Overall Design

According to the process requirements of TF card slots, the equipment needs to accomplish the following tasks: automatic screening and feeding of the base, automatic feeding and pressing of the special-shaped springs, automatic feeding of the latch, visual inspection of the product, and overall performance testing. The overall design of the equipment is shown in Figure 2, and the specific process is as follows:

1) Automatic screening and feeding of the base: The base is poured into a vibrating tray, which orderly conveys the base to the conveyor line. The base is grabbed by pneumatic grippers and placed on the eight-station turntable.

2) Automatic feeding of the special-shaped springs: The special-shaped springs are manually preloaded onto the spring connecting piece, and then placed on the conveyor line. A robotic gripper grabs the special-shaped springs and presses them into the base.

3) Automatic feeding of the latch: The latch is poured into a vibrating tray, which orderly conveys the latch to the conveyor line. The base is grabbed by pneumatic grippers and installed onto the base.

4) Visual inspection and overall performance testing: The turntable rotates to the visual inspection station, where a visual inspection device detects the product and rejects any products that do not meet the inspection criteria. The turntable then rotates to the performance testing station, where a performance testing device tests the product's performance and rejects any products that do not meet the testing criteria.

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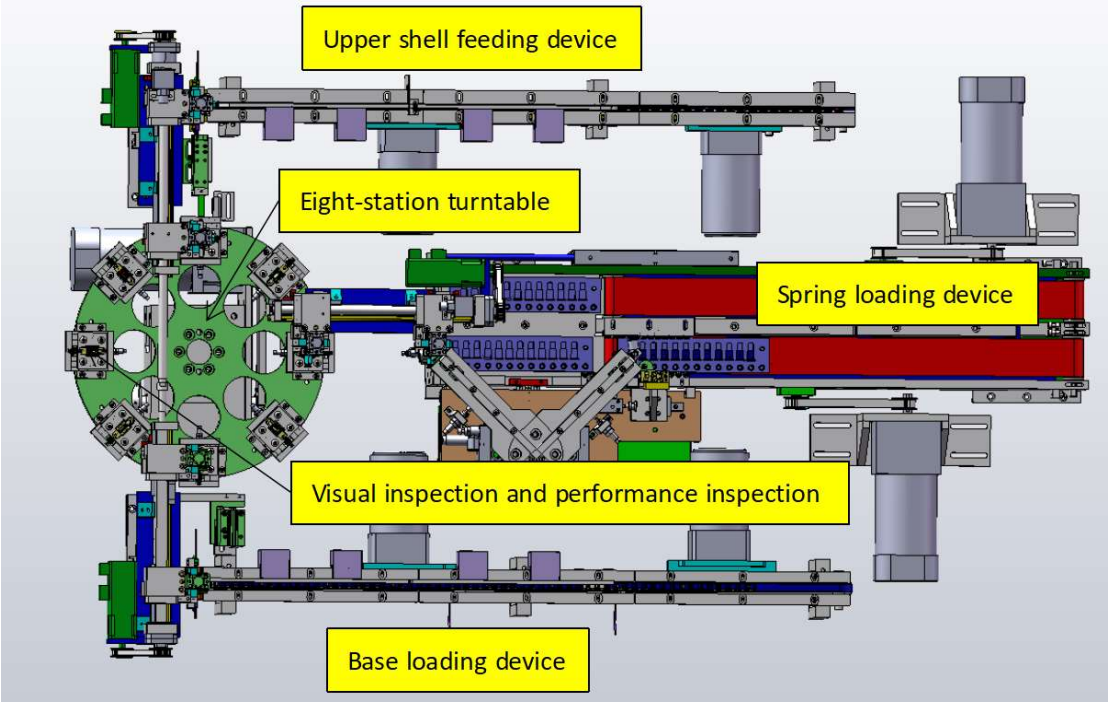


**Figure 2.** Equipment overall design

### 3.3 Key Technology of Equipment

Perform a process analysis of the TF card slot assembly based on the product characteristics and technical requirements, and design the steps and process route for the TF card slot automatic assembly system. Conduct the overall design of the TF card slot automatic assembly and testing equipment.

1) Study the TF card slot fixture logistics fixture: Due to the structural characteristics of the slot base and the installation process of the slot, it is not possible to directly place the slot base on the conveyor line for transportation. Therefore, it is necessary to design a TF card slot fixture logistics fixture that can accommodate the slot base and facilitate the automatic installation of the special-shaped springs and latches.

2) Study the automatic feeding mechanism for the slot base: Design a suitable feeding mechanism based on the structural design of the slot base. Priority should be given to the vibration tray feeding method. If that is not achievable, a pendulum feeding method will be used. Design the automatic feeding mechanism and gripping mechanism to place the slot base on the fixture logistics fixture.

3) Study the automatic assembly mechanism for the special-shaped springs: Due to the irregular shape and the need for preloading of the special-shaped springs, the automatic installation of the springs presents difficulties. Structural design is required for the loading, preloading, and installation of the special-shaped springs to achieve fast and accurate automatic assembly.

4) Study the TF card slot testing equipment: After the TF card slot is installed, perform visual inspection to check if it is properly installed. Conduct electrical testing on the TF card slot and reject any defective products to reduce the defect rate.

## 4. Design of Each Workstation for the Automation Equipment

### 4.1 Compatible Tooling Plate Design

The compatible fixture plate consists of a prototype mold, sliders, and a clamping device, as shown in Figure 3, which facilitates the automatic installation of the bottom base, female springs, and clips.

During the installation of the bottom base, after the base is placed inside the mold, the clamping device slides along the slider and presses the base tightly using a spring. When installing the female springs, the springs and spring connectors can be accurately pressed into the base along the guide

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groove. Similarly, the clips can also be accurately pressed into the base along the guide groove during installation.

Due to the small size and irregular shape of the TF card slot, the compatible fixture plate can hold the TF card slot and facilitate its automated transportation. The compatible fixture plate is installed on an eight-station turntable, as shown in Figure 4, making it convenient for the installation and testing of each workstation, as well as facilitating the electrical performance testing of the product.

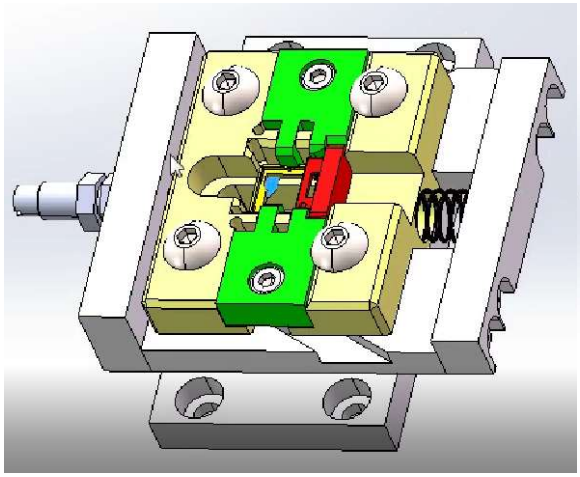

**Figure 3.** Compatible tooling board

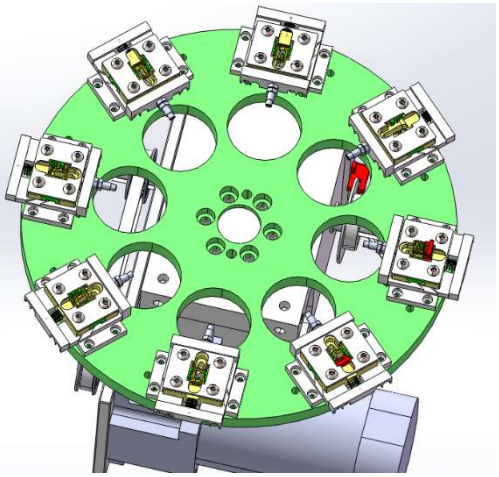

**Figure 4.** Eight-station turntable

### 4.2 Base Loading Device

Pour the base into the vibrating plate, and the vibrating plate will transport the base to the conveying line in an orderly manner. When the proximity switch sensor detects that the base is in place, the lifting cylinder drives the mechanical claws down and grabs the base. The lifting cylinder rises, and the translation mechanism Move the base to the eight-station turntable and install it in the tooling plate.

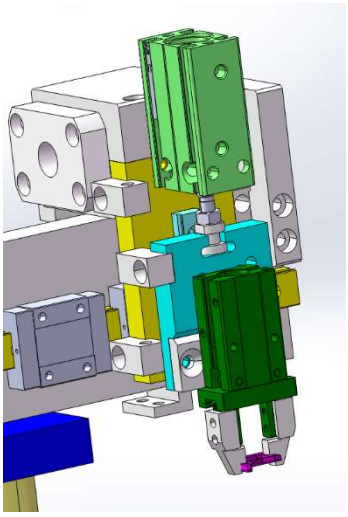

**Figure 5.** Base grabbing device

### 4.3 Shaped Spring Feeding Device

Manually pre-press the special-shaped spring onto the spring connecting piece, place the special-shaped spring together with the spring connecting piece in the tray, then place the tray on the conveying line, transport the tray to the waiting area, push the cylinder to push the tray to the feeding area.

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The mechanical claw grabs the special-shaped spring and presses it into the base. After the special-shaped spring in the tray is installed, the empty tray returns through the conveyor line.

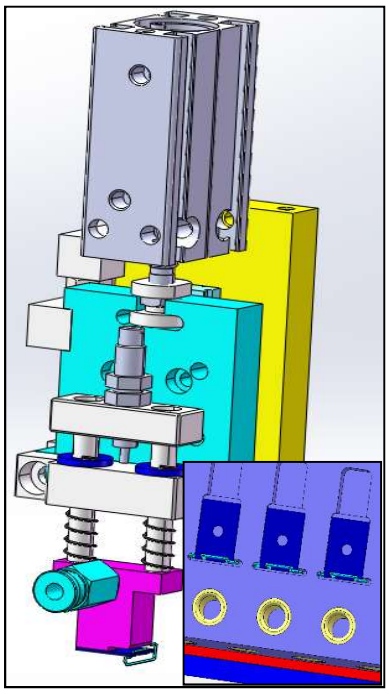

**Figure 6.** Shaped spring feeding device

### 4.4 Latch Loading Device

Pour the latch into the vibrating plate, and the vibrating plate will transport the latch to the conveying line in an orderly manner. When the proximity switch sensor detects that the latch are in place, the lifting cylinder drives the mechanical claws down and grabs the latch, and the lifting cylinder rises. And the base is moved to the eight-station turntable by the translation mechanism, and installed in the tooling plate.

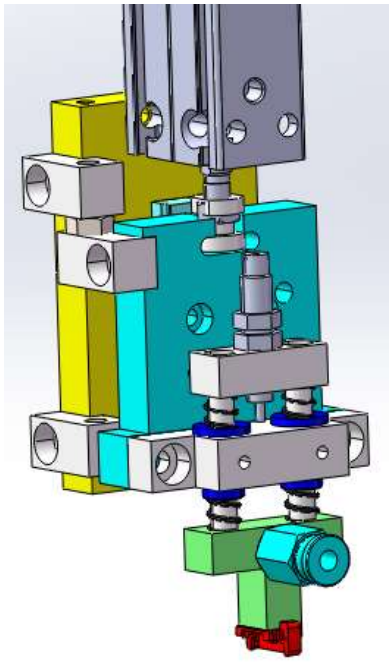

**Figure 7.** Latch loading device

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### 4.5 Visual Inspection and Performance Testing

The eight-station turntable rotates to the visual inspection station, and the visual inspection device detects the product, matches the detected product with the standard template, and rejects the unqualified products when the matching degree is insufficient; the eight-station turntable rotates to the performance inspection station The performance testing device conducts a power-on performance test on the product and rejects unqualified products.

## 5. Summary

Through the analysis of the process requirements of TF card slots, an automatic assembly line for TF card slots is designed, including automatic screening and feeding of bases, automatic feeding and pressing of special-shaped springs, automatic feeding of buckles, product visual inspection and Overall performance testing, etc., equipment operation reduces the labor intensity of workers, improves the working environment, avoids worker production accidents, and at the same time improves production efficiency, reduces operating costs, and ensures product quality.

## Acknowledgments

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## References

[1] Wang Liwei. Research on coaxial visual inspection technology for laser cutting SIM card slot [D]. University of Chinese Academy of Sciences, 2017.

[2] Zhang Xingxing. Development of automatic assembly equipment for SMT series memory card slots [D]. Shanghai Jiaotong University, 2015.

[3] Li Tao. Design and implementation of an SD card automatic test system [D]. Shanghai Jiaotong University, 2017.

[4] Research and design of SD card and CF card performance test platform [D]. Zhang Gang. Wuhan Engineering University 2013.

[5] Zhang Pan. Design of control system for automatic card issuing machine with double card slots [J]. Journal of Jingchu Institute of Technology, 2016, 31(02): 33-38+50.

[6] Assembly method and technology of electronic equipment [J]. Li Shiquan, Yang Yun. Journal of Hebei Energy Vocational and Technical College. 2012(04).

[7] Design of machine vision teaching experiment system based on HALCON [D]. Jin Bei. Beijing Jiaotong University 2012.

[8] Realization and Application of Modular Adaptable Design System for Non-standard Equipment [J]. Li Jian. Mechanical Engineer. 2013(11).

[9] Zhong Chunyan. A device for opening connector slots [P]. China: CN112886353A, 2021.

[10] Shenzhen Qiangrui Precision Equipment Co., Ltd. SIM card slot automatic centering clamping device [P]. China: CN110774033A, 2020.

[11] Zhuhai Bojie Electronics Co., Ltd. A SIM card slot automatic testing machine [P]. China: CN212008767U, 2020.