Research and Application of SYA-I Microphone Intelligent Assembly System

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Abstract. At present, most of the pin-plug type earphones and microphones rely on manual production, and the production efficiency is extremely low. It is difficult to accurately control the neatness and aesthetics of the microphone insertion. Based on the principle of electromagnetic vibration, this paper studies and designs a smart assembly system specifically for SYA-I microphones. This system realizes automatic feeding and docking of SYA-I microphone production, which greatly improves production efficiency and product quality.

1. Introduction
With the development of economy and society, the demand for earphones and microphones is increasing. At present, adding microphones on the headset microphone control board generally depends on manual operation [1]. Because the earphone microphone components are small and mostly pin-plug type, the control board is small and there are positive and negative poles. At present, most of the production methods rely on manual plug-in microphones. The production efficiency is extremely low, and it is difficult to precisely control the neatness and aesthetics of the microphone plug. Therefore, it is very urgent and important to study how to realize the automatic assembly of the microphone. This thesis focuses on the research and application of SYA-I microphone intelligent assembly system.

2. Overall Design of SYA-I Microphone Automatic Assembly Production Line
The automatic assembly production line of the microphone is mainly composed of automatic feeding device, electric and pneumatic automatic device, feeding platform, automatic plug-in device, and PLC control system. The whole automatic assembly line automatically arranges the installation direction of materials by the feeding plate, and achieves the purpose of improving production efficiency, product quality and realizing production automation through the linkage device composed of electromechanical sensor, PLC controller, step motor, pneumatic device, conveyor belt, etc. The overall schematic diagram of the automatic assembly production line of the microphone is shown in Figure 1.

3. Design of Automatic Feeding Device for Automatic Testing Machine
3.1. Classification and Selection of Automatic Feeder
The automatic feeder is divided into mechanical type and vibration type[2]. In the feeding mechanism, a vibration-type automatic feeding device is relatively common. The mechanism uses a reciprocating vibration method to realize automatic supply of materials. The vibrating automatic feeder uses baffles, card slots, etc. to sort out the workpieces in an orderly manner. At the same time, through the linkage device composed of PLC, stepper motor, pneumatic claw, conveyor belt, etc., it effectively solves the
problem of automated production. According to the driving mode, the automatic vibration feeder is divided into motor type, piezoelectric type and electromagnetic type[3]. According to the material conveying method, it can be divided into spiral type and linear type[4]. The electromagnetic vibration feeder uses a coil as a vibration source, has high feeding efficiency, strong carrying capacity, and low cost, and is widely used in industrial production [5].

Figure 1. Overall schematic diagram of automatic microphone assembly line

This article uses a spiral electromagnetic vibration feeder, which is mainly composed of a feeding device, a vibration device, and a feeding plate. It can realize the automatic feeding process of the headset microphone and can distinguish positive and negative electrodes. The processing efficiency of the microphone is improved, and the cost of the enterprise is saved.

3.2. Working Principle of Spiral Electromagnetic Vibration Feeding Device

Spiral electromagnetic vibration feeder is a kind of vibration machine excited by electromagnet, also known as disc electromagnetic vibration feeder. It has a circular hopper with a spiral groove for vibrating torsion, and is especially suitable for small workpieces such as headsets and microphones that require regular sequencing.

After the electromagnetic coil is energized, a periodically changing pulse electromagnetic force is generated, and the armature and the iron core also generate periodic vibrations. Match the corresponding mechanical system to amplify the signal, and rely on the combined effect of inertia and friction to move the workpiece forward. By using the slot method, a certain slot is made according to the shape of the tool, so that the moving workpiece can enter the slot and automatically locate, and automatically orient in the process of movement. The armature is fixed on the top plate. Under the control of the inclined spring plate, the armature makes a synchronous torsional movement of the electromagnetic coil about its central axis, and finally forms a high-frequency reciprocating vibration of the space spiral. The automatic feeding device and the physical diagram of the automatic detection machine are shown in Figure 2 and 3.
The microphone rises along the spiral track of the vibrating disk and enters the linear track, so that the scattered earphones can automatically distinguish the correct arrangement of the front and back sides and the polarity during the rise (When the headphone head rises in the spiral track, the headphone head with the pin outward is not easy to drop because the center of gravity is inward, otherwise it falls back to the bottom of the tray). The device can increase the vibration of the earphone microphone, the rising speed is determined by the vibration frequency, and can be adjusted to achieve the purpose of fast feeding and automatic dropping when too much feeding.

4. Research and design of electric and pneumatic automatic devices

4.1. Hardware System Design of Electric and Pneumatic Automatic Device

The electromagnetic vibration feeder uses an electromagnet as a driving element, and the division of labor between each module is clear, and the structure is simple. In the process of reclaiming, transporting and plugging, a pneumatic gripper is needed to grab and plug the microphone to the corresponding circuit board. Because the circuit board is small, the accuracy of the plug is high. In order to realize this process, the whole system is designed as three-axis plus a pneumatic grab. The three axes are x axis, Y axis and Z axis. Among them, the X axis is used to carry the microphone control circuit board; The Y axis realizes the forward and backward movement of the pneumatic gripper, and the microphone is transported from the feeding track to the circuit control board; The Z-axis realizes the up and down movement of the pneumatic gripper, which realizes the pick-up, release and insertion of the microphone element. The schematic diagram of the device is shown in Figure 4.
4.2. Design Principles of Electric and Pneumatic Automatic Devices

The electromagnet is a vibrator energy conversion device. The quality of the electromagnet will affect its vibration effect. Therefore, the accuracy of related parameters such as the magnetic pole air gap, amplitude, and excitation frequency must be guaranteed. Suppose the effective supply voltage is $U$, the angular frequency is $\omega$, the frequency is $f_z = \frac{\omega}{2\pi}$, the number of electromagnetic coil turns is $z$, the magnetic pole area is $S$, and the number of magnet poles is two. Then the maximum magnetic flux of the iron core is:

$$\phi_{\text{max}} = \frac{U}{4.4Zf_z}$$

The maximum magnetic induction is:

$$B_{\text{max}} = \frac{\phi_{\text{max}}}{\sigma_0 S}$$

The amplitude of the exciting force of the electromagnet is:

$$F = \frac{4B_{\text{max}}^2S}{3\pi\mu} = \frac{4U^2}{4.44^2 \times 3 \times \pi \mu f_z^2 Z^2 \sigma_0^2 S \cos 45^\circ}$$

In the design, the parameters of the electromagnet are shown in table 1:

![Figure 4. Schematic diagram of electric and pneumatic devices](image-url)
Table 1. Electromagnet parameter table

| Serial number | Name                              | Parameter                                      |
|---------------|-----------------------------------|-----------------------------------------------|
| 1             | Maximum magnetic induction        | $B_{\text{max}} = 0.5T$                       |
| 2             | Magnetic leakage coefficient      | $\sigma_0 = 1.1$                              |
| 3             | Air permeability                 | $\mu = 4\pi \times 10^{-7} \text{H/m}$        |
| 4             | Magnetic pole area               | $S = 3.5 \times 10^{-3} \text{m}^2$           |
| 5             | Frequency                        | $f_z = 60 \text{Hz}$                          |
| 6             | Number of coils of electromagnet | $Z = \frac{0.9U}{4.44 \times f_z \phi_{\text{max}}} = 386$ |
| 7             | Excitation force amplitude       | $F = 258W$                                    |

5. Design of control system

The entire system is controlled by the PLC control system with two servo motors plus a stepper motor to complete the return, positioning and operation of the entire system. The system interface is shown in Figure 5. The parameters can be uniformly modified by the touch screen, of which there are two modes conversion: automatic mode and manual mode.

Automatic mode: After completing the return to origin, the plug-in process is played into the entire process at one time.

Manual mode: The workers can control each work process in turn. In this mode, you can obtain the reference points and the coordinates of each jack; It can also be used for individual modification of a certain point. After obtaining one plug-in point, the remaining jacks can be generated step by step by the program, without setting them in turn.

Parameter modification: It can complete the unified setting of manual speed, automatic speed, high-speed return parameter, low-speed return parameter, acceleration time and deceleration time of each axis, and its accuracy can be accurate to ms.

In addition, the position of each axis of the starting point and gripping point of the robot can also be set. After replacing different types of headset mounting boards, the corresponding parameters can be adjusted according to the actual situation of different mounting boards--row spacing, column spacing, number of rows, number of columns. Use the suction and deflation time of the pneumatic gripper to control the gripping and plugging, and complete the cooperation with each axis.
6. Conclusion
The SYA-I microphone intelligent assembly system studied in this paper is an indispensable part of modern processing, which can be said to be the "throat" of the whole automatic production line. Its performance and structure will directly affect the production efficiency, production quality and automation level of the microphone. The prototype designed and manufactured has undergone field tests. The plug-in of the headset microphone can reach 2000 per hour, which is much higher than the manual plug-in which can complete about 300 production per hour. The product is reliable and stable, the pass rate is 99.7%, and the production efficiency is increased by 7 times, which greatly saves the labor cost of the enterprise. A device can save more than 600 yuan in labor cost per day.

7. References
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