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Exploration and Experimental Research on the Mechanism of Electromagnetic Driven Weft Insertion ⋆

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Abstract

In view of the current situation that there exists big impact and friction between the gripper and the guide in the weft insertion mode of the existing gripper loom, this paper puts forward the idea of the electromagnetic-driven two-way weft insertion on gripper in order to improve the energy conversion efficiency, reduce the friction and mechanical vibration. Electromagnetic drive is used as the basic method to study the projecting/braking of the shuttle, and it uses the principle of electromagnetic levitation as the basic principle of the shuttle's weft insertion. In this paper, a basic model of two-way insertion is established. After ANSYS simulation and experimental analysis, the speed of electromagnetic driving can reach 30 m/s. In the electromagnetic levitation stage, PWM modulator and DC power regulation were respectively used to conduct the levitation control experiment. HW101 hall sensor was used to judge the levitation state, and with the assistance of other Operational Amplifier, the requirements of electromagnetic levitation were completed.

Keywords: Gripper Loom; Weft Insertion; Electromagnetic Levitation; Shuttle Projecting

1 Introduction

The gripper loom is a kind of textile machinery used in the production of high-quality fabrics, it can be used in various yarn weaving, jacquard and industrial wide fabrics [1]. The shuttles are projected by stored mechanical energy and torsion shaft to meet the weaving requirements of the shuttles. Due to the limitation of mechanism principle, there exits high impact force, noise, high friction energy consumption, leading to the low speed and shuttle e?ciency. According to literature [2], the maximum mechanical efficiency is 18.3%. In order to further improve the efficiency of the shuttle loom, it is necessary to optimize its mechanism and improve its material properties.

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Due to the low efficiency of the traditional mechanism, electromagnetic projection technology has made great progress in theory and engineering [3]. At the same time, in order to reduce the matter of high friction, vibration and material loss in the process of weft insertion of traditional gripper loom, the new idea of electromagnetic levitation was combined. In this paper, an electromagnetic driving insertion model combined with electromagnetic projection and electromagnetic levitation is presented. The magnetic coil is used to project the shuttle, and the levitation process is realized by the magnetic levitation array system. This method is a new method to replace torsion shaft and guide in weft insertion process.

2 The Principle of Electromagnetic Driven Weft Insertion

In the control system of the electromagnetic driver, the shuttle is driven by the speed-response coil and the suspension coil is directly driven, in which the speed-response coil is controlled by the speed-response controller and the suspension coil is controlled by the electromagnetic suspension controller.

The following figure shows the three different states of the shuttle.

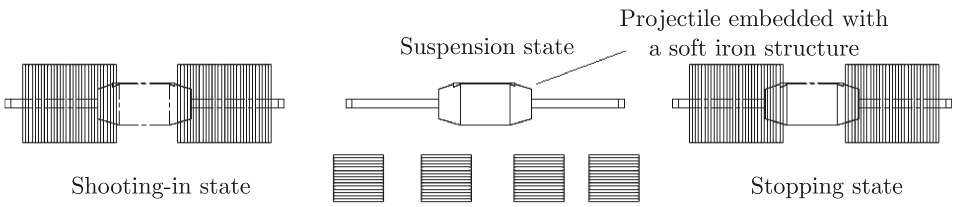

Fig. 1: Diagram of different states of the shuttle

2.1 The Principle and Structure of Electromagnetic Projecting

The basic principle of electromagnetic projection is that the electromagnetic force drives an electrically charged conductor or a ferromagnetic object in a magnetic field. The electromagnetic projection mechanism is mainly composed of coil and shuttle, and the shuttle body is composed of the shed skeleton and embedded soft iron. Electromagnetic emission model is composed of power supply, switch, coil and shuttle, as shown in Fig. 2. When the projectile is in front of the coil, the electromagnetic force attracts the projectile to move toward the centre of the coil and accelerates the projectile motion. The force slows the coil as it passes through the centre of the coil. The continuous acceleration of the coil can be guaranteed by controlling the on-off sequence of the coil [4].

The mechanism uses the electromagnetic force of the coil to accelerate the shuttle. After the shuttle moves to the other side of the coil, the electromagnetic force slow it down reversely. After the bobbin is loaded onto the yarn, the electromagnetic force will re-accelerate the shuttle and repeat the filling process, so that the shuttle does not need to be reversed itself.

The formula derivation is as follows:

According to electromagnetism theory [5], the magnetic flux density B of the axial component