Automated and High Speed Machine Design for Telecommunication Products

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Abstract

This research focuses on an automated and high speed machine design, which is assembling the bronze wire inside the plastic block to meet the manufacturing and production specification. In this research, an automated system has been designed and developed to perform serial operations in assembly line. This automated system is divided in five different mechanisms. The first station is the loading, feeding and straightening of the wire. The second station is to upload the plastic block into the assembly line and holding the block precisely for bronze wire insertion. The third station includes wire inserting into the plastic block and wire cutting at desire length. The fourth station is to bend the wire and final station is the inspection of final assembly product by using special sensing techniques. This research is mainly focusing on utilization of automated machinery with simple tooling, cost-saving fixtures, high speed assembling technology, and reliable function.

Introduction

Design and development of an automated and high speed machinery system require considering many different design methodologies that are different from regular conventional machines designing procedure [1], [2]. Automated machining brings different problems in design area; such as high acceleration, high declaration, unpredictable forces / moments while machine is working, more accuracy at positioning, and proper materials in high speed manufacturing processes [3], [4], [5]. This research is to design an automated assembly machine to assemble the Ø 0.5mm bronze wire into the Ø 0.5mm plastic block hole and bend it at high volume production rates. Since it is automated machine system, all the machinery design layout and calibration must be very accurate otherwise it will cause significant damages to the machinery and products. The whole assembly process is fully automated at high speed performance with cost-effective tooling and fixtures, reliable function, and easy maintenance.

New Automated and High Speed Machinery System

1. Loading, Feeding and Straightening of Wire.

The material reel is mounted on the shaft which locked by the bush and screw arrangement and the whole shaft assembly is mounted on the table stand. The wire passes through the reel mounted on four pulleys so that the wire gets easy movement in feeding. Before entering to the feeder the wire passes through the wire guider which keeps wire inside the feeding track. The wire in the feeder machine is feeding through precision rapid air feeder. The installations of stainless steel telescoping tubes enable the air feeder to deliver wire smoothly and accurately to the machine. Whip and buckling problems disappear when using the wire feeder for round materials over both long and short progressions. After precisely feeding wire through the feeder, it passes the other wire guider and get wire straightened, shown in figure 1. The wire comes out of the wire feeder through wire guider and moves to the plastic block in next station.

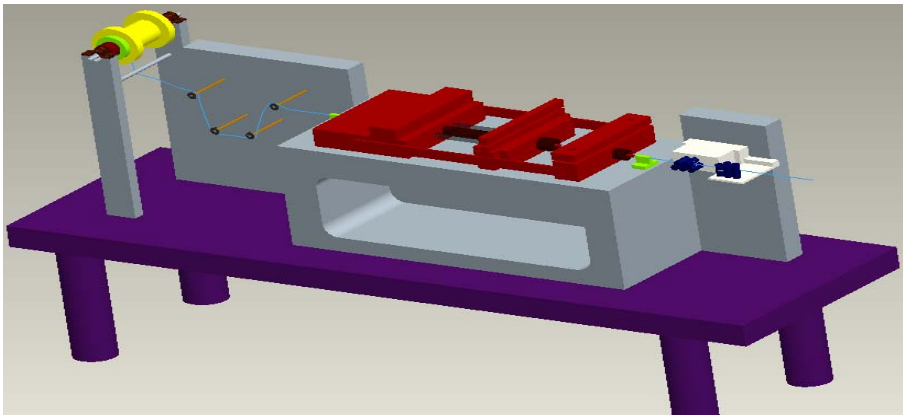

Fig. 1 Prototype of loading, feeding and straightening of wire

2. Block loading.

This station delivers and guides plastic block with proper orientation to the production line. One conical shape vibrating bowl is used to supply the plastic block at correct orientation to the metal rail conveyor. The metal conveyor is used for transporting plastic block from the vibrating bowl to the location where block is picked up by a gripper. At the same time, many blocks are continuously fed to the metal conveyor rail and stopped by a stop mechanism that keeps block delivered one by one at end of the rail, indicated in figure 2. The grippers pick up block and placed at proper orientation for next station.

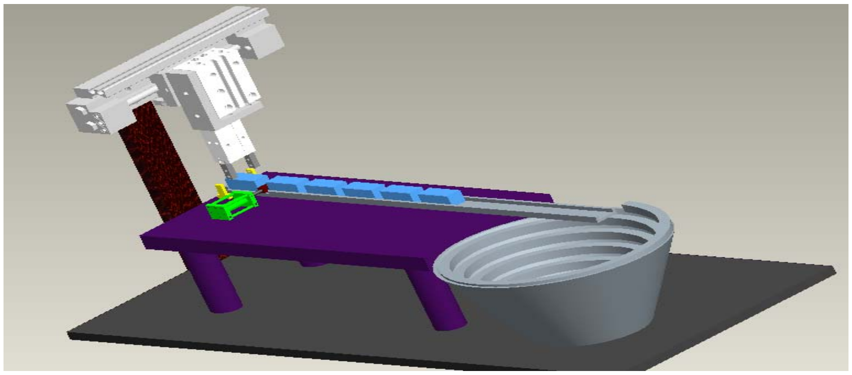

Fig. 2 Prototype of block loading

3. Wire inserting and cutting mechanism.

This station is designed for wire inserting and cutting. This automated assembly station consists of three assembling functions: slider assembly, cutter assembly and plastic block holding assembly. The plastic block is properly grabbed at its two opposite corner with the help of the fix L plate and movable L plate. The slider is mounted on the base plate with the Z shape-carrier and guide block. The square guide block with center hole is to guide and insert the wire precisely into the plastic block. The cutter assembly mounted with the top v- groove and bottom round shape holders on the linear pneumatic actuators and perpendicular mounted with the cutter to the linear pneumatic actuator. First an assembly line is set to insert wire into the guide block through the plastic block and cut wire at desire length. During wire inserting section, wire is continuously feeding through the feeder, at same time pneumatic slider is sliding and wire accurately inserting into the plastic block with guidance of guide block and then slider stop to slide for 1 second at the time wire getting its desire length into the plastic block. After that feeder also stop for 0.5 second and slider comes back to its initial position. At same time top and bottom wire holders retracted with linear pneumatic actuators and grab wire precisely, displayed in figure 3. Then perpendicular mounted cutter releases the linear pneumatic actuator and cut wire accurately in 0.5 second.

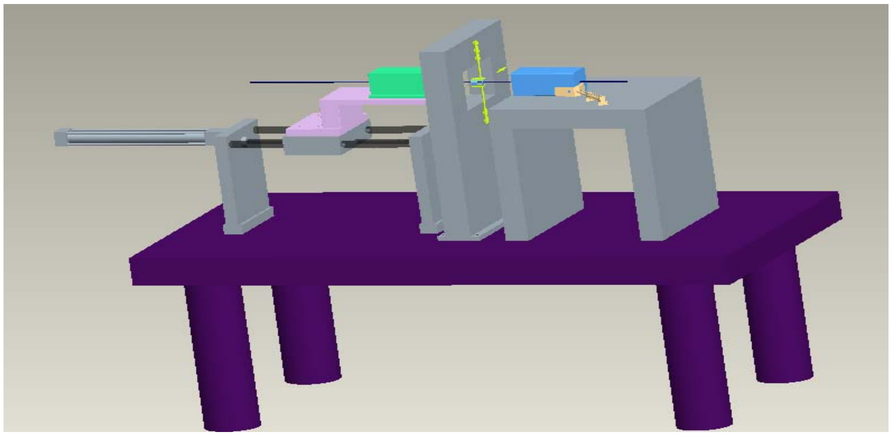

Fig. 3 Prototype of wire inserting and cutting mechanism

4. Wire bending mechanism.

This station is to bend the wire. The operation follows after wire insertion when the block is transferred to bending station. Both end of the wire requires bending over 120° at 5mm radius. Wire is bended at bottom side of 120°. To comply with 120° as requested, the overall bending degree can be divided into a two 60°. Two shaped components driven by a miniature centre cylinder are actuated and aim to punch the wire from different angle to bend the wire in the sequence. Both shaped component is responsible for 60° bending angle respectively. To guarantee that edges of shaped component will not cut the wire, the wire bending actuates cylinders is back to the home position. It support assembly cylinder simultaneously and semi-circle shape guider actuates vertical motion with wire assembly. Next assembly gripper picks up the wire assembly and rotates at 360° to the wire assembly and place at the other end of wire to bending at top side of 120°. During this operation, centre and top mounted cylinders are actuated to bend the wire precisely at 120°, presented in figure 4. Finally the whole assembly is properly gripped through the external grippers vertically and transferred to the next station.

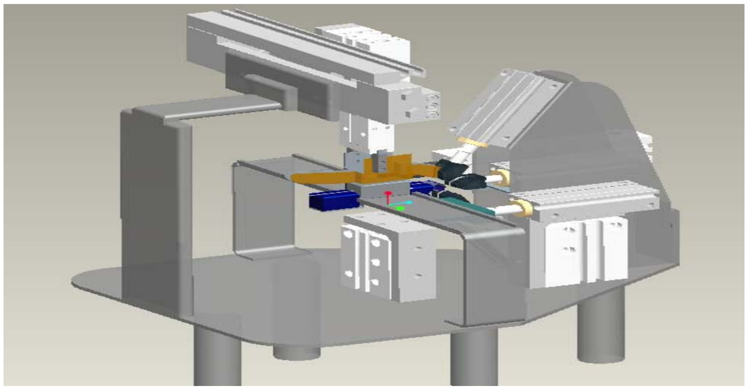

Fig. 4 Prototype of wire bending mechanism

5. Inspection system.

In this station, two main product features must be inspected: dimensions and bending angles of wire. Inspection should be done through the photo electric sensing technique. The sensors are mounted with 10 mm above at one side of the rail with help of the support block to cover the whole wire profile at 0°, 45°, 90° and 120° at both ends of the wire product assembly. Product assembly is moving towards inspection station in the conveyor rail and the linear pneumatic stopper stops the product at the station. The gripper arm is used to pick up the assembly to the sensors position and hold wire until the sensor inspect the product assembly. The gripper arm is designed in such way that it can accurately keep wire. Finally the inspected product assembly is transferred horizontally and delivered to the product acceptance or rejection area, demonstrated in figure 5.

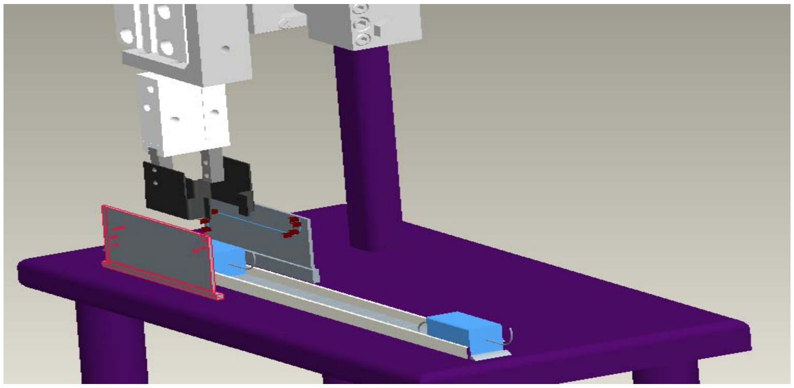

Fig. 5 Prototype of inspection system

Conclusion

This research provides an insight of dominate criteria and principals of automated machinery design and high speed manufacturing process. This new automated and high speed machinery system can be used for high volume production of jack connector in telecommunication industry. The prototype shows its reliable functionality, good feasibility, and cost-effective product in automated and high speed manufacturing processes.

References

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