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A PROTOTYPE OF AUTOMATIC ASSEMBLY OF BOLTS AND NUTS

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Abstract: Assembling is one of the essential manufacturing processes, and is typically the final step in producing the final product. The most common assembly in machine building technology, the bolt and nut assembly is highly efficient and simple to replace and maintain. This research involved the prototyping of automatic assembly and classify of bolts and nuts. The Machine elements were designed on Inventor software and then fabricated by 3D printing method. Experiments have demonstrated that the proposed model and the mechanism performed as anticipated. The obtained products are simple in construction, user-friendly, and less expensive than those currently available on the market.

Keywords: classify, assembly, prototype, 3D printing, bolts and nuts

INTRODUCTION

Assembling is one of the essential manufacturing processes, and is typically the final step in producing the final product [1-5]. Assembly encompasses the processes of completing a product from its components or parts. Assembly is a fundamental type of manufacturing in which components are permanently or semi-permanently joined [6-10]. These permanent techniques may include adhesive bonding or welding. Using a combination of mechanical actions and components, such as screws, bolts, and other threaded fasteners, the semi-permanent method of assembling components is accomplished. These conventional mechanical assemblies facilitate assembly and removal when necessary. Assemblies of bolts and nuts are frequently used in machines and structures to facilitate assembly and disassembly. The most common assembly in machine building technology, the bolt and nut assembly is highly efficient and simple to replace and maintain [11-15]. A low-cost automated bolt-nut assembly and classification system is presented in this paper. In the workshop, the traditional bolt-nut assembly procedure is frequently repeated. This is an extremely monotonous and repetitive task that degrades the quality of the work. The proposed system mimics human product sorting and assembly, but is entirely automated. This paper focuses on the design and manufacture of a low-cost, simple-to-operate, and easy-to-maintain system for sorting and assembling bolts and nuts.

OVERALL STRUCTURE OF MACHINE

The overall structure assembly model of the machine designed in this paper is shown in Figure 1. The machine consists of four main parts, as shown in Figure 1: (1): Bolt tray; (2): Groove rail track; (3): Nut- washer tray; (4): Assembly zone

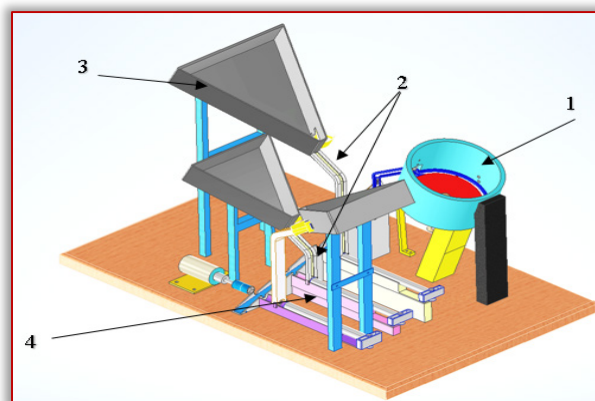


Figure 1. Overview of the machine

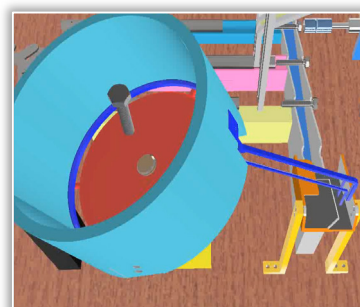
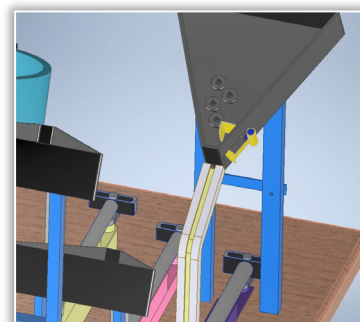


Figure 2. Bolt and nuts tray

Working principle: Bolts are placed haphazardly in the mechanism as shown in Figure 2, the mechanism rotates continuously in combination with the inclined plane, and gravity causes the bolt to roll towards the split groove. The head of the bolt will be directed downwards due to gravity and the clearance of the split groove. At this gap, there are jigs to hold the bolts. The bolt is then pushed by the joists and in the direction of the split groove to move down the assembly, as shown in the Figure 3.

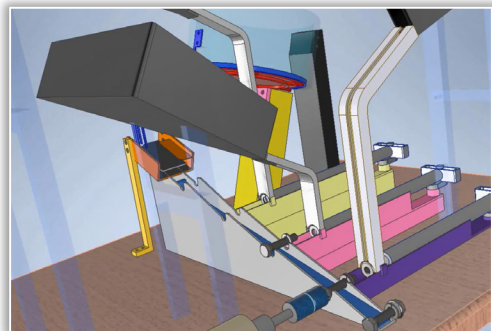


Figure 3. Assembly system

FABRICATION OF A PROTOTYPE MACHINE

Machine elements are designed on Inventor software and then fabricated by 3D printing method, as shown in Figure 4. Most of the machine's parts are manufactured and assembled at the Faculty of Engineering Mechanics and Automation (FEMA) - University of Engineering and Technology, VNU Hanoi. FDM (Fused Deposition Modeling) was the 3D printing technique used, and models are designed in Inventor software before being transferred to Cura software for setting the 3D printing parameters [16]. The printing temperature is 200°C and the layer height is 0.2 mm, it takes from 1 to 2 hours are required to print each parts.

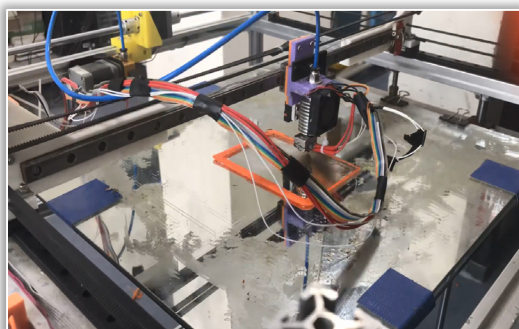
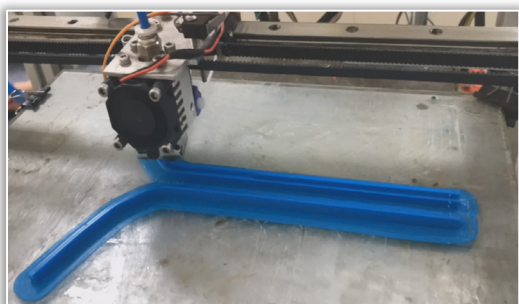


Figure 4. 3D printing technology

RESULT AND DISCUSSION

Figure 5 shows the complete manufactured prototype proposed in this study. The machine's dimensions in length, width, height correspond to 750 mm, 405 mm, and 412 mm, respectively.

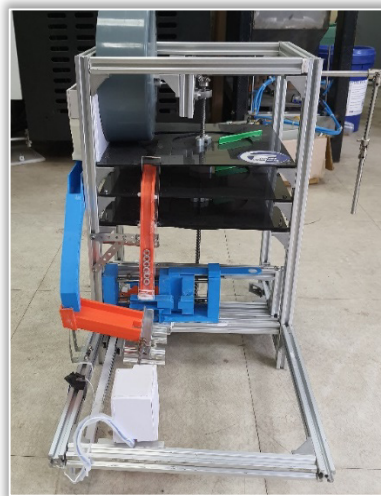


Figure 5. A prototype of assembly bolts and nuts machine

Other components, such as screw, bearings and shafts, are selected as standard parts and made available on the market to facilitate repair and maintenance. To evaluate the efficiency of the machine, a large number of bolts and nuts are arranged in trays and subjected to numerous experiments. Experiments indicate that the movements of product sorting, parts sliding on tracks, and assembly completion are executed with great precision.

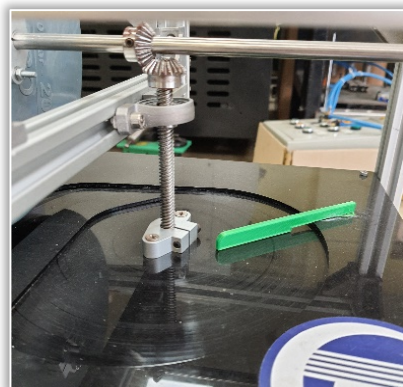


Figure 6. Classification mechanism for washers

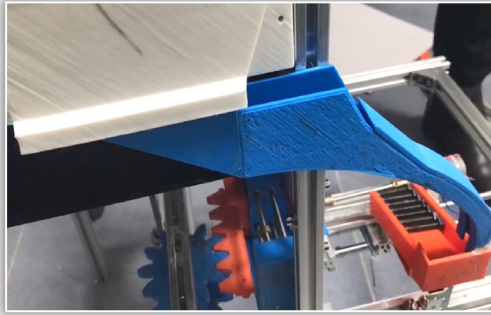
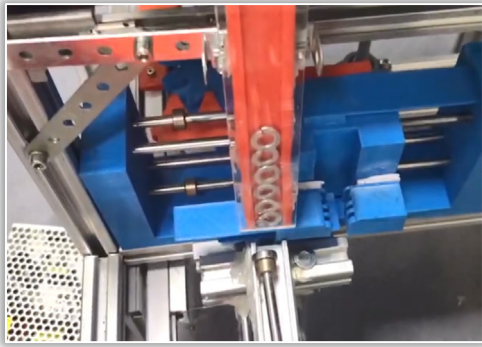


Figure 7. Groove rail track for bolt and nut

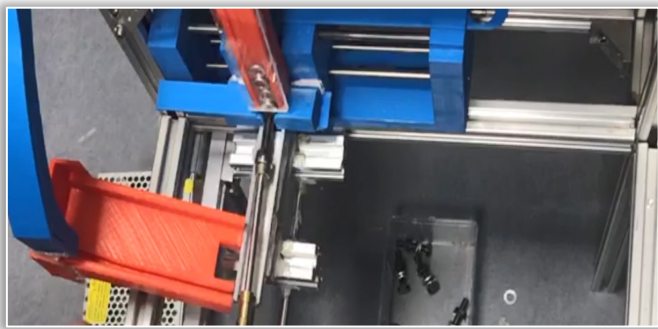


Figure 8. Bolt and nut assembly zone

During operation, components such as bolts, nuts, and washers are moved through the sorting mechanism and then lowered to the assembly area in accordance with their respective grooves, as shown in Figure 6 and 7. Then, these machine element components will be assembled using a hydraulic system in assembly zone as shown in Figure 8.

Table 1. Experimental results

No	Operation steps	Time sequences (s)
1	Push the component down to the assembly area	1
2	Push spring washer for the first bolt	5
3	Push washer for the first bolt Push spring washer for the second bolt	6
4	Push nut for the first bolt Push washer for the second bolt Push spring washer for the third bolt	8
5	Rotate nut for the first bolt	10
6	Rotate nut for the second bolt	12
7	Rotate nut for the third bolt	14
Total (3 complete sets)		15 s

Table 1 shown that assembly time for 3 sets of samples is about 15s. There are fifteen operational steps in the machine system, ranging from part placement to sorting and assembly. Experiments have demonstrated that the proposed model and the mechanism performed as anticipated. Therefore, it is demonstrated that the machine model is intended to achieve the stated objective, thereby improving the precision and efficiency of automatic bolt and nut assembly.

CONCLUSION

This paper describes a procedure for designing and fabricating a machine for sorting and assembling bolts and nuts. A model of a low-cost machine has been proposed. Simple construction and operation, with straightforward maintenance. The obtained products are simple in construction, user-friendly, and less expensive than those currently available on the market.

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