

Development of a Mechanical Rotary Part Feeding System with Performance Analysis

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ABSTRACT: Rapid industrialization and technological advancements in assembly lines and the growing demand for feeding the components in a proper orientation has become significant. Flexible assembly lines can be rapidly configured to handle new parts. This can dramatically reduce the time needed to bring new products to market and permit cost of assembly lines to be used for various products. This paper describes the development of a flexible rotary feeding system which is suitable for use in a flexible manufacturing system. This setup presents a mechanical feeder integrated with a counter to count the number of components. The present work is an attempt to design and develop an automated feeding system for industrial components, washers in this case with the aim of feeding them in a specific orientation. The counter uses Arduino and Infra-Red sensor to count the number of components, in this case washer. The complete automation of the process aims to reduce monotony and effort experienced in human inspection along with error elimination.

KEYWORDS: Arduino, Infra-Red sensor, integrated hopper, Self-feeding

I. INTRODUCTION

The predominant approach today to introduce factory automated technology into manufacturing is to selectively apply automation and create islands of automation. The phrase "islands of automation" has been used to describe the transition from conventional or mechanical manufacturing to the automated factory [1]. Automated flexible assembly systems (FAS) are capable of being programmed to assemble several different products on a single assembly line with minimal equipment changes [2]. With modern day industries moving towards automation to increase their rate of production, automated feeding of parts becomes an important accessory for them [3]. Flexible assembly lines can be rapidly configured to handle new parts. This can dramatically reduce the time needed to bring new products to market and permit cost of assembly lines to be used for various products [4]. The successful assembly lines in mass production require performance based part feeding systems. However, the lack of flexible programmable part positioners, facilitating the handling of smart sized parts, restricts the efficiency of a production unit. So, a flexible feeder in batch production is indeed important [5].

A typical parts feeding system comprises numerous components. First, a storage means, such as a bulk supply hopper or bin is used to store a plurality of parts. The rotary feeder is an active feeder [10][11] A rotating spindle with rotary arms or other feeder device transfers the parts from the storage means to a parts feeder, where separation and orientation of the parts typically occurs. After the rotary arm picks up the part, its goes towards the mouth of the feeding chute, this is again tilted at an arbitrary angle to enable the parts through the chute under their own weight. [6] Considering the current industrial setup, only a limited amount of quality research has been done on the feeder systems [7]. The given mechanism is equipped with a long length chute integrated with IR Sensor which helps to ensure the

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orientation of the parts as well as count the number of parts being fed and the parts flow over the delivery chute under their own weight and even by a push from the other parts.

II. WORKING MECHANISM AND PARTS

The study can be divided into two illustrative categories: -

1. Fabrication and Designing of storage hopper, chute, spindle, rotary arms
2. Analysis of operating parameters governing the feed-rate of the setup.



Fig.1 Working Mechanism of Feeder

1. **Spindle**- A spindle made of wood is used for driving the rotary arms in a circular manner. Diameter of spindle used and its thickness used is **75mm & 20mm** respectively.
2. **Rotary Arms**-A maximum of 6 Rotary arms are made of wood that are circular in cross section across half of its length and of rectangular cross section for the other half with circular section on the spindle side. Length of each rotary arm-**153mm**, Distance of each pickup point from the top end-**14mm**, Diameter of circular cross section-**14mm**, Rectangular cross section-**14mm*3mm**.
3. **Hopper**-The hopper is that part of the feeder where parts are stored in bulk. The shape of the hopper is circular so that rotary arms which move in a predefined circle can move easily sweeping the maximum amount of hopper area with arms having close tolerances with the base of the hopper.**330mm*185mm*60mm**
4. **Delivery Chute**- It is a long Y-shaped channel which transfers the part from the feeder ledge to the workstation. Dimensions-**275mm*187mm**.
5. **Motor**-A DC motor with rated maximum RPM of 30, Voltage rating of 30V was used to drive the spindle.
6. **Power Source**-A constant current DC power source was used to supply variable voltage to the motor to drive it at different speeds. Input: 220V AC, Output: 0-30V DC.

III. EXPERIMENTAL WORK

In order to utilize the feeder for various industrial based applications it is important to calibrate the feeder in response to different operating factors. The present work is based on graphical analysis of the performance of an elevated feeder. A systematic analysis of the part feed rate of the feeder was carried out under different operating conditions. A series of experiments was carried out by varying these parameters. The Various parameters which were involved in the analysis are: -

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Part Size: - It refers to the Outer diameter of the washer. (13mm, 17mm, 21mm)

Part Population: - It refers to the number of parts placed in hopper during analysis (50,100,150,200).

Motor Speed: - It refers to the speed of DC motor in RPM. (8, 10, 12)

Number of Rotary arms:-It refers to the number of rotary arms used with the spindle.(2,4,6).

Now, the data obtained by analysing the behaviour of feeder in different conditions is collected and organized and the graphs are plotted which shows the variation of feed rate by changing two of the parameters while the two parameter is kept constant.

Each one of the parameter was varied in equal steps of four. The experimentation has been carried out by following the One factor at a time technique (OFAT) [8] in which one of the factor is varied during a set of reading by keeping the Others constant [9].

Feed rate variation v/s part population and motor rpm, keeping the part size and rotary arms constant

Part Size=14mm

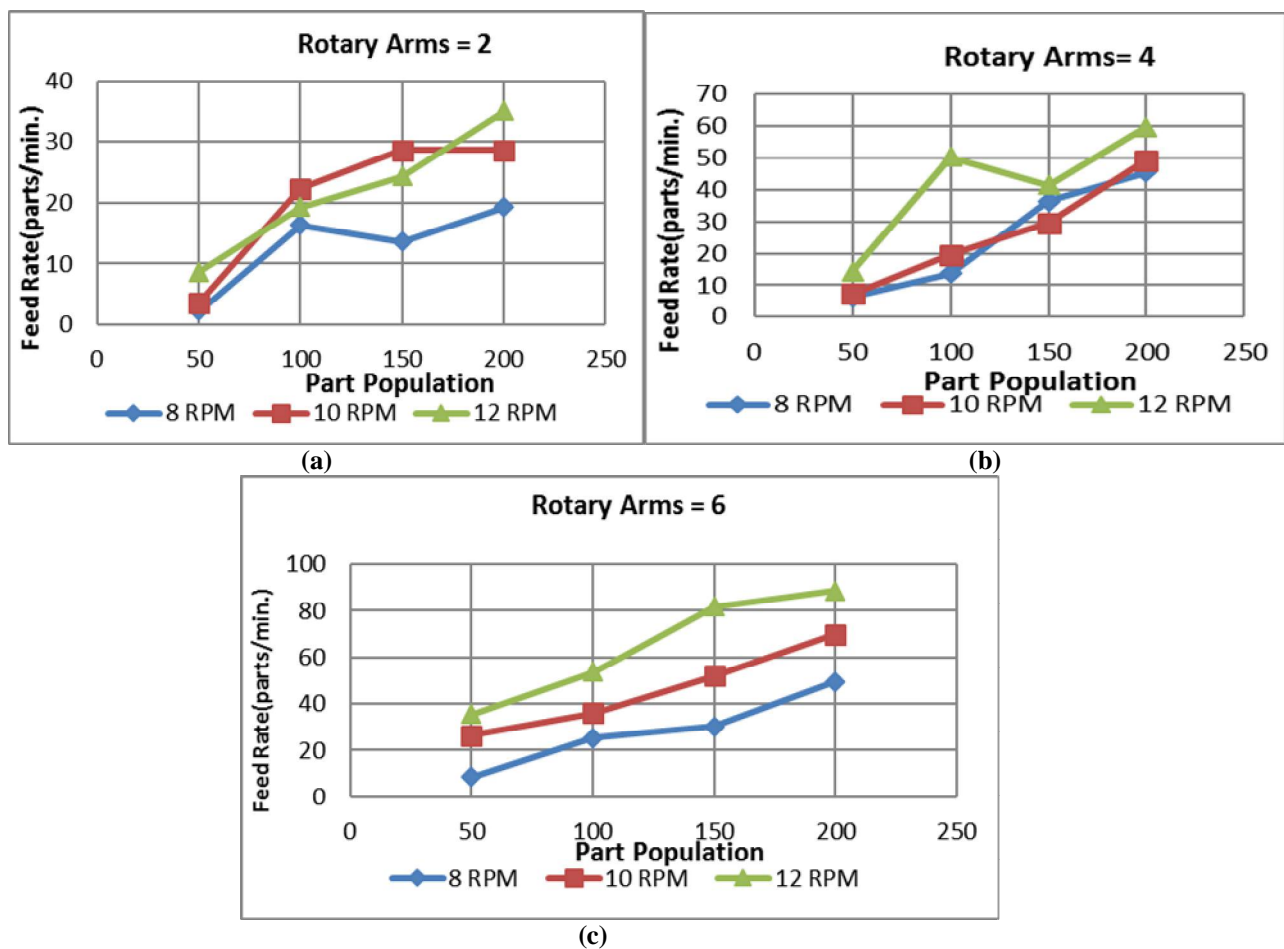


Fig.2 Feed Rate vs Part Population with (a) Least no. of rotary arms, (b) Nominal No. of Rotary Arms, (c) Max No. of Rotary Arms

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Part Size=18mm

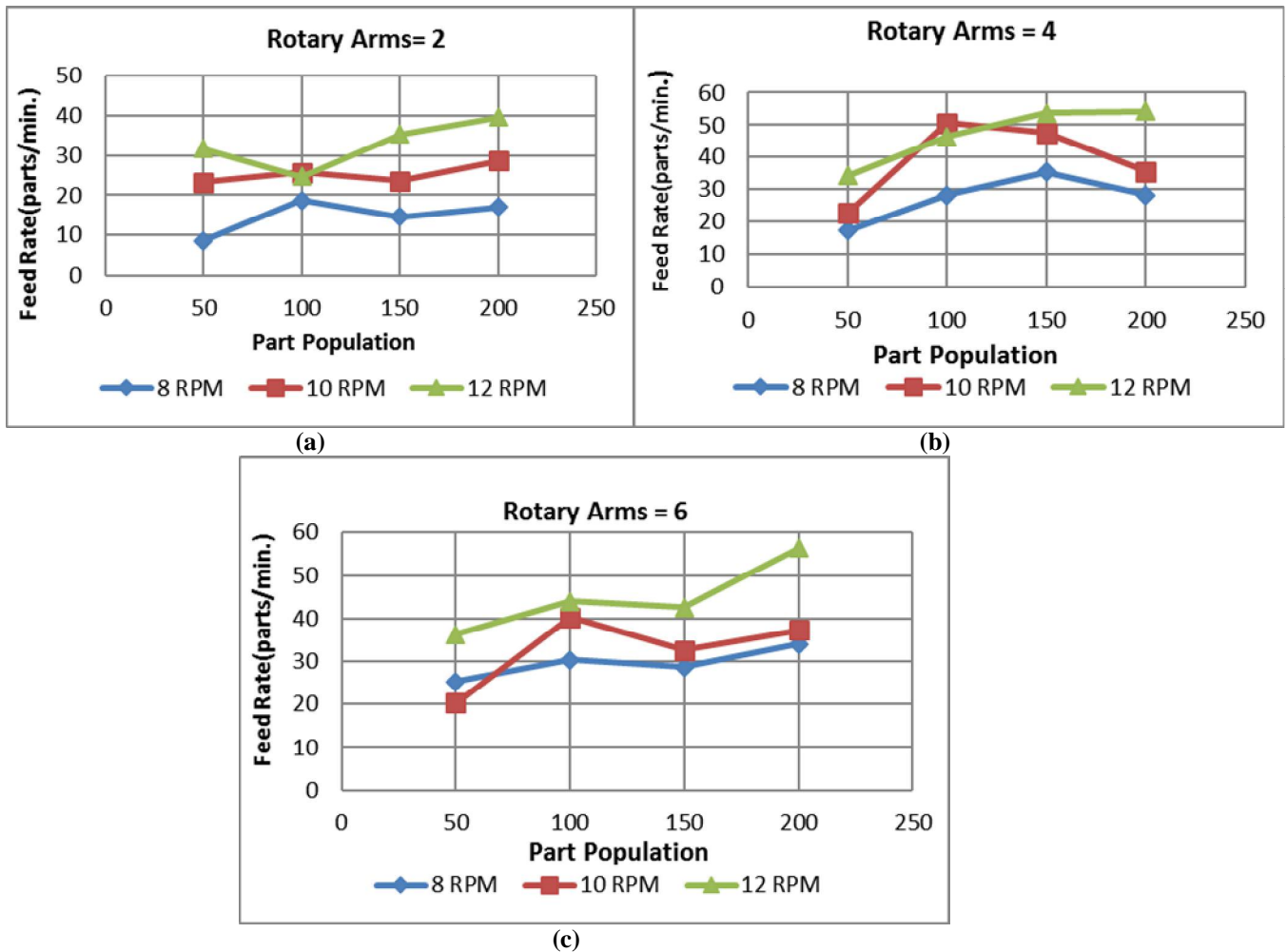


Fig.3 Feed Rate vs Part Population with (a) Least no. of rotary arms, (b) Nominal No. of Rotary Arms, (c) Max No. of Rotary Arms

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- Part Size=22mm

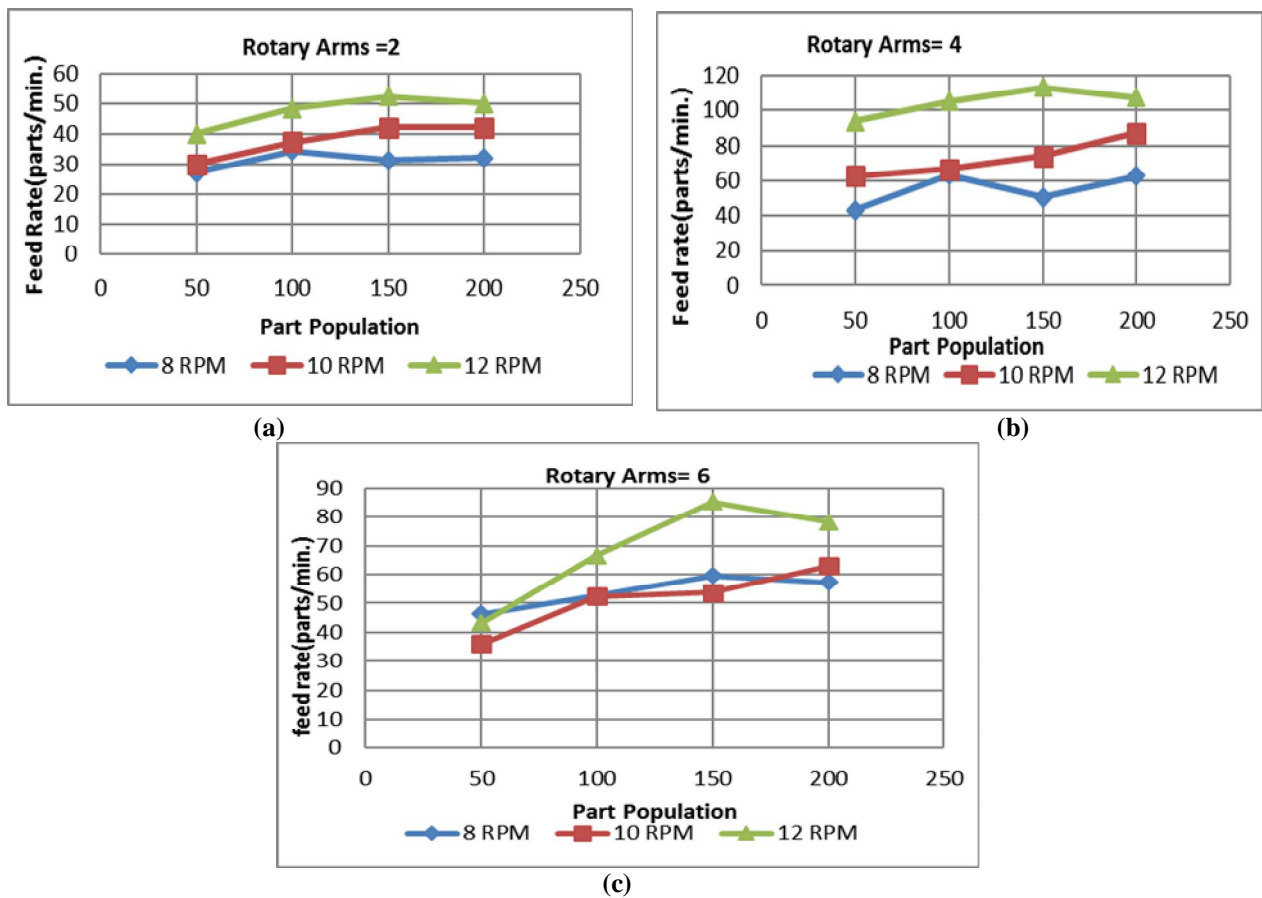


Fig.4 Feed Rate vs Part Population with (a) Least no. of rotary arms, (b) Nominal No. of Rotary Arms, (c) Max No. of Rotary Arms

IV. ANALYSIS

The result inferred from the above shown graphs can be summarized as: -

1. Effect of Part Population on Feed Rate

From the graph shown in Fig.2-4, for any particular part size, the parts fed per minute increases initially starting from the lowermost point i.e. 50 and then it starts increasing at a non-uniform rate. The inferred characteristic can be attributed to the fact that initially as we increase the load, the rotary arms lift more number of components, as much as they are capable of, but then the feed rate generally saturates and settles down to a value nearer to the previous value i.e. comparing the trend at part population 150 and 200.

2. Effect of Part Size on Feed Rate

From the graph shown in Fig.2-4, for a constant part population in the hopper being maintained, we infer that with increases part size, the feed rate increases, which is due to the fact that, as part size increases, the probability of the part getting picked up by the pickup point at the end of rotary arm increases.

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3. Effect of Motor Speed on Feed Rate

Again from **Fig. 2-4**, we can even infer that with increasing motor speed, the feed rate increases linearly, as the frequency of the rotary arms through the hopper increases, so does the feed rate increases, which is also up to the given rating of the driving motor.

V. CONCLUSION

An effort has been made to present an overview to an rotary gravimetric feeder in order to optimize its use in industry requiring small sized industrial components at given rate and orientation to encourage quality and uniform production rate. Results from the above graphs show that the designed system functions optimally at motor speed of 12 RPM with part population of 150 of corresponding size of 22mm and no of rotary arms equal to 4, giving a feed rate of 114parts/min. However, the future work is required to show the simulation of results on actual feeders.

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