Int. J. Chem. Sci.: 14(S2), 2016, 694-702
ISSN 0972-768X
www.sadgurupublications.com

DYNAMIC SIMULATION OF AUTOMATIC PART FEEDERS FOR HANDLING IRREGULAR PART

M. SURESH* and G. K. ARUL NAVALAN

Department of Mechanical Engineering, Sri Krishna College of Engineering and Technology, COIMBATORE (T.N.) INDIA

ABSTRACT

Various forms of the products manufactured which could either be symmetric or asymmetric, the stacking of the asymmetric parts are either done manually which is a time-consuming job or by installing robots which are costly. To overcome this problem, part feeders are introduced to stack the parts in a specific orientation. A Rocker arm, an asymmetric (irregular) component having more number of stable poses, has been considered for this research. The objective of this work is to achieve the desired orientation with the existing trap system. The parameters which are concentrated while orienting the parts are part geometry, part weight and angle of the trap inclination for effective part motion in the trap. In order to get accurate results the analysis are carried out with software simulation. The vibration analysis was carried out using dynamic simulation software. The comparison shows an appreciable relationship to each other. The obtained values help to improve the performance of the part feeding system and to improve the productivity of the component.

Keywords: Part feeders, Trap system.

INTRODUCTION

Automation is generally employed in the field of material handling and orienting in a manufacturing environment. An accepted definition of materials handling is the art and science of moving, positioning, packing and storing substances in any form. The material handling device are normally designed around standard production machinery and integrated with specially made feeders. Such feeders replace human effort by supplying the material to be worked at the work station. Linear Part Feeding System was used to handle the irregular parts without expensive robots and vision systems during the part assembly process. The part feeders receive the randomly oriented parts at its input and deliver them in a specified orientation. A vibratory feeder is an instrument that uses vibration to feed the part to a

*Author for correspondence; E-mail: rajasekaran.t@ktr.srmuniv.ac.in

process or machine. The vibration ensures that the parts keep moving towards the exit of the feeder without congested. The art of feeder design is a trial and error process with respect to the tangible nature of the part for which the feeding system has to be developed. The parts which are regular in shape yields more flexibility to feed and to assemble them. Being an irregular part, rocker arm having more than a stable form. It possess the function of feeding in a specified orientation, complex. Asymmetric components in the form of circular/cylindrical sectors are few areas unchartered. In the present work, brake pad, a typical irregular component has been considered and a feeding system is developed to feed and orient them. With our manufacturing sectors requiring large volume of such a product, automation based processes become essential. In the field of research, automation is not new and there has been substantial amount of literature published in this area. However, the published work is mostly limited to cylindrical and regular prismatic components. Hence, a specialized feeding system has to be designed.

EXPERIMENTAL

Literature survey

Jan Busch et al.[1] described the aerodynamic feeding technology developed at the IFA allows feeding rates up to 800 parts per minute while maintaining high reliability and variant flexibility. Suresh et al.[2] described the natural resting orientation of a brake pad through drop test is also compared with the likely orientations identified through theoretical methods like energy barrier method, centroid solid angle method, stability method and critical solid angle method. Author found that the orientation obtained through drop test matches with the results of three theoretical methods. Mucchi et al.[3] presented the elastodynamic modeling of vibratory bowl feeders and its experimental verification. Ashrafizadeh et al.[4] described a 2D numerical model based on discrete element method has been developed to perform a more accurate investigation on the dynamic behavior of a feeding part. Vose et al.[5] derived a linear model for the class of parallel mechanisms consisting of a rigid plate coupled to linear actuators through flexures. Using this model, we discuss manipulator design geared toward either universal parts feeding or single task automation. Baksys et al.[6] described vibrational impact motion of a mobile-based body on an inclined plane, which is a characteristic for vibrational alignment of components subjected to an automated assembly. UdhayaKumar et al.[7] specified low cost part feeder system uses sensorless mechanical devices or barriers such as slot, wiper blade, balcony, edge riser etc. to eliminate or reorient the arbitrary orientation into a preferred orientation which facilitates stacking. Reinhart et al.[8] described a method to ensure an optimal operating performance of the new feeder at single or double line frequency. Hereby, the modular system’s natural frequencies are adjusted adequately during the development phase by adapting the masses and inertias of the relevant components. Fantoni et al.[9] a brush feeding system based on tilted brushes is presented. Ramalingam et al.[10] deals with investigation of the behavior of a linear vibratory feeder, used for conveying small parts. A rotating drum with radial fins is designed and developed for carrying out experimental investigations. A tumbling barrel hopper is used for feeding the components onto the track. Special baffles are used for positioning the parts on the track. A linear vibrator is used for conveying the parts through the feed track. This track can be changed depending on the geometry of the components being conveyed.

Geometrical configuration

Trap

The function of the trap is to eliminate or reorient the part until they reach the final preferred orientation using various combinations of gates (diverting pin, guiding block, orienting pin etc). The model of a trap developed in this work consists of diverting pin, wiper blade and orienting pin to convert the possible orientation to the preferred orientation and also it consists of guiding block which guides the part which travels with the preferred orientation.

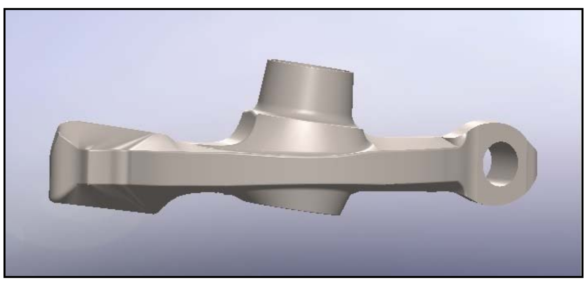


Fig. 1: Rocker arm orientation 1

In the analysis, it is assumed that the motion of a body of mass (m) is independent of it shape. Air resistance is negligible and there is no motion of the body in the Z-direction. Further, it is assumed that the body does not bounce upon impact (zero coefficient of restitution) and that there is no tendency for the part to roll down the plate. Figure 3 shows a model where forces act on the body while it is moving on an inclined plane. Trap angle for small amplitudes, the part will remain stationary on the plate as the parallel inertia force acting on it is too small to overcome the frictional resistance force (F) between the part and the plate. It must also be noted that the part moves during vibration due to the frictional effect. Fig 4 shows the layout of the trap considered for simulation.

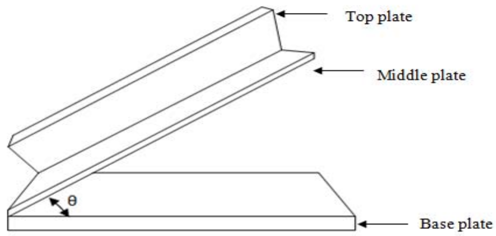


Fig. 3: Trap layout

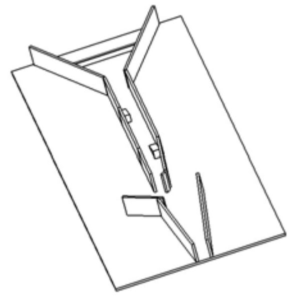


Fig. 4: Trap

Motion analysis

Dynamic simulation finds wide variety of applications in various fields. It is well known for its performance with complex designs, optimal cycle time, smoother sequence initialization and optimized process production. With all the advantages of dynamic simulation, it is sometimes surprising to discover resistance to its use. This resistance is understandable, however, when we examine the background and nature of many of the existing dynamic simulation tools. Due to the unique combination of computer programming, numerical integration, modeling, and sophisticated chemical and thermodynamics skills required, dynamic simulation has remained largely in the hands of "experts" over the years. Additionally, because of the extremely large number of calculations that dynamic simulations require, these simulations have been reserved for very large and powerful main-frame or mini-computers.

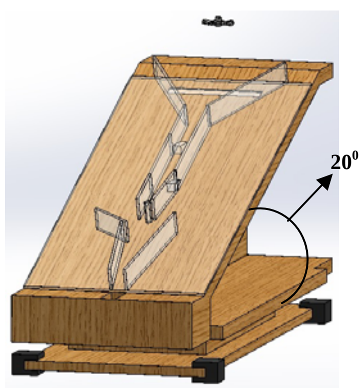


Fig. 5: Trap fixture for simulation

Simulation – Motion analysis

The Fig. 5 shows that the height from which is being dropped during simulation and this height varies for each part according to the potential energy of the part. The energy that tends to alter the position of the part while it is falling from a certain height place a major role in changing its orientation. Here the trap has been designed to give the desired orientation for any orientation input. Fig. 5 shows the trap fixture that is used for the simulation analysis. The angle of trap is 20^0.

The Fig. 6 shows the simulation graphs generated for each frequency levels with all orientations and from these results the required part motion time is being calculated.

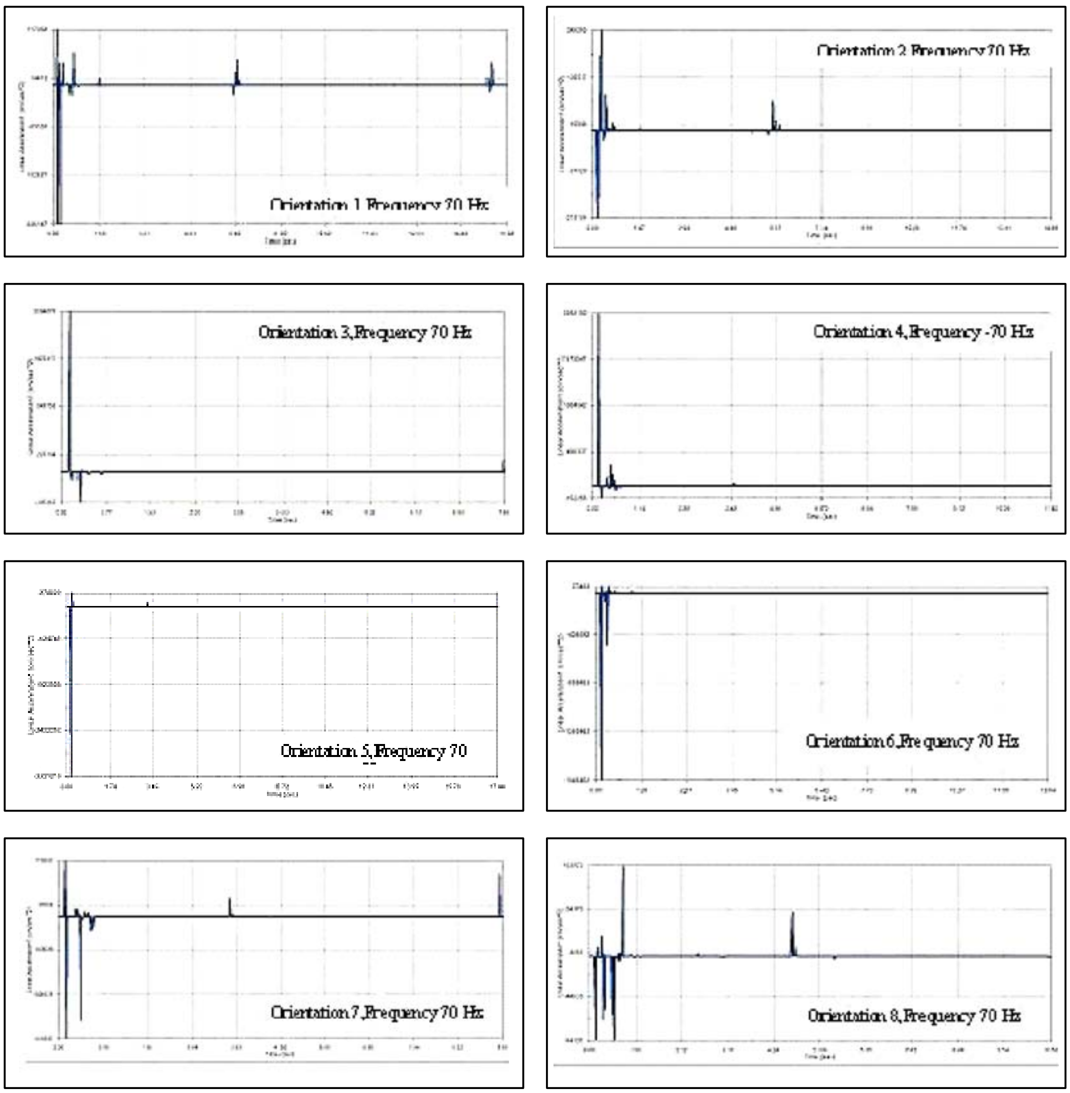
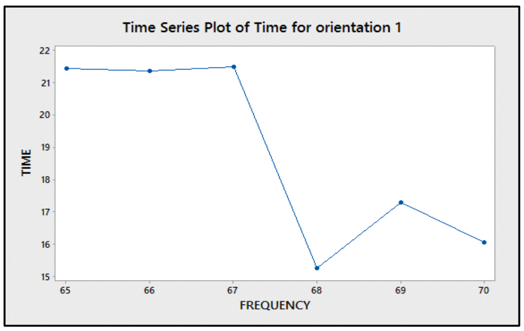


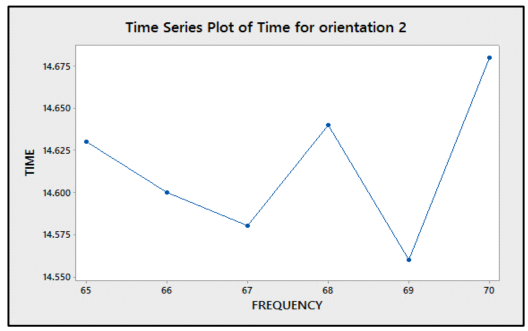
Fig. 6: Acceleration vs time for orientations at frequency 70 Hz

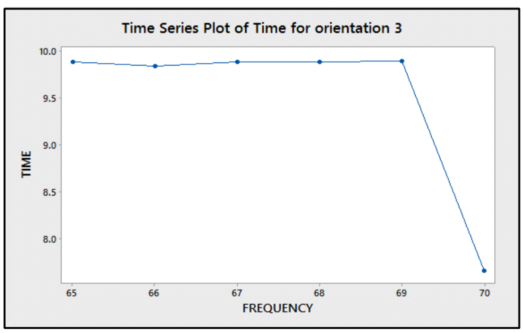
Simulaton analysis

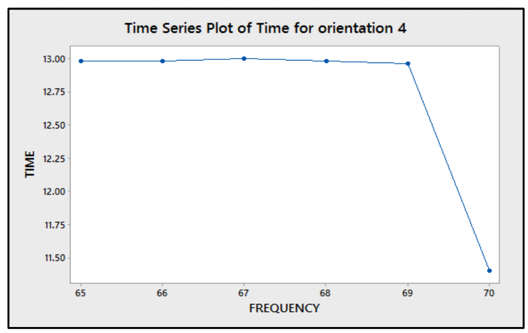
From the graphs it is evident that the frequency 70 Hz gives fastest part motion time than the other frequency levels.

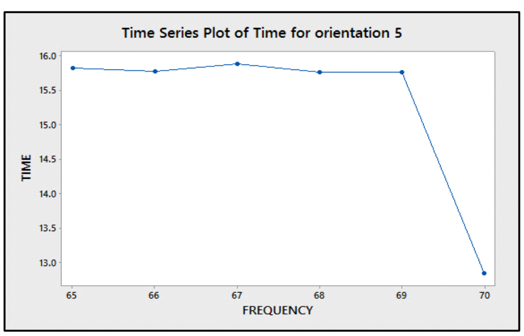
Here most of the orientation gives fast part motion time in 70 Hz. Hence from the simulation results of linear vibrational frequencies of 65 hz, 66 hz, 67 hz, 68 hz, 69 hz and 70 hz with trap angle 20^0, it is found that the part motion time is less than 19.36 seconds and the desired orientation is obtained at output.

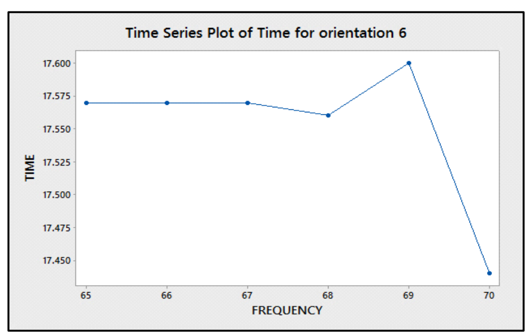












Cont…

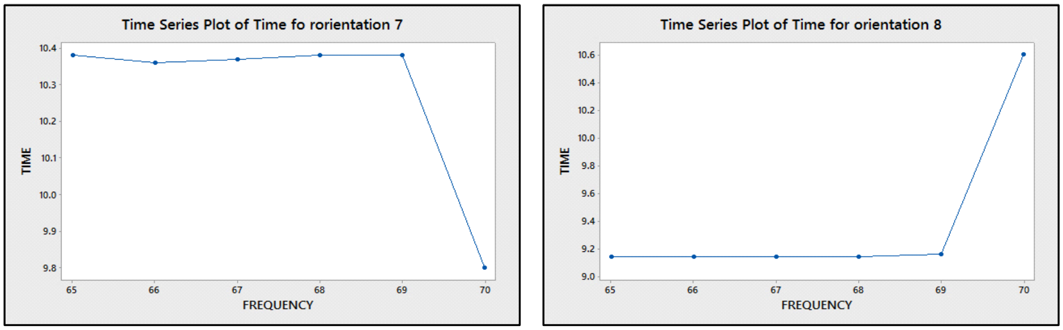


Fig. 6: Time vs frequency for orientation (1-8)

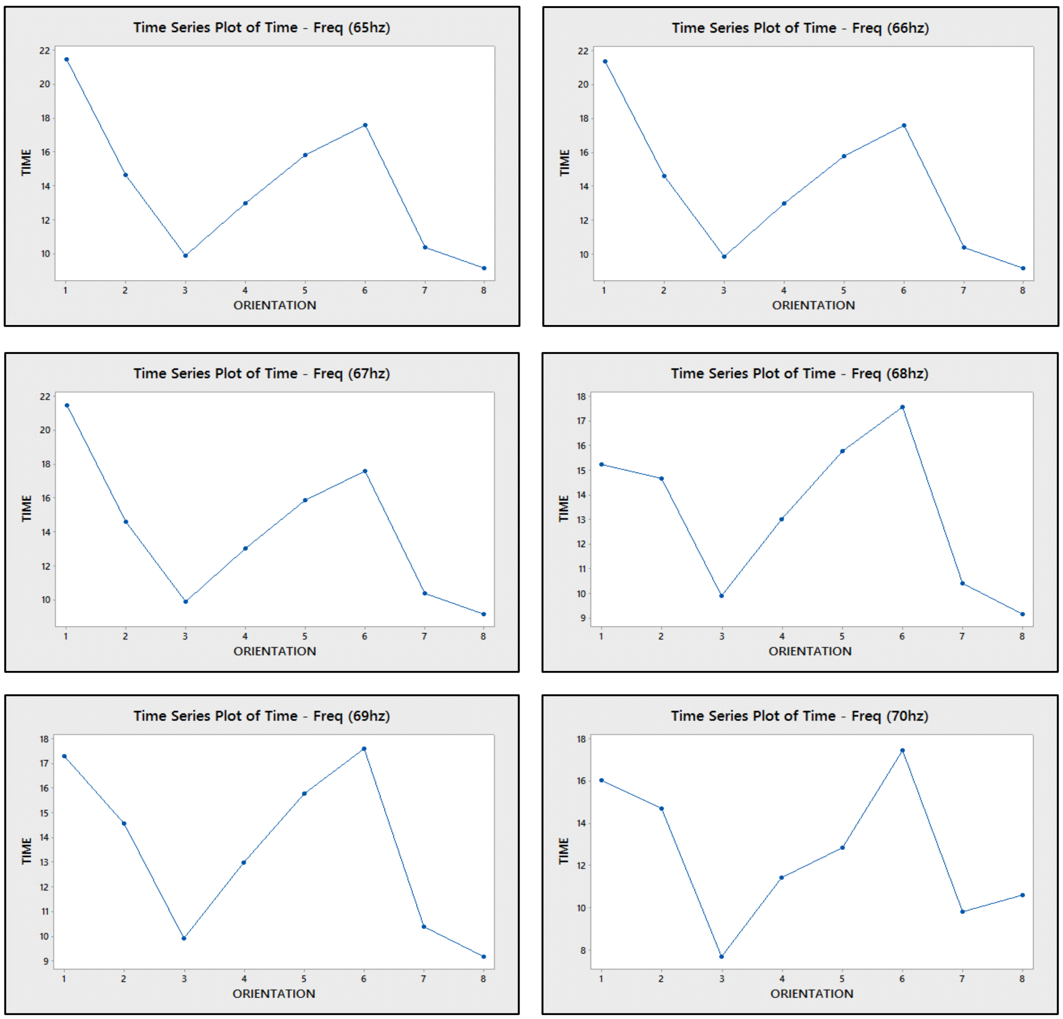


Fig. 7: Time vs orientation for frequency (65 Hz-70 Hz)

From the Fig. 7 it is clear that in most of the graphs orientation 3 has fastest part motion time. While other orientation except 8 has less part motion time.

CONCLUSION

Motion analysis

The rocker arm at trap angle 20^0 gives the better and perfect part motion time and the trap angle 20^0 is considered as the perfect angle for less part motion time. The orientation 1 in all trap angle gives the less part motion time.

ACKNOWLEDGMENT

I would like to thank Dr. P. Ashoka Varthanan Head of the Department of mechanical engineering department, The Sri Krishna College of Engineering, Coimbatore for his valuable support to develop this project.

REFERENCES

1. Jan Busch, Melissa Quirico, Lukas Richter, Matthias Schmidt and Annika Raatz, A Genetic Algorithm for a Self-Learning Parameterization of an Aero Dynamic Part Feeding System for High-Speed Assembly, **32**, 5-8 (2015).
2. M. Suresh, K. A. Jagadeesh and P. Ashoka Varthanan, Determining the Natural Resting Orientation of a Part Using Drop Test and Theoretical Methods, J. Manufacturing Systems, **32**, 220-227 (2013).
3. Emiliano Mucchi, Raffaele Di Gregorio and Giorgio Dalpiaz, Elastodynamic Analysis of Vibratory Bowl Feeders Modeling and Experimental Validation, J. Manufacturing Systems, **32**, 60-72 (2013).
4. H. Ashrafizadeh and S. Ziaei-Rad, A Numerical 2D Simulation of Part Motion in Vibratory Bowl Feeders by Discrete Element Method, J. Sound and Vibration - 12 March, 3303-3314 (2013).
5. Thomas H. Vose, Matthew H. Turpin, Philip M. Dames and Paul Umbanhowar, Modeling, Design, and Control of 6-DoF Flexure-Based Parallel Mechanisms for Vibratory Manipulation, Mechanism and Machine Theory, 111-130 (2013).
6. Bronius Baksysa and Nomeda Puodziuniene, Modeling of Vibrational Impact Motion of Mobile–Based Body, Int. J. Non-Linear Mechanics, **42**, 1092-1101 (2007).

7. S. Udhayakumar, P. V. Mohanram and G. Ranganathan, Manufacturing Automation for Handling Asymmetric Components, In Proc. ACTA (1997).

8. Gunther Reinhart and Michael Loy, Design of a Modular Feeder for Optimal Operating Performance, CIRP J. Manufacturing Sci. Technol., **3**, 191-195 (2010).

9. G. Fantoni and M. Santochi, Development and Testing of a Brush Feeder, CIRP Annals - Manufacturing Technol., **59**, 17-20 (2010).

10. M. Ramalingam and G. L. Samuel, Investigation on the Conveying Velocity of a Linear Vibratory Feeder While Handling Bulk-Sized Small Parts, Int. J. Adv. Manuf. Technol., **44**, 372-382 (2009).

Accepted : 01.07.2016