Mechanical and Power Research

Edited by
P. Manju, M. Suresh, R. Ramamoorthi and S. Narendiran

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Mechanical and Power Research

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PREFACE

Innovation is an inevitable factor in the growth of any nation. Innovation is possible only through sustained research. Exchange of knowledge and innovative ideas plays a key role in promoting research in the field of engineering and technology.

In this era of technological advancements every research aims to meet the increasing human needs. The conference aims to provide a platform for researchers, scientists, industrial professionals and students to exchange and share their research accomplishments and innovations on the contemporary and emerging trends in electrical and electronics engineering. The conference aims to explore the interface between the industry and real time environment with state-of-the-art techniques. The conference focuses to bring to limelight, the recent researches being carried out in the various fields of Electrical & Electronics Engineering. The conference targets to bring to table the futuristic technologies around the globe in meeting out these needs. The meeting of technocrats will bring to front various remedies and solutions to overcome the technical deficiencies in the various engineering problems.

The first "International Conference on Emerging Trends in Powering the Nation (ICETPN '14)" is a forum for scientists, professionals, researchers and engineers to present state of art innovations, scientific results and advancements in the field engineering.

In total we received 160 papers from various academic institutions and research organisation. After review by a team of experts, 50 papers were selected for oral presentation in ICETPN '14. The papers presented in the conference are the outcome of innovative researches carried out in various institutions, industries and research organisations.

We are extremely thankful to the Managing Trustee, Sri Krishna Institutions for all the help and encouragement extended for the success of ICETPN '14. We whole heartedly acknowledge the expert advice and support offered by Dr S Subramanyan, Advisor, Sri Krishna Institutions. We sincerely extend our heartfelt thanks to Dr S Annadurai, Principal, Sri Krishna College of Engineering & Technology for being a constant source of inspiration during the conference preparations.

We thank the National & International Advisory Committee members for their suggestions & guidance. We extend our heartfelt thanks to the sponsor of our conference, IEEE Madras Section. Our thanks to all other co-sponsors and advertisers of ICETPN '14.

We thank all the faculty co-ordinators, student volunteers and non-teaching staff of our department for their hard work and dedication in making ICETPN '14 a grand success.

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A DROP TEST FOR FINDING THE MOST PROBABLE RESTING ORIENTATION OF A PART

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Keywords: Brake pad, Drop test, Orientations and part feeders.

Abstract

The material handling is the art of moving, orienting, packing and storing the part. Industrial feeders are used to facilitate the operations by feeding the parts in a specific quantity and at a perfect orientation. It is a tedious task to obtain a particular part orientation, at the assembly station, in a short lead time. To overcome this problem, part feeders are used to segregate and orient parts prior to packing. The natural resting orientation of the part is the orientation in which the part rests on a horizontal hard surface, when dropped from a height. The most probable natural resting orientation of the part has to be identified which helps in the effective design of feeder and orienting devices. In this paper, an attempt was made to study the effect of initial orientation from different heights on natural resting orientation. Drop test was conducted at different heights with each initial orientation. The favorable orientation of the part (or) the most probable natural resting orientation is identified using drop test. In this work, most probable natural resting orientation of a typical asymmetric component, brake pad, is identified.

Introduction

Today's robots and automated assembly equipment have the precision and speed to make agile manufacturing possible. Assembling the components quickly is important for implementing agility in the industry. The part feeding system is the key for quick assembly. In intelligent automation systems, flexible parts feeder could eliminate that system handicap. Before implementing the part feeding system in the company, the most probable resting orientation should be determined. The feeder uses dual programmable parts orienting or singulate parts on the conveyor and low cost. Automation is mainly used for part handling and obtaining the desired orientation in a manufacturing environment. Part feeders are used to change the possible orientation into favorable orientation [1]. Based on the part shape and orientation, the part feeding system is developed to feed, orient and store them. In this paper, an attempt is made to study the effect of initial orientation from different heights on natural resting orientation.

Related Work

An attempt was made by Suresh et al [2] to find the most probable natural resting orientation of a brake pad using different methods. When a brake pad falls freely on a surface, it tends to rest in three distinct orientations. Udhayakumar et al [3] used part feeders to facilitate the industrial operations by feeding the parts in a specific rate and at a desired orientation. An attempt was made to study the effect of initial orientation (while dropping) from different heights on natural resting orientation. A sector shaped component was considered for experiments. Drop tests were conducted at different heights with different initial orientations to determine the probability of natural resting orientations of sector shaped component. Despite the initial orientation and height of drop, the most probable resting orientation was found. Udhayakumar et al [4] have already studied the effect of material and size of sector shaped components on final resting orientation and concluded that the most probable natural resting orientation does not change with the above two parameters.

Berkowitz and John Canny [5] considered the problem of designing traditional feeders for singulating and orienting industrial parts. The ultimate goal is to prototype new designs using analytic and geometric methods. They developed a tool for designing industrial parts feeders based on dynamic simulation. Ngoi et al [6] predicted the natural resting behavior of a square prism and a rectangular prism on a hard surface. The method presented here is the centroid angle concept, which assumes that the probability of any surface of a part on which it comes to rest is directly proportional to the difference between the centroid solid angle (CSA) of that aspect and the average of the critical solid angles of the neighboring aspects, and inversely proportional to the height of the centre of gravity of that aspect. The results showed that the predicted data agreed well with both the experimental data obtained. This is the first successful attempt that an analysis of the natural behavior of a part on a hard surface is done (without resorting to empirical factors). Using the CSA, the natural resting aspects of small engineering parts were verified. Ngoi et al. [7] also verified the existing hypotheses, which predicted the natural resting aspects of small engineering parts on soft and hard surfaces. Most of the existing hypotheses developed were verified using the "drop test" method in which parts were repeatedly dropped from a certain height onto a surface in order to analyze the natural resting behavior of parts.

Brake Pad considered for experiments

A brake pad which is asymmetric component has been considered in this work. They pose a challenge for orientation as they have more than one stable configuration. Most of the earlier researchers focused on cylindrical and regular prismatic components. This motivated the authors to find the most probable resting orientation of brake pad an asymmetric component. Initially the backing plate of the brake pad is stamped. After the stamping process, the surface of backing plate is roughened to increase adhesion to avoid material breaking away from the backing plate. Then adhesive is applied to the backing plate and the plate is prepared to bond with the friction materials. Raw materials are formulated for highest quality for better performance and long life. Materials are blended to obtain the best formulations so that the performance of the brake pad is improved. Then the unique formulations are moulded under extreme temperatures and pressure into the shape of the bricks. After the molding process, the friction materials are bonded to the backing plate under immense heat and pressure. Then the pads are heated again in the heating processor for 8 to 10 hours to attain everlasting attachment. Painting embellishes the appearance of the brake pads and protects them from rust and corrosion.

After the molding process, the brake pads are oriented and stored manually, which consumes more labour time. So a part feeding system is introduced in-between the molding and bonding process. Because of the part feeding system, productivity can be increased by reducing the labour time.

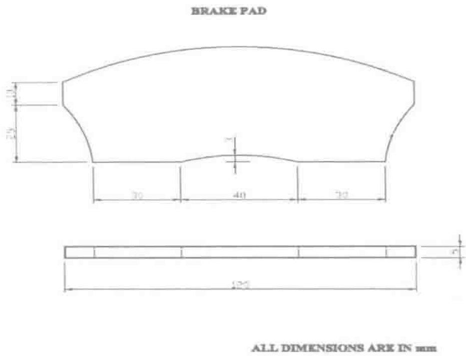

Fig 1. Brake Pad

The brake pad chosen for experiment is asymmetric in nature. The brake pad with detail dimension is shown in figure 1.

Drop Test

For knowing the possible resting orientation, the preliminary experiments were conducted by dropping brake pad randomly. The possible resting orientations for the brake pad when it falls freely from a height are shown in figure 2. These eight possible resting orientations are used for drop test.

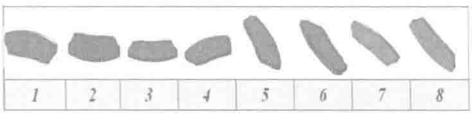

Fig 2. Possible orientation of Brake pad

Every component will have many orientations. A drop test is used for finding the possible orientations and most probable resting orientation or favorable orientation [8]. This drop test methodology is shown in figure 3. Figure 4 shows the experimental setup which is used for conducting drop test. In this setup, linear scale is used for measuring the height when drop a part. Hopper is used to hold the part when it comes to rest. Hopper is considered a hard surface because it is made up of steel tray.

Samples of n parts (say 40) are chosen for drop test. All the parts have same dimension, shape and weight. These parts are dropped one at a time from a particular height into a hopper setup. For this height measurement, only linear scale is used. The dropping height, drop orientation and resting orientations are noted.

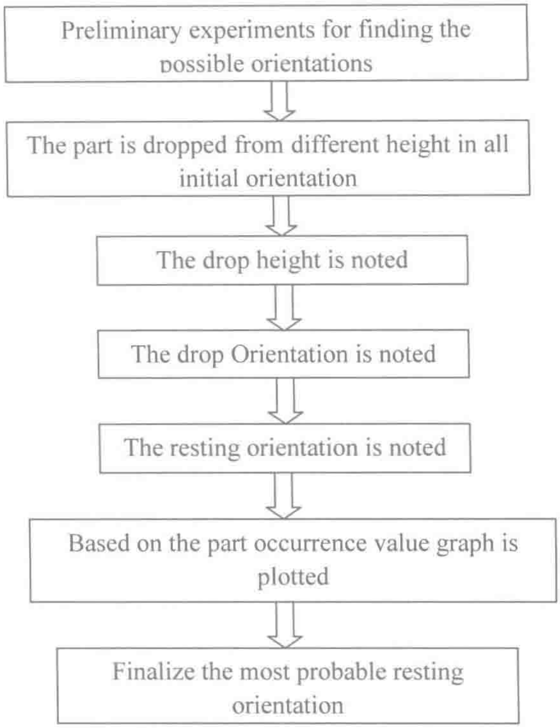

Fig 3. Methodology

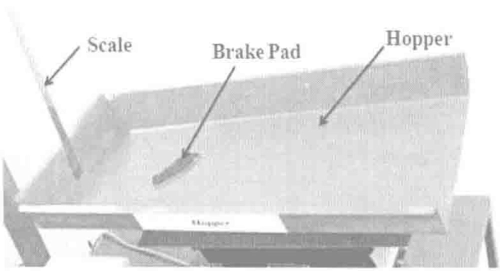

Fig 4 Experimental Set-up

Parts are dropped from 10mm, 20mm, 30mm, 40mm, 50mm upto 500mm. For each height, all possible orientations are dropped and resting orientations are noted. The orientation which occurs most frequently is considered the most probable resting orientation or favorable orientation of a part. The outcome of this drop test is discussed detail in section 5.0.

The cumulative occurrence frequency of different orientations, when dropped from 10mm, 20mm and 500mm heights alone are shown in tables 1 – 3 respectively. But experiments were carried out by dropping the brake pad from heights 10mm, 20mm,30mm, 40mm, 50mm upto 500mm. Outcome of the resting orientations are recorded. Finally, cumulative values of all resting orientations are calculated. The same steps are repeated for all dropping height.

Table 1 Data table for 10mm height

Dropping Height	Dropping Orientation	No. of Brake pads	Resting Orientations								
			1	2	3	4	5	6	7	8	
10mm	1	5	4	0	0	1	0	0	0	0`	Frequency of occurrence (O)
	2	5	0	4	1	0	0	0	0	0	
	3	5	0	0	5	0	0	0	0	0	
	4	5	0	0	0	5	0	0	0	0	
	5	5	0	0	0	0	5	0	0	0	
	6	5	0	0	0	0	0	5	0	0	
	7	5	0	0	0	0	0	0	5	0	
	8	5	0	0	0	0	0	0	0	5	
Cumulative Value (C)			4	4	6	6	5	5	5	5	

Table 2 Data table for 20mm height

Dropping Height	Dropping Orientation	No. of Brake pads	Resting Orientations								
			1	2	3	4	5	6	7	8	
20mm	1	5	3	0	1	1	0	0	0	0	Frequency of occurrence (O)
	2	5	0	3	1	1	0	0	0	0	
	3	5	0	0	5	0	0	0	0	0	
	4	5	0	0	0	5	0	0	0	0	
	5	5	0	0	0	0	5	0	0	0	
	6	5	0	0	0	0	0	5	0	0	
	7	5	0	0	0	0	0	0	5	0	
	8	5	0	0	0	0	0	0	0	5	
Cumulative Value (C)			3	3	7	7	5	5	5	5	

Table 3 Data table for 500mm height

Dropping Height	Dropping Orientation	No. of Brake pads	Resting Orientations								
			1	2	3	4	5	6	7	8	
500mm	1	5	0	0	0	0	4	1	0	0	Frequency of occurrence (O)
	2	5	0	0	0	0	4	1	0	0	
	3	5	0	0	0	0	4	1	0	0	
	4	5	0	0	0	0	2	3	0	0	
	5	5	0	0	0	0	3	2	0	0	
	6	5	0	0	0	0	4	1	0	0	
	7	5	0	0	0	0	3	2	0	0	
	8	5	0	0	0	0	4	1	0	0	
Cumulative Value (C)			0	0	0	0	28	12	0	0	

Results and Discussion

In order to find the possible resting orientation of brake pad, drop test methodology is used and it is discussed in detail section 4. The outcome of the drop test is explained in detail in this section.

Table 4 shows that the cumulative values of each drop height. In this table 'H' indicates drop height. The cumulative value of each drop height is arrived from corresponding data tables of each drop height. This frequency of occurrence of cumulative value is used to plot the graph. By using equation (1) the cumulative values are found.

$$\mathbf{C = \Sigma O_i} \quad (1)$$

Where,
C – Cumulative value
O – Frequency of Occurrence
i - Orientation

Figure 5 shows that the frequency of occurrence of part orientation at 10mm height to 100mm height. In this graph, X axis indicates orientation of part and Y axis indicates number of brake pads. In figure 5 10mm, 20mm, 30mm and 40mm drop heights have no potential energy to change the orientation and 50mm, 60mm, 70mm, 80mm, 90mm and 100mm drop heights have very low potential energy to change the orientation. But 110mm, 120mm, 130mm, 140mm, 150mm, 160mm,