ABSTRACT

In the global manufacturing environment, automation plays a major role in the field of material handling and assembly line. The art and science of positioning, moving, packing and storing components in any form is material handling in industries. The material handling devices are specially designed for a particular task and integrated with part feeders to decrease the lead time in industries. Production industries handle large volume of components and hence there is a need to introduce automation techniques. In order to implement automation in assembly line, a part feeding system is essential for handling the parts and the linear vibratory part feeder is designed and developed in this research work.

Part feeders in assembly automation are widely used to handle various shaped parts since they transform any orientation of part into desirable orientation. This reduces the cost and time of part handling in industries which increases the productivity and profit. Part feeding system consists of a series of gates or barriers to change the orientation of part from its initial orientation to desirable orientation. Linear vibratory part feeders and vibratory bowl feeders are commonly used in industries.

In this present work, an irregular shaped component i.e. rocker arm is selected for study. It is widely used in automobile industries to open and close the valves in internal combustion engines. The handling of rocker arm in assembly process requires automation to reduce the lead time and improve the productivity. To implement the same, a linear vibratory part feeder is developed in this research work to handle the rocker arm.

Drop test is performed by considering the drop height from 10 mm to 500 mm with 10 mm incremental height. Eight possible resting orientations are observed during the trial experiment. The rocker arm is dropped from eight possible orientations, the natural resting orientation of rocker arm is observed and most favourable natural resting orientation of rocker arm is determined. Theoretical methods such as stability method and centroid solid angle method are used to determine the most favourable resting orientation by considering the geometry of rocker arm. The probability of various resting orientation of rocker arm is calculated using theoretical methods and verified with the experimental results using drop test. The most favourable orientation (i.e. orientation 3) of rocker arm is found by comparing the results of drop test and theoretical methods.

Markov model is used to design the hopper and trap for handling rocker arm in industries. The trap consists of two parts (trap 1 and trap 2) used to obtain the most favourable orientation of part from possible orientations of rocker arm. Trap 1 is used to obtain the desirable part orientation 3 and orientation 4 from any initial orientation of part. Trap 2 is used to obtain the part orientation 3 from part orientation 4. Acrylic plastic is used to fabricate the trap which is fitted with linear vibrator to study the performance of trap. Trial experiments are conducted to set the input levels of trap angle and frequency of vibration. Taguchi's based design is used to generate L18 Orthogonal array by considering the trap angle and frequency of vibration. The experiments are conducted by considering the trap angle (20° - 30°) and frequency of vibration (65 Hz - 70 Hz). Minimum part motion time of 6.96 s is observed for the trap angle 30° and frequency of vibration 70 Hz.

Dynamic simulation of part feeder is used to analyse the performance of trap. The effect of frequency of vibration and trap angle on

part motion time is investigated using solid works software. 65 Hz to 70 Hz of frequency of vibration and 20° to 30° trap angle are considered for this present work and the part motion time while handling rocker arm in trap is recorded. 69 Hz – 70 Hz of vibration frequency and 30° trap angle offered minimum part motion time for part orientation 3 when compared to other part orientations, frequency of vibration and trap angle.

The results of real time experiments and dynamic simulation performed using motion analysis clearly reveals that part motion time is lower for part orientation 3 when the trap angle of 30º and 70 Hz frequency of vibration is used in part feeder. Analysis of variance is performed to check the significance of process parameters on part motion time. It is found that trap angle (A), frequency of vibration (B) and square of trap angle (A^2) significantly influences the part motion time. Trap angle of 29.79º, vibration frequency of 70 Hz are found to be the optimum process parameters for the linear vibratory part feeder which offered lowest part motion time. The model developed using analysis of variance shows that (R^2 = 90.32%) the predicted values are closer to the actual response values. Regression equation is developed to predict the part motion time and it is solved using LINGO software. Minimum part motion time of 6.66 seconds is obtained for a trap angle of 29.85° and 70 Hz frequency of vibration. Contour plots are generated to study the effect of process parameters on part motion time. The results reveal that higher level of trap angle and vibration frequency offered minimum part motion time. Finally the optimum process parameters for obtaining minimum part motion time are found to be a trap angle 30° and frequency of vibration of 70 Hz. The developed linear vibratory part feeder improves the productivity, reduces the cost and saves part handing time in automotive industries.