Design & Fabrication of Tomato Sorting Machine

Mr. Nikhil O. Singh[1] Mr. Siddhesh A. Waman[2] Mr. Hitesh S. Yadav[3] Mr.Bikaschandra R. Yadav[4] Prof. Ashish Chaudhari[5]

[1,2,3,4,5]Vidyavardhini's College of Engineering and Technology

Abstract— This paper is intended to discuss the design of tomato sorting machine. Tomato Sorting Machine (TSM) is a machine used to effectively sort the tomatoes on Size based sorting. This machine can be used for the agricultural purpose and it can be also employed in the food industries. TSM will sort the tomatoes in three grades based on their size i.e. Small, Medium and Large. TSM works on belt and pulley arrangement. Tomatoes are fed through feeding tray into the machine.

Key words: Tomatoes, size based sorting, belts and frame

I. INTRODUCTION

A. Overview

Grading of agricultural produce especially the vegetables has become a perquisite of trading across borders. In India mostly vegetables growers grade the vegetables manually. Manual grading was carried out by trained operators who considered a number of grading factors and vegetables were separated according to their physical quality. Manually grading was costly and grading operation was affected due to shortage of labour in peak seasons. Human operations may be inconsistent, less efficient and time consuming.

New trends in marketing as specified by World Trade Organization (WTO) demand high quality graded products. Farmers are looking forward to having an appropriate agricultural produce-grading machine in order to alleviate the labour shortage, save time and improve graded product's quality. Grading of vegetables is a very important operation as it fetches high price to the grower and improves packaging, handling and brings an overall improvement in marketing system. The vegetables are generally graded on basis of size and graded vegetables are more welcome in export market. Grading could reduce handling losses during transportation. The similar problem is observed in sorting of tomatoes.

B. Objective

To design and fabricate semi-automated machine which will help the farmers in sorting out the tomatoes effectively. Proposed Tomato Sorting Machine will increase the rate of sorting. It will reduce labour cost as only one labour is required to feed the tomatoes in the machine. This eventually reduces the yielding cost of farmer which in turn increases his profit.

II. EXPERIMENTAL DETAILS

A. Component

1) Shaft

Shaft is a mechanical element used to transfer torque and can take transverse loading. Shaft is placed on the frame with the help of bearing. In proposed design, Pulleys are clamped on the shaft. Material of shaft is C-20, yield strength 260MPa.

2) Frame

The frame or body of the design is used to support the other components over it like the bearing, shaft, pulleys, collecting bin over it. All the reaction force in the operation is transferred to the frame at the end. The frame should be rigid enough to sustain these forces and should have good damping property to avoid vibration.

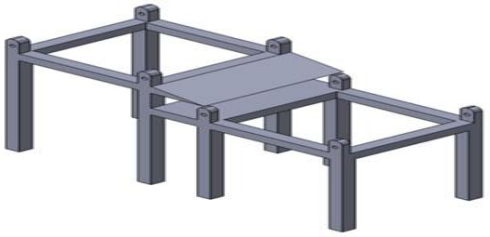

Fig. 1: Frame

3) Pulley

Pulley is the part which would be mounted on the shaft. It will provide the required linear velocity to the belt. Since there is no speed reduction between input shaft and output shaft the pulley diameter on these shafts would be same.

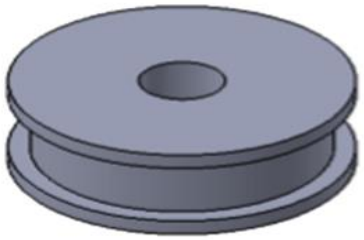

Fig. 2: Pulley

4) Belt

Belt is a mechanical element in the form of band which is used to transfer motion from one shaft to other. Here the belt is passed over two pulleys namely driver and driven pulley. In proposed design, belt is used to just transfer the motion from one pulley from other. Belt material used is PVC flat belt. There are such 16 belts in the design of thickness 3mm and width 20mm each.

5) Bearing

Bearing is a mechanical device used to provide relative motion with low friction and supports another part. In proposed design, bearing would be used for support the shaft on frame and would provide relative motion between frame and shaft and the bearing used is ball bearing. There would be such 8 bearings on frame in intend design. In bearing design, outer race is fixed and inner race is coupled with the shaft.

6) Collecting Bin And Feeding Tray

The other members in the design are collecting bin simply used to collect the sort tomatoes and the feeding tray with rubber pads are used to feed the tomato into the sorting arrangement.

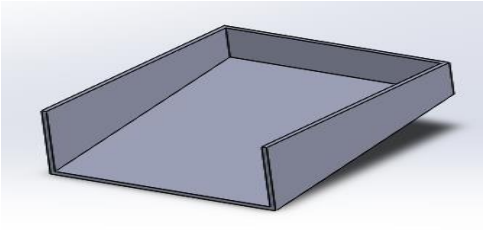

Fig. 3: Feeding tray

B. TSM Assembly

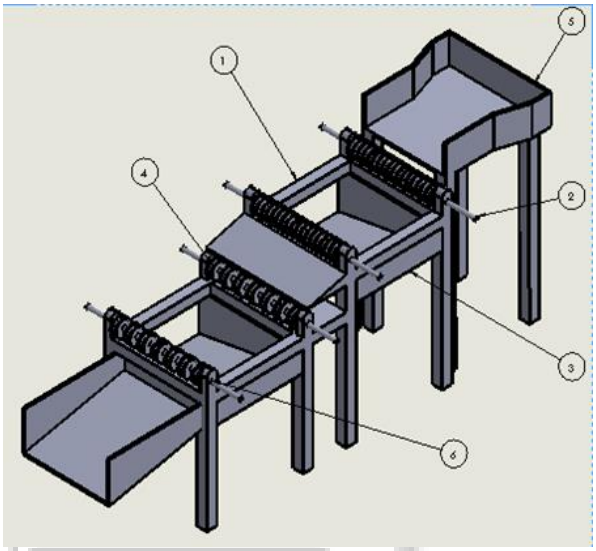

Fig. 3: Assembly of Tomato Sorting Machine

No	Description
1	Frame
2	Shaft
3	Collecting Bin
4	Pulley
5	Feeding tray
6	Deep Groove Ball Bearing 6304

Table 1.

Fig. 4: Final manufactured assembly

C. Sorting Test

The proposed TSM is check for sorting capacity and quality. One carat of tomato is put into the feeding tray and is being allowed to go through the rubber pads which are placed into the feeding tray to reduce the speed of incoming tomatoes. After passing through the rubber pad it falls on the first arrangement of belt, where the gap between the belts are 30mm. Tomatoes having diameter less than 30mm falls down into the collecting bin as small size tomatoes and rest tomatoes moves ahead on the second arrangement of belts where the gaps between the belts are 50mm and as the tomatoes are rolls over the belt if the size of tomato is less than 50mm it falls down in the collecting bin as medium size tomatoes and the rest bigger size tomatoes are collected at the end of machine through third collecting bin.

III. RESULTS

Feeding tray angle	% error in sorting	Sorting Rate (tonnes/hr)
2^o	5.26	1.8
6^o(Optimum angle)	5.98	2.7
10^o	9.03	3
15^o	24.28	3.8

Table 1. % error v/s sorting rate for different feeding tray angle

A. Cost Analysis

Assuming picking span of 2 month/year
Labour cost:- Rs. 300/day

Method	M/c cost (Rs.)	Labour cost (Rs.)	Electricity cost (Rs.)	Total cost (Rs.)
TSM	15000	12000 (for 1 labour)	2000	29000
Manual	0	90000-118000 (for 5-6 labours)	0	90000-118000

Table 2. Cost estimation

Sorting Rate Comparison:-
Manual = 0.45 tonnes/hour.
Machine = 2.7 tonnes/hour.

IV. CONCLUSION AND DISCUSSION

The proposed TSM is capable of sorting out the tomatoes into 3 grades successfully with accuracy of 94%.

From result table & graphs we conclude that the above sorting accuracy is obtained for 〖6〗^o of feeding tray angle.

As we went for higher angles (i.e. 〖10〗^o, 〖15〗^o) there is drastic increment in % error which reduces accuracy with merely increase in sorting rate.

Graph of % error v/s kg of tomatoes shows that it is advantageous to feed 10-15 kg of tomatoes at a time rather than 2-5 kg which gives lower accuracy.

The 6^oof feeding tray angle gives high rate of sorting i.e. 2.7 tonnes/hour.

Cost estimation shows that, there is considerable difference of Rs.61000-Rs.89000 between manual sorting and machine sorting.

Also the machine sorting rate is 2.7 tonnes/hour & manual sorting rate is 0.45 tonnes/hour.

Experimentation performed with potatoes shows that proposed machine is also capable of sorting other vegetables like chickoo , lemon , onion etc.

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