Design and Development of Low Cost Orange Sorter

Prof.P.T.Patokar[1] Kalyani A. Agnihotri[2] Mohammad Mobin R.Memon[3] Abhishek V. Gorakh[4] Sonali V. Chim[3]
[1]Assistant Professor
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]Shri Sant Gajanan Maharaj College of Engineering, Shegaon, India

Abstract— The present review provides brief information about various types of innovations done in orange grading equipment's. The basic objective of grading operation is to grade oranges into different sizes as per the requirement. The farm and food industries were using manual sorting to grades the fruits based on their sizes and colour quality but this method was time consuming, laborious and suffers from the problem of inconsistency and inaccuracy due to involvement of huge human worker. Now a days huge machine are too costly, because of this many small scale industries cannot afford them and also these machines require large space. Thus at present, sorting of the fruits become very difficult industrial process and issues of concern. The main objective of this project is to design a system for grading orange. To design such a system fruits weight, sizes and surface area need to be found. In this project we are using mechanical sorter to grade the oranges. By using this system we completely eliminate manual sorting work and reduce cost and also increases production rate.

Keywords: Design, Development, Low Cost, Orange Sorter

I. INTRODUCTION

Naturally orange occurs in various sizes, so there is a need to grade the orange on the basis of its size as per the company requirement. Now a days, most farms & food industries use manual experts for sorting of the fruits which is time consuming, laborious, and suffers from the problem of inconsistency and inaccuracy in judgment by different human experts. Maharashtra owns 2nd rank in the country for production of oranges, Yet, no any automated sorting machine is developed for this. In this project, we developed the orange grading machine which grades the oranges on the basis of size.

Previously the work was done manually but continuous sorting causes fatigue to the worker. Due to inaccuracy and less efficiency there is a need to develop a machine to sort oranges. Although the solutions are available, these solutions are not feasible for small scale industries. The production of orange is in the higher rate. So for quality sorting, this product sorter is a requirement as per the market survey. For sorting, there is a requirement of intelligent machine in agricultural sector to raise the quality and to lower the sorting costs and to reduce the manual labor. This innovation tends to decrease sampling time and costs of the task as well as increase its accuracy.

II. MECHANICAL DESIGN

A. *Material Consideration:*

The knowledge of material and their properties is of great significance. The machine elements should be made of such material which has properties suitable for the consideration of operation. The choice of material, for our project depends on following factors:

- Availability of materials.
- Suitability of materials for working condition in service.
- The cost of material.
- Low weight of material.

B. *Design of system:*

The main channel is fixed on table using helical springs in between. For free fall of oranges over the main channel, the table must be inclined. For this the slope is required to be calculated. We have to find the slope of machine such that the orange will fall freely. The slope should not be large enough that it will create difficulty in sorting.

We are using mild steel cold rolled (CR) sheet for main channel.

Its coefficient of friction is 0.4

Length of main channel is 1m.

For calculating the slope, consider orange is rolling freely over the main channel.

Let "m" be the average mass of orange,

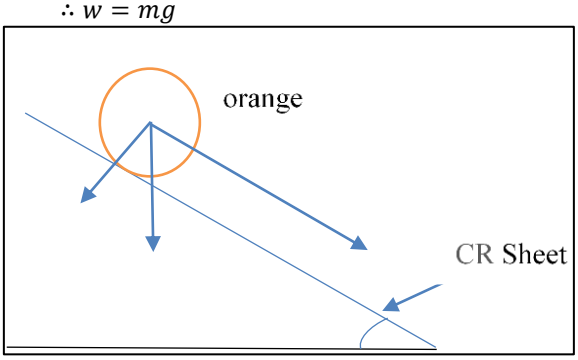
g = acceleration due to gravity,

μ = coefficient of friction between orange and CR sheet,

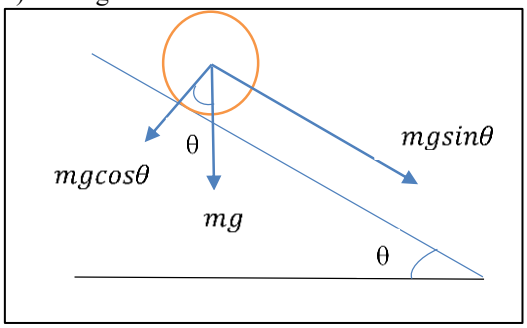
θ = angle of inclination.

Let w be the weight of orange,

$\therefore w = mg$



We consider that the angle between horizontal and surface of main channel (where the oranges make surface contact) i.e. angle of inclination be θ.



Therefore, the angle between vertical and perpendicular to CR sheet will also be θ.

Hence the component of weight perpendicular to CR sheet is $mgcos\theta$ and the

Component of weight parallel to CR sheet is $mgsin\theta$ which will made the
Orange roll freely on sheet.

We know that μ is the coefficient of friction which is opposing this motion.

∴ Net force acting on orange = $mgsin\theta - \mu.N$

Here N is the normal reaction which is $mgcos\theta$

∴ Net force = $mgsin\theta - \mu.mgcos\theta$

∴ $m.a = mg[sin\theta - \mu.cos\theta]$

∴ $a = g[sin\theta - \mu.cos\theta]$

∴ $a = 9.81*[sin12 - 0.4 * cos12]$

By trial and error our angle is found to be 12°.

∴ a = 1.79 m/s^2

From above, as the orange is stationary initially consider μ=0.

Also, s = 1m length of CR sheet

Now we have μ, a & s.

So, we can find the time to sort 1 orange by using formula

∴ $s = ut + \frac{1}{2}at^2$

∴ $1 = 0 * t + \frac{1}{2} * (1.79) * t^2$

∴ $1 = \frac{1}{2} * (1.79) * t^2$

∴ t = 1.05sec

In 1.05 sec, 1 orange gets sorted.

∴ Our Machine capacity = 3780 orange/hr.

Let average weight of orange is 140gms.

Sorting takes placed on both sides of system hence,

Then capacity of complete system = 2*(3780*0.140) kg/hr.

= 1058.4 kg/hr

≈ 1058 kg/hrs.

C. Component used:

The system consist of following components,

1) Table:

The component over which the mainframe channel is fixed. It is designed with 12^0 of inclination with base.

Fig.1 Table

Dimension:

- Length = 1225mm
- Width = 570mm
- Height = 710mm
- Inclination = 12^0

Operation:

- Cutting
- Welding
- Grinding

2) Mainframe channel:

This is the main area of the system. Mainframe channel has 2 inclination for easy sorting of oranges, one with base and another with vertical plane.

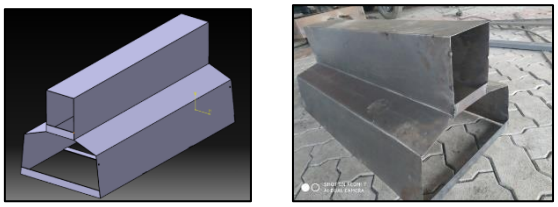


Fig. 2: Mainframe channel

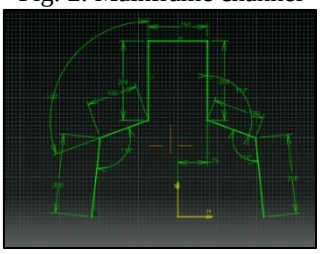


Fig.3: Dimensions for mainframe channel

Dimension:

- Length = 1000mm,
- Thickness = 1mm

Operation:

- Cutting
- Press breaking

Machine used:

- Pressing machine

3) Hopper:

Hopper is connected to the mainframe channel in inclined position. The oranges from previous line, supply the oranges continuously to it. Hopper is design by considering the capacity of the system.

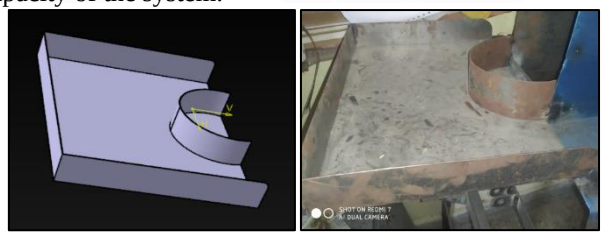


Fig. 4: Hopper

Dimension:

- Length = 380mm
- Width = 300mm
- Height = 50mm

Operation:

- Cutting
- Welding
- Bending

4) Helical spring:

A spring is defined as an elastic body, whose function is to distort when loaded and to recover its original shape when the load is removed. The helical springs are made up of a wire coiled in the form of a helix and are primarily intended for compressive or tensile loads. The cross-section of the wire from which the spring is made may be circular, square or rectangular.

Fig. 5: Helical spring

Dimension:

- Coil Diameter = 5mm
- Outside diameter = 40
- Pitch = 8mm
- Free Length = 60mm
- Number of coil = 8

Operation:

- Welding.

5) Adjusting strip :

The main function of this strip is to sort the orange of different size. Adjustable strip can provide the size variation by adjusting slot.

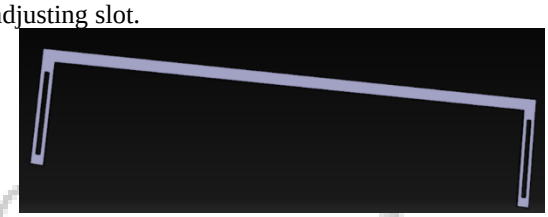


Fig. 6: Adjustable strip

Dimension:

- Length = 1000mm
- Thickness = 2mm
- Width = 25 mm
- Height = 200mm

Operation:

- Cutting
- Welding

a) Fixed strip:

The main function of this strip is to sort the orange of different size.

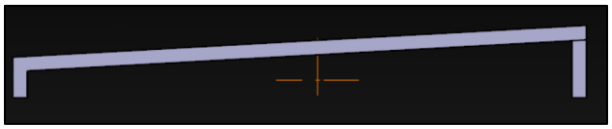


Fig. 7: Fixed strip

Dimension:

- Length = 1000mm
- Thickness = 2mm
- Width = 25 mm
- Height = 45 (left side) and 100mm (right side)

Operation:

- Cutting
- Welding

D. Auxillary component :

1) Washer:

It is a thin plate with a hole that is normally used to distribute the load of a threaded fastener, such as a screw or nut.

2) Nut and bolt:

These are tightened so that some axial force present in that will prevent movement of the connected members in the axial direction of the bolt. Proper tightening also prevents loosening of the nut.

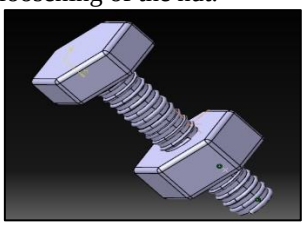


Fig. 8: Washer

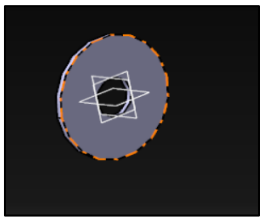


Fig. 9: Nut and bolt

E. Project Assembly:

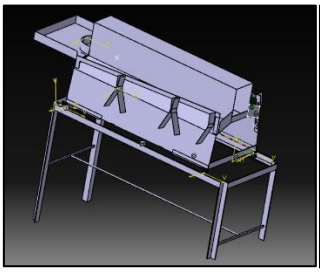


Fig. 10: CATIA View of assembled system

Fig. 11: Assembly of complete system

III. METHODOLOGY

A. Fabrication:

Fabrication is the process in which finished and assembled product is obtained from raw materials by doing some manufacturing processes. For fabrication we have selected the standard cold rolled sheet available in market having thickness of 1mm.Then as per our project concept, we are required to bend the sheet by press brake forming process. The obtained component is rest on table with 4 helical springs in between. The strip is attached on both sides of component and divided into 3 parts as per the size requirement. The 3 collection boxes are provided on both sides. The motor is installed inside the main component with small mass attached to it for producing vibration in system.

The main processes used for the fabrication are:

1) Cutting
2) Welding
3) Drilling
4) Grinding

1) Cutting:

This process is used for the cutting of sheets, angles as per our dimensions.

2) Welding:

In this process, we have welded the angles, strips to main component of machine, helical spring in between main component and table which acts as support for mechanism. The process used for welding was arc welding because it is economical and also results in good weld.

3) Drilling:

This operation is used to make drill on so as to adjust size as per requirement. For this operation, we have used vertical drilling machine.

Fig. 12: Welding of the strip

Fig. 13: Welding of the helical spring

4) Grinding:

The sharp edges of the metal were smoothed with the help of grinder. Also welded joints were smoothen by grinder

5) Assembling:

All the components after the various processes were assembled to obtain the finished mechanism.

B. Methodology:

Manufacturing Stages:

Following are the different stages of the project:

1) Recognition of need of mechanism.
2) Design of the components.
3) Selection of the material.
4) Fabrication and assembly.
5) Trial.

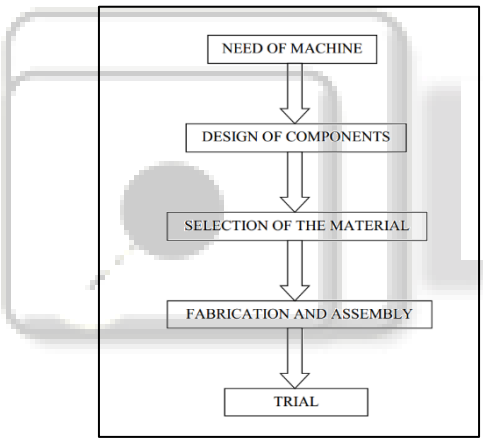


Fig. 14: Manufacturing Stages.

C. Working:

This device came to actualization from interconnecting various components, frames together using appropriate tools and equipment. By switching on the motor, the vibration is produced due to eccentric loading of mass attached to the motor shaft. Also excess vibration is provided with the help of helical spring. As soon as the motor started the shaft rotates and the oranges available in the hopper automatically dropped over the mainframe channel of system.

The oranges move forward and due to 12 degrees of inclination of base on which the oranges are dropped, they make contact with strip which is connected on both sides. The strip is connected to machine part in such a way that it can sort smallest size of orange i.e. 40mm (which we had taken in our project) at beginning and largest size of 110mm sort at the end portion. And accordingly 3 different sizes of oranges get sorted in ascending order and collected in boxes.

D. Motion Flow diagram

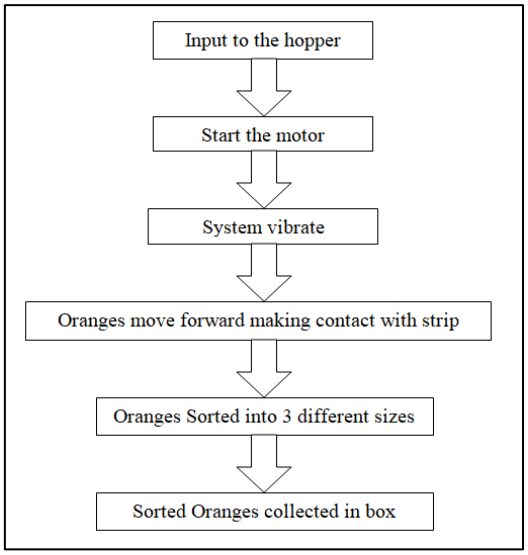


Fig. 15: Motion flow diagram

IV. Result and Discussion

From the trial taken on fabricated mechanism we come to know that the orange sorting machine can work efficiently with the help of our mechanism. Although the machine has the ability to grade more than 20 oranges per minute based on the requirement as the machine is built with high feed rate but were not loaded beyond 15 pieces since it was under test run.

Fig. 16: Front view of sorter

For each test, number of different size fruits was recorded and machine performance evaluated by comparing with the number of fruits identified and sorted by the machine. Machine performance determines how much it closes or deviates from the set standard criteria. Thus, a maximum of 87% accuracy was achieved for small and medium size oranges and 100% for large size oranges with less than 0.2 error margins.

Sr. no.	Fruit size	Number Of fruits before sorting	Number of fruits after sorting	Error	Accuracy (%)
1.	Small	15	13	0.13	87
2.	Medium	10	12	0.2	80
3.	Large	10	10	0	100

Table 1: Results obtained from testing the mechanical fruit sorting machine.

V. CONCLUSION AND FUTURE SCOPE

A. Conclusion

The objective of our project is to design a low cost machine that will sort orange on the basis of its size. An effective solution is provided that sorts orange into three categories via –small, medium and large without damaging it. The whole system has an advantage of small volume and high reliability.

The system has relatively low cost of around Rs.15000/- and can be purchased by a small trader. The input is given to the hopper from the caret of mixed oranges .The machine is being started. The orange passes through the main part of machine and as per their size they get collected into the caret and thus sorted. The operation is quite easy and the power consumption of the system is also very low.

This system brings innovation in the existing technology of sorting and also replaces the tedious job of manual sorting by machine and thus provides an effective solution.

B. Future Scope

We done this uptill now. In the future, we will,

1) Provide some adjustment in the machine so that it can sort some other citrus fruits such as sweet lemon, lemon etc.
2) Do some arrangement for washing of fruits.
3) Make machine more reliable so that we may be able to set the size of sorting manually. Like now our machine sorts orange in the size of 4 cm, 7cm and 11cm. We will be able to change the size of sorting to 3cm, 5cm, 7cm. Different size of orange grows in different geographic location. So in order to cope with this we will provide some arrangement which will allow us to decide the size of sorted orange as per our requirement.
4) Try to reduce the noise of the system.
5) Increase the productivity and accuracy of the machine.
6) Try to increase the operation time of machine so that it can be operating continuously without stopping the machine.
7) Provide wheels to the machine so that it can be shifted from one location to another location easily.

REFERENCES

[1] Ahmad, U., S. Mardison, R. Tjahjohutomo, and A. Nurhasanah. 2010 in Australian Journal of Agricultural Engineering, 1(5): 165-169.
[2] S.Sattom, K. Islam, and S.C. Banik in International Conference on Mechani-cal Engineering and Renewable Energy, Vol. I, Jul. 2013, pp. 2-5 (2013).
[3] Brosnan, T. and D.W. Sun. 2004 in a review. J.Food Eng.61(1):3–16.
[4] J Blasco, S Cubero, J Gomez-Sanch ´ ´ıs, P Mira, and E Molto in Journal of Food Engineering, vol. 90, no. 1, pp. 27–34, 2009.
[5] J. C. Sergio, A. Nuria, G.S. Juan, and B. Jose, Food Bioprocess Technology, DOI 10.1007/s11947-010-0411, Nov,2011.
[6] S. Sheela, K.R. Shivaram, Meghashree, S. and Shriya, M.K , Int. J. Mech. Sci., vol. 5, pp. 4-8, 2016.
[7] S. Sattom, K. Islam, and S.C. Banik, in International Conference on Mechanical Engineering and Renewable Energy, Vol. I, Jul. 2013, pp. 2-5, 2013

