DESIGN & FABRICATION OF VEGETABLE SEGREGATION MACHINE

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Abstract

The method of manual segregation is adopted from many centuries across the world. With having its own drawbacks, making farmers to look forward for a sorting and grading machine. Usually it comprises frame equipped with power transmission system, segregating unit and collecting unit. We could go with the various materials for frame. But the availability of MS Steel made us to opt it as a frame material. In order to decrease the weight of entire machine, we could go with the materials with lower density. In power transmission, with the help of motor the power is supplied. The shaft of the motor connected with pulley and then is supplied to the gear box. The gear box is connected to crank which has got eccentric fixed point to the connecting rod, linked with the slider. The segregation is done in three stages. Depending on size of the vegetables rollers are arranged. On the basis of their size, the roller is going to sort out the vegetables at three different stages. The collecting unit made of Sheet metal, which is welded to frame of the machine.

Keywords: Grading and sorting, Gear mechanism, Reduction ratio, Pulley, Crank

1. INTRODUCTION

India is an agricultural nation with large agricultural products, producing different kinds of fruits and vegetables throughout the year. In order to sell or to export the products, it has to be graded and sorted. Usually done with the help of Manual labour, which may lead into some drawbacks like subjective grading, tedious work, inconsistencies and low productivity. The grading systems were developed for easing the labour-intensive work and create consistency in the quality of the product. Manual grading is carried out by trained operators who considered a number of grading factors and vegetables were separated according to their physical quality. Manual grading was costly and also affects the labours scarcity during peak seasons. Human operations may be inconsistent, less efficient and time consuming.

New trends in marketing as specified by World Trade Organization (WTO) demands high quality graded products. Farmers are awaiting for an appropriate agricultural produce sorting or grading or segregating machine in order to alleviate the labour shortage save time and improve rate of sorting. The grading and sorting system used in many food processing industry sorts using one of the following features like colour, shape, weight and size. It requires specific environment to work efficiently. The values for grading must be manually fed into the system prior to the grading process.

2. LITERATURE REVIEW

There has been an ever increasing literature in the field of machine vision based inspection of agricultural products. Several Scientists and engineers have carried out research on extensive work in the field. Few relevant works have been studied and the outcomes are summarized in the literature review.

Sorting is the segregation of edible or marketable product into distinct quality categories on the basis of shape, size, weight, image and color. Sorting of the marketable items is accomplished by both mechanical equipment (sizes, color sorters) and by manual means (visual or tactical).

Color, spots and bruises are simply recognized by the constituent level. Chemist (2002) reports the applying of a multi-color system to pick tomatoes thought-about physiologically immature, claiming

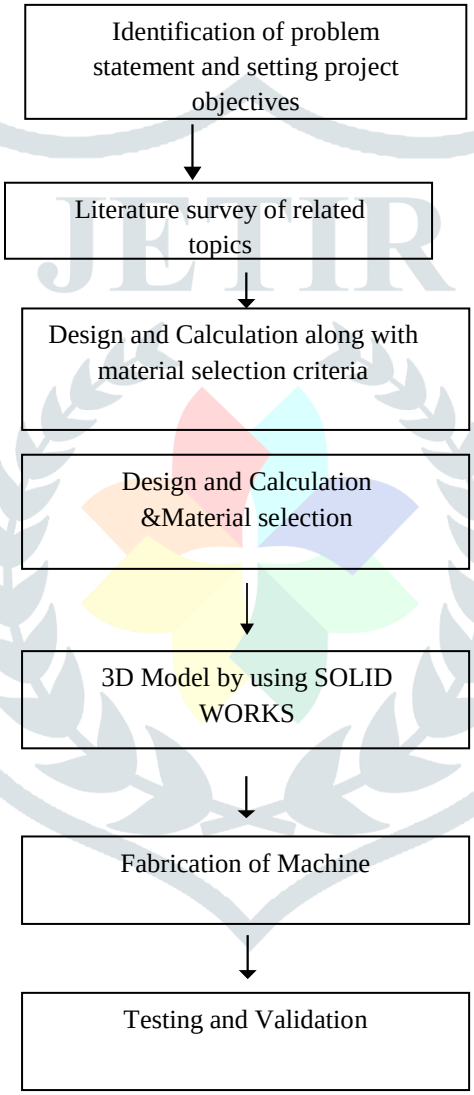
Shape, texture and colour features to sort tomato fruits according to their circularity, size, maturity and defects. Colour, texture and shape features have been evaluated for fruit defect detection system, also in conjunctions with PNNs.

The ripening of tomato occurred an increase of the red colour and a decrease of the green colour, indicating chlorophyll degradation meanwhile lycopen started to be produced.

Proposed fruit size detecting and grading system based on image processing. The system takes ARM9 as main processor and develops the fruits sized detecting program using image processing algorithms on the QT/Embedded platform.

3. METHODOLOGY AND CONSTRUCTION

This study methodology flow chart is shownbelow.



3.1. Construction

The frame is designed and manually drafted which is then constructed with the help of L frames of MS material. The joints are joined with the help of Arc Welding. The hopper is connected to the frame via welding.

The rollers are of same material which are welded with nut at their end which will help to bolt the rollers rigidly to the frame.

The motor with 1000rpm is adopted and connected with the pulley of one inch diameter.

The pulley is connected via belt to driven pulley of six inch. The driven pulley is coupled with the Gear box with reduction ratio of 6:1.

The output shaft of Gear box is connected with crank linked with connecting rod.

The sorting unit is developed for segregation process at three stages which are sorted out with the help of the rollers whose distance are fixed uniquely for different kind of vegetables.

These vegetables sorted are collected at different elevations with the help of collecting unit.

3.2. Methodology

The vegetable which is to be segregated is putted into a hopper.

The motor connected with the power supply is switched which rotates the pulley, which in turn drives the driven pulley.

The Gearbox connected with the driven pulley transmits the power to its output shaft at its reduction ratio.

The crank along with the assistance of connecting rod, coupled with Gearbox converts the angular velocity to linear velocity. The connecting rod drives the sorting unit.

The vegetable from the hopper falls on the sorting unit and gets sorted out at three stages and collected at three corresponding collectors with different size at each collector.

4. CALCULATIONS

Iteration 1: Gearbox with reduction ratio 2:1

n_1 = 1000 rpm; n_2 = 500 rpm; Torque, T = 150 Nm; Allowable stress=120MPa

Assume $z_1=20$; $n_1 / n_2=2$;

$$T= 9550 *10^3 *N / n_1$$

Therefore, N=15.7kW

module, $m= (2T/\sigma CkYz)^{1/3}$

C=0.5; k=10; on substituting m = 5.23mm = 6mm (approx.)

$d_1=m*z1=6*20=120mm$ $d_2=m*z2=6*40=240mm$

d_1= 120mm **d_2 = 240mm** $V=\pi* d_1*n_1 / (60*10^3)$ =6.28 m/sec **V = 6.28 m/s**

$C=3.05 / (3.05+V) = 0.3269$

C=0.3269

$F= \pi*\sigma*C*b*y*m$ (1)

$F= 2T/d_1=2500$ N (2)

Substituting andequating

σ= 62.32 MPa <σ(allow)

Design is safe

Iteration 2: Increasing the gear reduction ratio

n_1 = motor speed; n_2 = gearbox output speed Now, the gearbox ratio,
$n_1 / n_2 = 6$

We have, n_1 = 1000 rpm

Therefore, n_2 = 1000 / 6 = 166.67 rpm

Iteration 3: Decreasing the speed by using a belt drive

(Previous iteration resulted in higher sliding velocity which may damage the vegetables. Thus, a belt drive using two pulleys are adopted in this iteration)

Therefore, select the pulley such that the velocity is reduced to three times the initial velocity. Diameter Pulley 1 = 25.4 mm
Diameter Pulley 2 = 152.5 mm

Therefore, speed of Pulley 2 = 1000 / 6 = 166.67 rpm Further, (Pulley 2 speed) / (Gear box speed) = 6 Gear box speed (n) = 166.67 / 6 = 27.77rpm

d = diameter of crank = 101.6 mm

Now, sliding velocity is given by

$$V = \pi * d * n / 60$$

$$V = \pi * 0.1016 * 27.7 / 60$$

$$V = 0.14735 \text{ m/s} = 0.537 \text{ km/ hr}$$

Thus, this sliding velocity is accepted as the damage for vegetables are very negligible.

Hence, the calculation in iteration 2 is adopted.

RESULTS AND PERFORMANCE TESTING

The vegetable segregator was tested using two different vegetables separately They are:

- Onion
- Potato

The vegetables were segregated into three different levels.

I. Inthefirsttrial,thespeedofthemachinewasveryhigh.Thiswouldobviouslyleadtodamage to the vegetables. The speed of the rolling tray is not a major factor for this setup.

Hence for second trial, two pulleys were added and the reduction ratio of gear box was increased from 2 to 6. This resulted in slowing down the speed of rolling tray to greaterextent.

Thevegetablesarefurthercollectedindifferentbagsattheendofeachcollectors.Thisreduces the damage on them.

Total number of rollers adopted were 18. Multiple trials were carriedout by varying the distance between the rollers of eachlevel.

Further similar vegetables can be used for segregation with respect to the diameter as a major factor.

5. COST ESTIMATION

SL No.	Part Description	Cost (Rs.)
1	Mild Steel Angle Frame Structure- 1 No	4000
2	Motor	2500
3	Gear Box	2000
4	Hopper	1200
5	Round Pipe	1000
6	Fasteners	300
7	Paint	500
8	Lathe Work	1000
9	Misc.(Pulley and belt, washers)	3000
	Total in Rs.	**13,500**

6. CONCLUSION

The proposed sorting machine has capable of sorting different vegetables according to the sizes which are almost spherical in dimension. This technology will resolve many issues faced by the vegetable merchant such as high cost, inefficient, low productivity, like subjective grading, tedious work and inconsistencies, reduces the efforts, damage of vegetables etc.Moreover, this machine has longer work life as it has simple working mechanism. This project has designed and fabricated the sorting machine that has resolved the above problems faced by manual process; therefore, it has replaced existing method to sort the vegetables.

REFERENCES

1. Stanley E. Prussia et al. [1] studied Sorting is the segregation of edible or marketable product into distinct quality categories on the basis of shape, size, weight, image and color. Sorting of the marketable items is accomplished by both mechanical equipment (sizes, color sorters) and by manual means (visual or tactical).
2. Van der Heijden et al. [3] (2000) and POLDER et al. (2000) additionally compared pictures with normal RGB pictures for classifying tomatoes in several matureness categories exploitation individual pixels and obtained similar results.
3. Jahns et al. [4] (2001) additionally report that color, spots and bruises are simply recognized by the constituent level. Chemist (2002) reports the applying of a multi-color system to pick tomatoes thought-about physiologically immature, claiming Associate in nursing approximation of eighty fifth. KADER (2002) reports that it had been necessary to capture a definite range of pictures to get fruit diameter, recommending the applying of video pictures to examine the fruit look.
4. Fernando et al. [5] (2010) designed a system to diagnose six differing kinds of surface defects in citrus fruits employing a variable image analysis strategy. Pictures were flat and projected onto a reference space to make a score matrix wont to reckon defective maps. A 94.2% accuracy was reportable.
5. Omid et al. [6] in 2013 used shape, texture and colour features to sort tomato fruits according to their circularity, size, maturity and defects. They achieved 84.4% accuracy for defect detection using a probabilistic neural network (PNN) classifier. Colour, texture and shape features have been evaluated for fruit defect detection system, also in conjunctions with

PNNs.

6. Lino et al. [7] (2008) proposed a grading system for lemons and tomatoes using colour features for ripeness detection. In this system, the ripening of tomato occurred an increase of the red colour and a decrease of the green colour, indicating chlorophyll degradation meanwhile lycopen started to be produced.
7. Hongshe Dang, Jinguo Song, Qin Guo [8] have Proposed fruit size detecting and grading system based on image processing. The system takes ARM9 as main processor and develops the fruits sized detecting program using image processing algorithms on the QT/Embedded platform. Authors in [2] have proposed system which finds size of different fruits and accordingly different fruits can be sorted using fuzzy logic, here author proposed mat lab for the features extraction and for making GUI.