Design And Fabrication Of Automatic Onion Peeling And Cutting Machine

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Abstract: Automation plays an important role in industrial and domestic applications. The purpose of automation is to get higher production rates, efficient utilization of materials, better quality, reduce time consumption and to improve safety. In present days, automation is not only implemented in industrial problems but also in domestic applications. This paper describes the application of automation in one of the work in kitchen called onion peeling and cutting. Onion peeling and cutting is one of the fatigues and time consuming job for preparation of food and it is everyday activity in all food processing system. In hotels, hostel mess and restaurants high man power is required for the peeling and cutting the onion and also it consumes more time. On the other hand there is a shortage of workers for these types of works. Hence, there is a good opportunity for the implementation of automation in onion peeling and cutting machine. The objective of this project is to implement the mechatronics approach for automating the onion peeling and cutting operation.

Index terms : Automation, Onion peeling, Circular drum, AC motor, Punched metal sheet, Cutter, Operating time

1. INTRODUCTION

Emerging automatic and semiautomatic machines like extruding, dispensing, cutting, slicers, mixers, depositors are introduced in food processing industries. The automatic equipment has witnessed higher demand in recent years as compared to semiautomatic machinery. Industry 4.0 has revolution in the manufacturing sector favors automation in the food processing industry. Food processing refers to an activity which converts food materials to final consumable products. Onion is one of the majorly used vegetables for cooking, it is used after the skin is peeled and cut down into pieces. In home for cooking, onion skin is easily peeled and sliced by knife, but for large quantity of onion it takes much time in restaurant and hostel mess. Time required for cooking is less but the time taken for peeling and cutting of onion is more. So by integrating the both peeling and cutting process, a semiautomatic machine is fabricated to reach the demand. Generally, the available machines are heavy and their marketed price refrain people from buying them.

2 LITERATURE REVIEW

2.1 Literature survey

Maurya and Lami (2019) discussed in detail about peanut peeling machine. The machine has crushing, roller and separation mechanism. It peels the dry peanut and separates the waste. Narayanan and Jagadeesh (2017) have developed automatic vegetable cutting machine. They used the slidercrank mechanism to cut the vegetables. The system is powered by the AC motor. The rotary is converted into reciprocating motion and it presses the vegetable and cuts the vegetables by blades. Balavignesh and Karthikeyan (2016), discussed about the French fries making machine. In their prototype model, potato was cut by horizontal square cut blades for French fries. Reuben and Fernandez (2015), discussed about green mango peeling machine. In this study, a mango peeling machine was designed, fabricated and tested which used a different peeling approach – peeling along the direction of the longitudinal axis of the fruit against the more common peeling around the longitudinal axis. And it was implemented successfully and the mango skin is peeled up-to 77%. Mohan (2015) discussed the garlic peeling machine. In this model the used cutter blades which are arranged horizontally with 90 degree angular difference with the help of vertical shaft. The blower is used to blow off the garlic skin.

2.2 Summary of literature review

After going through a lot of literatures and models in the market, the peeling mechanism is inferred from the poultry de-feathering machine, garlic peeling machine and peanut crushing machine and the cutting mechanism is inferred from the vegetable cutting machine.

3 PROPOSED SYSTEM

3.1 Existing system and its problems

Onion skin is removed manually and knife is used to slice the onion. In villages, people put onion in the closed vessel and they sake it to remove onion skin. The machine which is available in the market peels excess fleshy and the removed skin is separated by manually from the peeled onion. The machine available for cutting is not compatible. Existing machine doesn't have integration of both peeling and cutting mechanism together. It does not collect the waste separately. Present technology is no longer provides precise operation.

3.3 Proposed system and its merits

Integrating both onion peeling and cutting parts together to have a process flow. The system has two major parts that is peeling and cutting parts. Circular drum with rough punched sheet covered inside the drum for peeling the onion. The circular plate with three blades fixed 120^{o} apart is used to cut the onion. From the circular drum, pathway is created to cutter to have a process flow of peeled onion to cutting. Both peeling part and the cutter use the single motor using a belt drive. The removed onion skin is collected separately by pipe from bottom of the drum for using it as a fertilizer. Low budget

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machine have both onion peeling and cutting operation. Onion skin is separately collected to use as a fertilizer. Onion peeling and cutting time is effectively reduced.

4 FEASIBILITY STUDY

4.1 Economical feasibility

The important parameter of any product which determines its Success rate is the cost of the device. The cost of peeling machine available in the market range from ₹20,000 to ₹40,000 depends upon the capacity. Hence cost analysis of our proposed model should be feasible in order to penetrate the market. The components of the system are easily available.so the cost of installation will be cheaper and in terms of mass production, it will be more economical. Our model peels the onion up to 50kg per hour and it cost around ₹6000.

4.2 Operational feasibility

The model doesn't use blade or hard friction for peeling, so the outcomes will whole shaped fresh onion. The operation and construction of the project is very simple which leads to easy identification, rectification and replacement of the components. The operation is simple, so the chef can easily operate the machine.

4.3 Technical feasibility

As mentioned earlier, this system involves simple process. Since it mostly involves basic components, the project is technically feasible with low maintenance cost. The maintenance in the setup is to periodically changing the onion cutting blade and peeling metal sheet.

5 WORKING OF THE MODEL

Circular drum with rough punched sheet is covered inside the drum for peeling the onion and is fixed inside by means of nut and bold. The circular disc is fixed at the bottom of drum and a shaft which is extended downwards from the flat plate .The shaft which is connected to the motor by means of pulley. On the other end (i.e.) in the cutting section there is a circular plate with three blades fixed 120^{o} apart from each other is used to cut the onion. The AC motor is connected to both the by means of belt drive. Initially the motor is switched ON, the cutter blade and the flat plate inside the drum also rotates at 1350 rpm. When the motor reaches the rated speed onion is feed to circular drum. It also starts rotating along with the plate and in addition to that water is sprayed to the drum by the submersible mini pump which is attached at the top of the drum. The rotation of circular disc at bottom of the drum creates centrifugal force, due to this force onion circulates over the punched rough sheets and the onion skin peels off slowly and it combines with the water and reaches the bottom and comes out from the hole created at the bottom. After the skin is peeled the onion needs to be taken out for that hole created at the side from that hole the onion comes out when the door is kept open. Onion is guided by the hopper to the cutting blade, it is a horizontal blade, it slices the onion into small pieces the sliced onion pieces is collected by the container placed at the bottom of the cutter blade.

5.1 Components used

The Various components used in the project and their specifications are shown in the Table 1.

TABLE 1

LIST OF COMPONENTS

S.No.	Materials	Specifications
1	Single phase motor	1350 rpm, 0.25 HP
2	Submergible pump	1φ, 0.023 HP
3	Ball bearings	5 mm diameter
4	Mild steel drum	40 mm diameter
5	Punched Sheet	As required
6	Mild steel Flat plate	36 mm diameter
7	Steel frames	As required

Based on the different process the conceptual design is made and is shown in Figure.1. All electrical and mechanical components are used to finish the required job. From this it can be inferred that setup divided into four parts Onion feeder, Peeler, cutter, Motor.

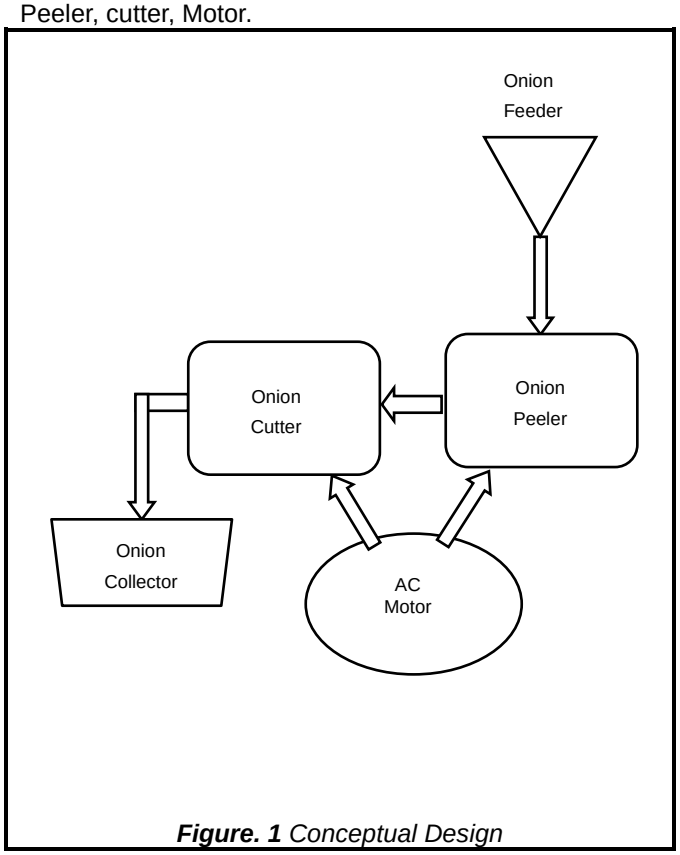

Figure. 1 *Conceptual Design*

6. DESIGN CALCULATION

6.1 Specification of the flat belt drive

Driving pulley diameter (D) =40 mm
Driven pulley diameter (d) =30 mm
Speed of the motor (N1) =1350 rpm

(driving pulley speed)
Center distance between pulley =300 mm

6.2 Speed of the driven pulley

N1/N2 =D/d …… (5.1)
N2 = (30×1350)/50
N2 = 810 rpm

6.3 Length of the flat belt drive

L = 2c + $\pi/2\ (D + d)$ + (((D-d)^2)/4) ×c …… (5.2)
L =0.68 + 2.61+3.5×10^-5
L = 425mm

6.4 Belt velocity

V = (π×D×N1)/60 …… (5.3)
= 3.14×0.05×1350
V = 3.5 m/s

6.5 Torque Calculation-Disc

Mass of the Onion =2.0 Kg
Mass of the Plate =0.3 Kg
Mass of the Shaft =0.150 Kg
Total mass =2.45 Kg
Acceleration due gravity = 9.81 m/s^2
Force (F) =Total mass x Acceleration due gravity …… (5.4)
F =2.45 x 9.81
=24.0345 N
Torque = Force x Radius of the Disc ……. (5.5)
=24.0345x 0.15
=3.6051 N-m

Hence the torque needed to rotate the disc containing 2 kg of onion is 3.6051 N-m

6.6 Torque Calculation-Cutter Blade

Mass of the cutter Plate =0.3 Kg
Mass of the shaft =0.150 Kg
Mass of the onion =0.5 Kg
Total mass =1.05 Kg
Acceleration due gravity = 9.81 m/s^2
Force =Total Mass x Acceleration due gravity ……. (5.6)
=9.31 N
Torque = Force x Radius of the Cutter Plate ……. (5.7)
=9.31 x 0.1 m
=0.93 N-m

Hence the torque required for Cutting onion is 0.93 N-m

6.7 Total Torque Required

Total torque required =Torque required for peeling + Torque required for cutting
= 3.60 + 0.93
T = 4.531 N-m

Hence the total torque required for whole process is 4.6351N-m

6.8 SPECIFICATION

Circular drum = 52cm height, 32cm diameter
Circular disc = 30cm diameter
Cutter plate = 20cm diameter
Motor
Speed = 1350 rpm
Hp = 0.25
Supply =220 V single phase supply
Submersible pump
Discharge = 400 lph
Supply = 220v single phase supply
Power = 18 w

Figure. 2 *3D Model of the Project*

Figure. 3 *Prepared Model of the Project*

7 SEQUENCE OF OPERATION

7.1 Feeding Onion and Spraying Water

2 kg of onion is feed into peeling drum which is covered by rough punched sheets and water is sprayed from the pump to the drum. After that top door was closed.

7.2 Onion Peeling

The motor is switched on and the circular disc will rotates. Due to centrifugal force, the onion is circulates around rough punched sheet and the skin is peeled.

7.3 Separately Collecting the Peeled Skin

The peeled skin is separated by the water and fed to the side gap of the circular disc. From the bottom of drum, there is a hole which is connected by a pipe. By this extent the peeled skin with water is comes out and collected to use as a fertilizer. Even without using the water the onion skin is removed by using blower setup to separate the onion skin.

7.4 Onion Cutting

The peeled onion is passed to the hopper by the pathway. The cutter rotates by the belt drive from the motor pulley, which is used for peeling. And the onion is sliced and collected. When the onion falls on the hopper, hopper guides the onion to reach the cutter. The cutter is powered by the motor used for peeling operation. When the cutter blades present in the setup slices the onion when it falls on the cutter. It is rotating around 800 revolutions per minute. Various sizes of blades are used to cut the onion of different sizes for various preparations of food items. This mechanism slices the onion rather than chopping it.

8 CONCLUSIONS

The prototype model of Onion peeling and cutting machine is designed (Figure 2) and fabricated (Figure 3) to reduce manpower and time. The motor with torque capacity of 5 Nm is enough to run the circular disc and the cutter for peeling and cutting the onion respectively. The designed machine will peal the 2kg of onion in 3 minutes and for both peeling and cutting, it takes 8 minutes to complete the process. This model successfully peeled the onion and while cutting, it has 75% efficiency, but it can be overcome by the changing the cutter blade to have a desired output. The peeled skin is stored separately and makes a use as a fertilizer to agriculture. By this technic of onion peeling and cutting will effectively reduce the preparation time for onion than the cooking. Overall the proposed model was able to satisfy the proposed advantage.

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