AUTOMATED PINEAPPLE PEELING AND SLICING MACHINE

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Abstract

Pineapple cutting machine is a machine used to cut and peel the pineapple to form the cylindrical shape pulp. Various fruit cutting machines are available in the market, but most of the machines cannot accomplish all the process automatically. The main aim of this research is to develop a pineapple cutting machine to solve the problems faced by Small Medium Enterprise (SME) industries, where the machine developed can reduce the time taken for pineapple slice preparation.

The present work involves the design and development of pineapple machine to fulfill the user needs. Designed machine aims at automating the process of peeling and slicing of pineapple. It consists of motor and pneumatic cylinder to operate the pineapple peeling and slicing equipment. In order to operate the machine, pineapple is initially located at the machine. Air supply to the pneumatic cylinder is fully controlled by a microcontroller through the solenoid valve and also controls the lead screw movement. Once the machine gets operated, pneumatic cylinder peels the skin of the pineapple which is placed at the outside of the cutting cylinder where as core of the pineapple will be placed at the inside of the cutting cylinder. The pineapple is pushed by a push plate using motor and lead screw arrangement. After pushing of the pineapple core, cutting blade cuts the pineapple with the help of air supply from the pneumatic cylinder. The main purpose of this project is to reduce the man power, work load and production time.

Keywords: Automation, Pneumatic Cylinder, Microcontroller, Solenoid valve.

I. INTRODUCTION

In this project, we have automated the operation of pineapple peeling and slicing in various places. Machine consists of motor and air supply to operate the pineapple peeling and slicing equipment. Some needs of automation are described below.

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc. of these sources, pneumatics form an attractive medium for low cost automation.

Now a day, almost all the manufacturing process is being atomized in order to deliver the products at a faster rate. The manufacturing operation is being atomized for the following reasons.

- To reduce man power
- To reduce the work load
- To reduce the production time
- To reduce the fatigue of workers

2. Materials Used And Discussion

Pineapple peeling and slicing machine mainly consists of 6 major parts as motor, pneumatic cylinder, solenoid valve, lead screw, microcontroller and proximity sensor.

a.The Machine consists of DC motor. The purpose of using DC motor is to provide rotational motion to the lead screw.

b.The Machine consists of two types of pneumatic cylinders. 100 × 100 and 50 × 100 pneumatic cylinders.

c.100 × 100 pneumatic cylinder has provided with a lead screw arrangement and is used for removing the core and skin of the pineapple.

d.50 × 100 pneumatic cylinder has provided with a linkage system and cutting blade.

e.The Machine is provided with a solenoid valve. The use of solenoid valve in pineapple peeling and slicing machine is to control the supply of air to the pneumatic cylinder.

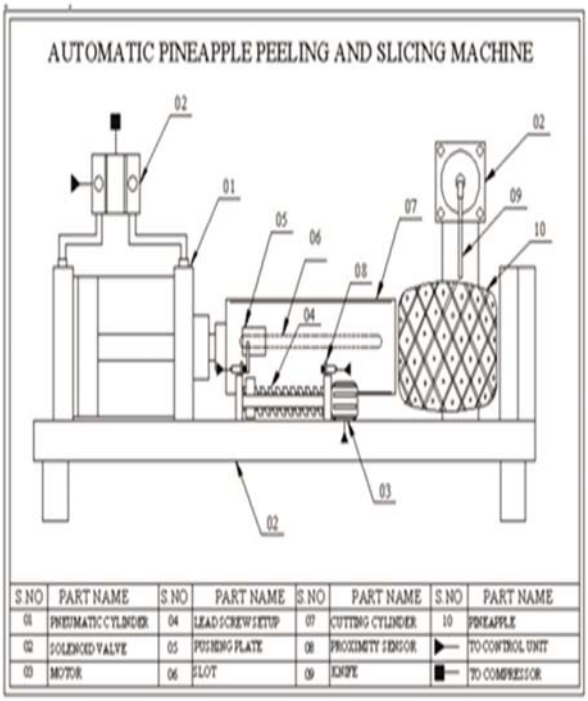
f.The Machine is also provided with a lead screw which is also known as power screw or translation screw. A lead screw is a screw designed to translate radial motion into linear motion. While working of the Machine, lead screw converts the rotary motion and provides the linear motion to the push plate.

g.The Machine consists of microcontroller which controls the movement of lead screw.

h.Last component of the Machine is proximity sensor. Two proximity sensors are needed and are placed at the both sides of the lead screw. The purpose of using proximity sensor is to sense the object without any physical contact.

3. Method of operating the Machine

While operating the Machine, first the low pressure atmospheric air enters the compressor where the air gets compressed into high pressure. High pressure compressed air is then passed into solenoid valve which controls the supply of air into pneumatic cylinder. As soon as the solenoid valve opens, air enters the pneumatic cylinder which is connected to the cutting cylinder. Cutting cylinder is provided with a motor and lead screw. Due to the entering of air into the pneumatic cylinder, both extraction and retraction processes takes place. During extraction process, cutting cylinder moves forward and hits the pineapple and starts peeling of pineapple. During retraction process, skin of the pineapple will be placed at the outside of the cutting cylinder where as core of the pineapple will be placed at the inside of the cutting cylinder. At the same time, lead screw converts the rotary motion supplied from the motor into linear motion to the push plate. Because of the slot provided in the cutting cylinder, push plate pushes the core of the pineapple and cutting will take place with the help of cutting blade provided at the top of the pneumatic cylinder. Proximity sensors are used to sense the object.



S.NO	PART NAME	S.NO	PART NAME	S.NO	PART NAME	S.NO	PART NAME
01	PNEUMATIC CYLINDER	04	LEAD SCREW SETUP	07	CUTTING CYLINDER	10	PINEAPPLE
02	SOLENOID VALVE	05	PUSHING PLATE	08	PROXIMITY SENSOR	▶	TO CONTROL UNIT
03	MOTOR	06	SLOT	09	KNIFE	■	TO COMPRESSOR

Fig 3.1: Pineapple Machine 2D Drawing

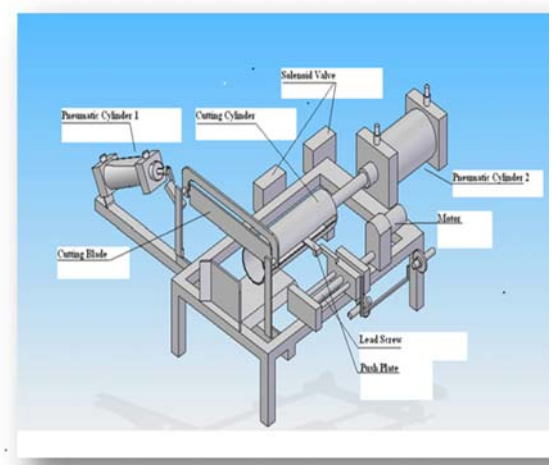


Fig 3.2: 3D Drawing of Automated Pineapple Peeling and Slicing Machine

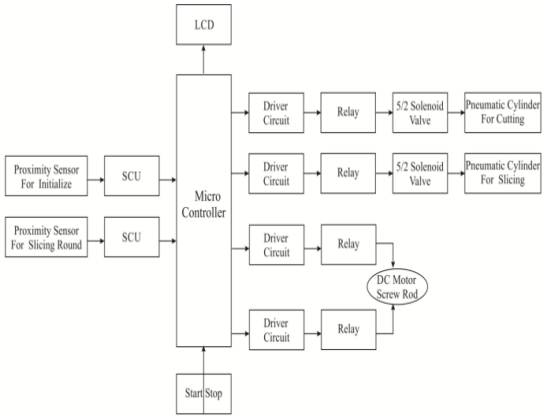


Fig 3.3: Block Diagram

Inductive proximity sensors are provided, one for initializing the motor in forward direction and other for sensing the motor in reverse direction. This function is to sense the metal object to some distance. The maximum sensing distance is 25mm. Proximity sensor is connected to the microcontroller through the signal control unit. The microcontroller used here is ATMEL 89S52.The microcontroller operates at 5V, for these purpose one step down transformer is used, which converts 230v to 5v and is passed through the 7085 regulator which supplies exactly 5V to the microcontroller. The program returns to the microcontroller by flashing method.

Microcontroller connects the driver circuit which contains bridge rectifier, capacitor and regulator. The bridge rectifier converts the A.C current into D.C current. Capacitor is used for reducing the noise. Regulator maintains exactly 5V to the relay system. The relay is an integration of all circuit. The relay supplies current to the solenoid valve (5/2 solenoid valve), which contains 5 ports and 2 valves.

4. Design and Calculations

Pneumatic Cylinder (100 x 100):

Mini pressure applied in the cylinder (P) = $2x10^5 N/m^2$

Diameter of the cylinder (D) =100mm

Diameter of the piston rod (d) = 25 mm

Stroke length = 100 mm

Area of cylinder (A) = $(3.14/4*(D^2)$

$= (0.785x0.1^2)$

$A= 7.85 \times 10^{-3} m^2$

Force during forward stroke,

$F = \{\pi/4x\ D\text{^}2 \times P\}$

$F = (2 \times 10^5\ N/m^2)\ (3.14/4*(0.05^2)$

$F = 1570.8\ N$

$1kg = 9.81\ N$

Load capacity during forward stroke W= F / g

$W = 1570.79 / 9.81$

$W = 160.12\ KG$

Force during return stroke,

$F = \{\pi/4x\ (D^2 - d^2) \times P\}$

$F = \{\pi/4x\ (0.1^2 - 0.025^2) \times 2x10^5\}$

$F = 1472.6\ N$

Load capacity during return stroke W= F / g

$W = 1472.6/ 9.81$

$W = 150.11\ KG$

Theoretical Air Consumption:

Air consumption = 0.785 liter

Boyles Law, $P_1V_1 = P_2V_2$

$V_2 = P_1V_1/ P_2$

$V_2 = (2+1)\ (0.785)/ 1$

$V_2 = 2.35$ liter /stroke

During return stroke,

Air consumption = $\{\pi/4x\ (D^2- d^2) \times L\}$

Air consumption = $\{\pi/4x\ (0.1^2 - 0.025^2)\ x0.1\}$

Air consumption = $7.36x\ 10^{-4}\ m^3 = 0.736$ liter

Boyles Law, $P_1V_1 = P_2V_2$

$V_2 = P_1V_1/ P_2$

$V_2 = (2+1)\ (0.736)/ 1$

$V_2 = 2.208$ liter /stroke

Theoretical air consumption per cycle = (Air consumption during forward stroke + Air consumption during return stroke)

Theoretical Air consumption per cycle =2.35 + 2.208

= 4.559 liter/ cycle

Specification of Motor:

Speed N = 30 RPM

Voltage V = 12 Volt

Loading Current I = 300 mA

No Load Current I = 60 mA

Power P =V x I

=12x0.3

= 3.6 Watts

P= 0.0048 HP

Motor Efficiency E = 36%

Motor shaft diameter = 6 mm
Torque of the Motor:
The formula for calculating torque will be
$T = (I * V * E * 60) / (N * 2\pi)$
Speed N = 30 RPM
Voltage V = 12 Volt
Loading Current I = 300 mA
$T = (0.3x12x0.36x60)/30x2\pi$
Torque = 0.412 Nm
T =4.2 Kg-cm

Parameters taken from standard lead screw:

1. Pitch of the lead screw P = 12.3 mm
2. Speed of Lead Screw, N = 30 rpm
3. Outer diameter = 19 mm
4. Inner diameter = 15 mm
5. Thickness = 4.7 mm
6. The linear velocity of the lead screw = N x p
   i. = 30 x12.3
   ii. =369mm/min
   iii. = 6.15 mm/s
7. The angular velocity of the lead screw = $2\pi N/60$
   i. = 2π (30)/60
   ii. = 3.14 radian/s
8. Power of the lead screw, P = 3.6 W
9. Torque of the lead screw = P x $60/2\pi N$ = 3.6 x $60/2\pi N$= 0.57 Nm

Maximum withstanding capacity = torque/radius of lead screw = 0.57 /9.5 x 10^{-3}
Maximum withstanding capacity = 60 N

5. Result and Discussion

Graph shows the relationship between the force v/s air pressures. When pneumatic cylinder diameter increases, force generated also increases. From the graph it is observed that for the larger increase in the force value only at smaller air pressure.

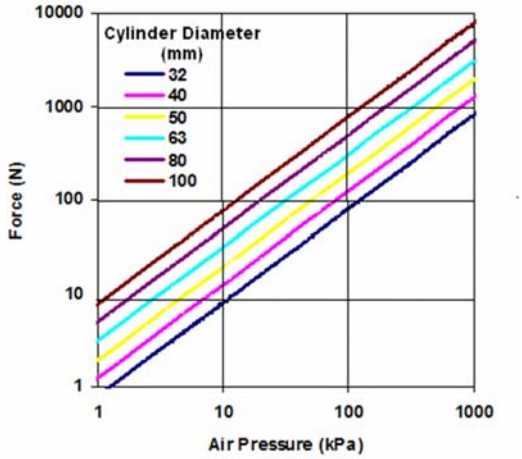


Fig 5.1: Graph of Force v/s Air Pressure

6. Conclusion

This work provides automaton of pineapple peeling and slicing process. The time required for the peeling and slicing is less compared to manual operation. Manual operation requires 5 minutes for cutting and slicing of a single pineapple. But automated pineapple machine will take nearly 30 seconds for cutting and slicing operation.

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