Development of Automated Pizza Making Machine

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Abstract Automation, the art of remote controlling machines has been a subject of research since the early 1900's. But the studies based on automated machines have witnessed booming growth and appreciating the support from MNCs, due to the resources available and the advancement in today's hardware system, enforcing a cutting-edge technology in industries. This research field has made the multi-cultural approach of mechanical and electronics & telecommunication possible. This paper involves the market study, concept design, simulation, costing, testing and validation, manufacturing and demonstration of a vending machine used to prepare pizza. Automated pizza vending machine is comprises a Microcontroller whose behavior is described using a hardware description language. With the help of microcontroller such as Arduino or Raspberry pi, it is now possible to write and understand and as well as execute the following commands in real physical world easily. This project has the potential to prove a future scope as it one-time investment and economical for the bulk production. It increases the production and manual work is nullified to a greater extent.

Keywords —Pizza, Vending machine, Conveyor, Electronic Control Unit

I. INTRODUCTION

PIZZA is a savory dish of Italian origin which is been widely sold in India and in other countries. As of Jan 2016 Dominos had over 1000 outlets in India and Pizza hut over 750, this shows the cravings for the cuisine by the people of our country alone. From a survey made, the pizza market in India is worth over Rs1500 crores and has been growing at a consumer annual growth rate of 26% for the last 5 years. Relatively automation technology in industries is a revolution and is growing at a faster rate. Automation is the technology by which a process or procedure is performed without human assistance, it has been achieved by various means including mechanical, hydraulic, pneumatic, electrical and electronic devices in combination. Automation didn't only make human effort less but also eliminated human error, got precision in work and procure the same kind of product quality irrespective work time and is economical. Automation in preparing a pizza is a key to a better production and cost effective, which also makes the work easy for anyone with less or no experience to prepare a pizza.

This project is feasible to design and manufacture, and has a great scope in the future developments. It involves the design of a mechatronics system to meet the requirements of a specific application. The system consists of input/output devices coupled with digital logical circuitry.

This paper is organized as follows:

Phase 2 Market Survey, Problem statement, expected solution, Phase 3 Concept Design, Prototyping and Costing. Phase 4 Later it talks about the process of production of pizza at quicker rate. Phase 5 finally tells the Conclusion of this paper

II. MARKET INFORMATION GATHERING

A. Market Survey

To begin with many market surveys have been conducted in recent with a greater demand in western culture in India, it may be clothes, lifestyle and food they consume. And one of the foods that Indians become a fan of is the pizza.

According to Pizza Power 2013(Source Internet) State of Industry Report, the U.S., Brazil, Russia, India and China are seen as emerging pizza market in the world. The Pizza market in India is worth over Rs 1,500 crores and has been growing at a consumer annual growth rate of 26% for the last 5 years.

In the pizza market, Domino's has captured over 55% of the share in the organized pizza market and 70% in the home

delivery category. Domino's operates 1126 stores in 264 Indian cities.

B. Problem Statement

With greater demand in pizza, it has become difficult to prepare large quantities pizza quickly and supply. On the other hand, the quality of the pizza should not deteriorate.

C. Expected Solution

To procure a solution system to prepare pizza within a stimulated time lower than that of primitive manually prepared pizza i.e. 3 minutes, and also reduce the human effort and error. And keep the quality of the pizza same throughout.

III. CONCEPTUALIZATION AND PRODUCTION

A. Concept Design

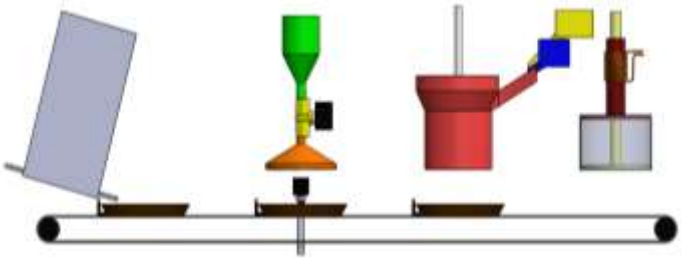

Fig 1 Design Layout of Mechanism

Four Stations:

Stations	Food Contained	Function
Pizza Base Feeder Mechanism	Pizza Base	To eject pizza base on the pan
Sauce Dispenser	Sauce	To dispense and spread the sauce
Topping Feeder	Vegetable	To mix and distribute vegetables all over
Cheese Grater	Cheese	To grate cheese

Table 1. Name of the stations and its functions

A1. Base Feeder Mechanism

Part	Function	Specification
Base Container	To store multiple (10) pizza base at a time	Contains 10+1 pizza base
Connecting arm	Supports and mount the motor	Mild Steel
Stepper Motor	Swivels the slider blade	NEMA 17 100 steps in 3 secs--1 (10 rpm)
Slider Blade	It ejects the pizza base to the pan	3D Printed, ABS

Table 2: Specifications of base feeder mechanism

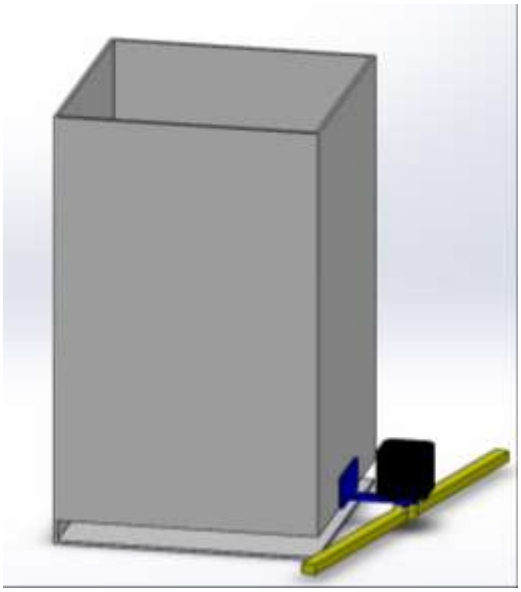

Fig 2: Base Feeder Mechanism

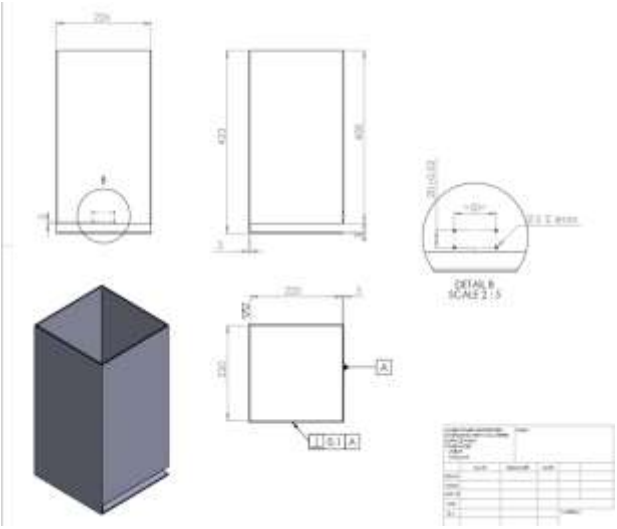

Fig 3: Detailed Drawing of Base Feeder Mechanism

Design parameters for the base feeder mechanism:

1. Size of the pizza base
2. No. of pizza base to accommodate at whole
3. Time to pop out the base on the pan
4. Right inclination of the container to aim the pan.

A2. Sauce Dispenser

Part	Function	Specification
Top Container	To store enough sauce for 25-30 pizza	SS 316 Food-Grade, 108 dia with 2 mm thickness
Solenoid Valve	Acts as gateway to the semifluid for stipulated time	1inch standard solenoid valve
Bottom Plate	Perforation provides distribution of sauce all over the bas	No. of holes-180Diameter of one hole- 7mm

Table 3: Specifications of Sauce Dispenser Mechanism

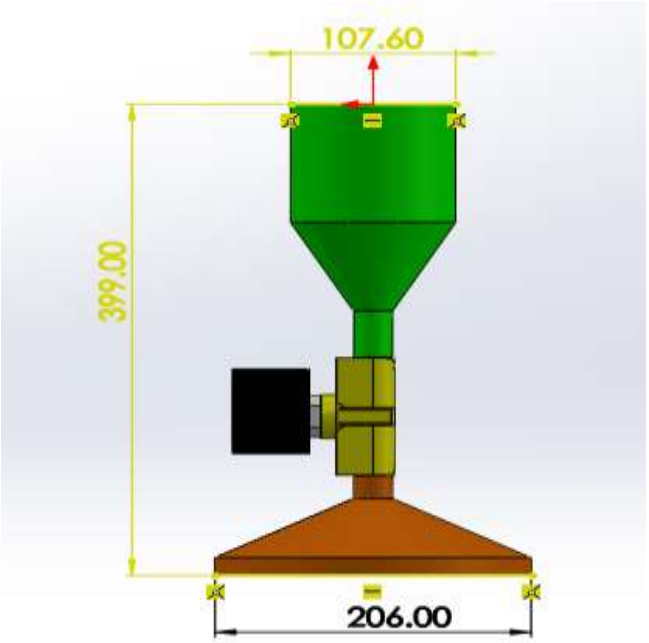

Fig 4: Sauce Dispenser

Design Parameters for the Sauce Dispenser Mechanism

1. Targeted time to fall sauce on pizza base.
   Sauce required for 1 pizza is targeted to fall in 3 sec.

2. Volume of sauce required for 1 pizza in targeted time.
   Calculated volume of sauce for 1 pizza is $6.473*10^{-5.}$
   Now the flowrate is calculated as following:
   Q = VOLUME/TIME
   = $6.473*10^{-5}$/ 3 = $2.15*10^{-5}$ m^3/ sec.

3. Selection of solenoid valve
   Flow rate through solenoid valve is calculated by using formula:-

$$Q = K_V * (d_p / sg)^{1/2}$$

Where,
   Q = Flow rate (m^3/ hour)
   K_v = Flow coefficient
   Dp= differential pressure between inlet and outlet (bar)
   SG= specific gravity
   Q = 12*(0.5/ 1.149) ^ (1/2)
   = 7.91 m3/hr.
   = 2.197 m^3/sec.

Above calculated flow rate is greater than the calculated flow rate required for one pizza in one sec. Hence our selected solenoid valve is correct.

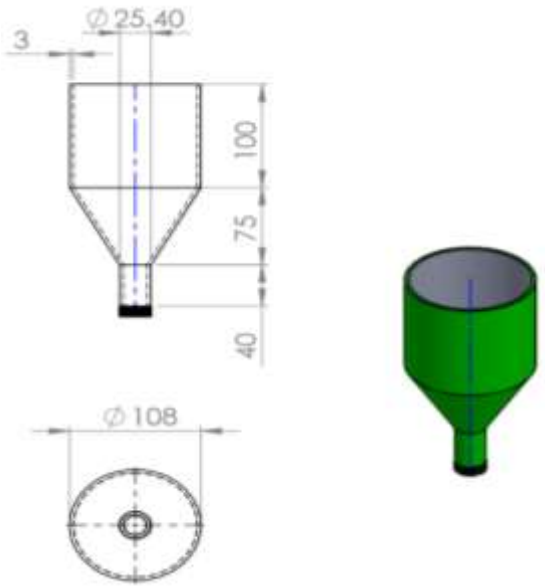

Fig 5: Detailed Drawing of Sauce Dispenser

A3. Topping Feeder

Part	Function	Specification
Conveyor cover	Jackets the screw conveyor and protects the vegetables	SS 316 Food Grade with dia equivalent to base (8 inch)
Screw conveyor	Used to feed, distribute, collect or blend and control flow	SS 316 Food Grade 1inch rod dia and 7.5 inch helical blade dia (10 rpm)
Vegetable containers	Vegetables gets chopped and mixed to go through the conveyor	SS 316 Food Grade

Table 4: Specifications of Topping Feeder Mechanism

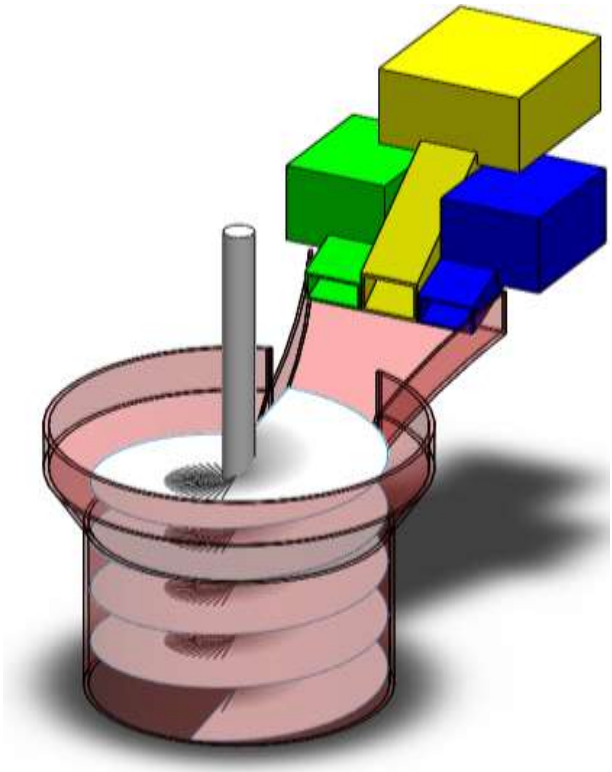

Fig 6: Topping Feeder Mechanism

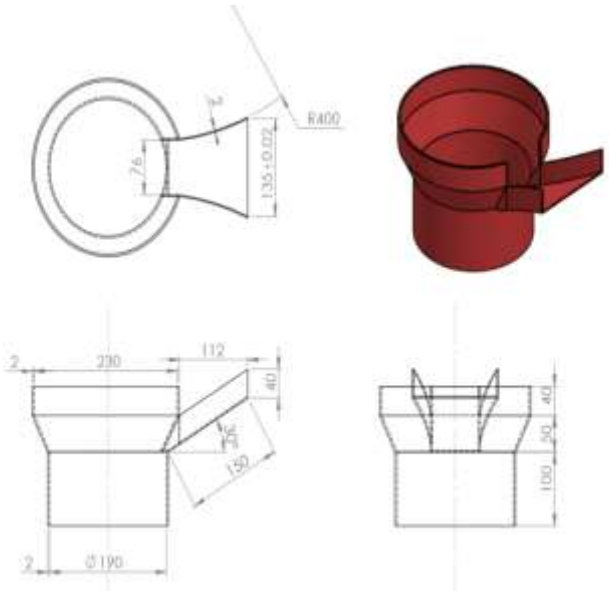

Fig 7: Detailed Drawing of Topping Feeder

Design Parameters for topping feeder mechanism

1. Equal chopping of every piece.
2. Proper rate of feeding.

A4. Cheese Crusher

Part	Function	Specification
Base Container	To store multiple (10) pizza base at a time	Contains 10+1 pizza base
Connecting arm	Supports and mount the motor	Mild Steel
Stepper Motor	Swivels the slider blade	NEMA 17 100 steps in 3 secs--1 (10 rpm)
Slider Blade	It ejects the pizza base to the pan	3D Printed, ABS

Table 5: Specifications of Cheese Crusher

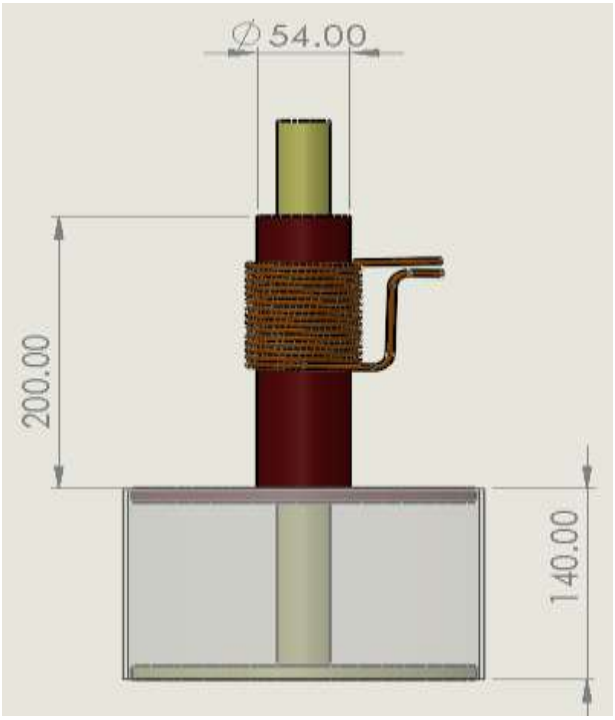

Fig 8: Cheese Crusher

Design parameters for cheese crusher mechanism:-

1. Force requires to crush the cheese.

It is found out by using cheese dimensions.
Assume cheese block dimensions as 100*100*50mm.
Volume of cheese block- $5*10^{\wedge(-4)}$ m^3.
Density Of cheese = 1100 Kg/ m^3.
Mass of cheese is calculated as = Density*Volume
$= 1100*(5*10^{-4})$
= 0.55 Kg
= 5.399 N.
According to newton's third law, applying this principle, we calculated the force required to overcome the reaction.

IV. PRODUCTION PROCESS

1. First of all, the pizza base is being fed to the conveyor using base feeder mechanism in 3 secs.
2. After this, the base is being taken to the next station in 46 secs.
3. The sauce is being fed on it in 5 secs.
4. Again, the same thing happens and base is being taken to next 'toppings feeding' station in 46 secs, and the toppings are fed over it in 8 secs.
5. Then the base is taken to the last station of cheese crusher, grated cheese is being fed over base in 8 secs.
6. And here it completes its targeted time of 3minutes.

V. TIME SPECULATION

Assumptions-

1. Distance between two stations- 460 mm
2. Conveyor belt velocity- 1 cm/sec

Station	Travel Time
Pizza Base Feeder	3 sec
Sauce Dispenser	5 sec
Topping Feeder	7-8 sec
Cheese Grater	7 sec

Table 6: time speculation

The Maximum time taken for a station is **7**sec. All stations work simultaneously, so the conveyor stops at each station for 8 sec irrespective of their process completion. The time to travel between 2 stations is **46** secs at the rate of 1cm/sec (46 cm travel distance).

Therefore the total time taken is given by travel time between all the station and the stoppage time for the process to take place. I.e. 7+7+7+7+46+46+46 =166 secs.

VI. CONCLUSION

The main objective of this work is to propose a machine to prepare pizza within a stimulated time lower than that of primitive manually prepared pizza i.e. 3 minutes, whereas the study concluded to finish the complete process in a stipulated time of 166 sec. It also reduces the human effort and human error, keeping the quality of the pizza same throughout.

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