

Palestine Polytechnic University

College of Engineering



Graduation project

**Design and Implement of a Prototyping
Automatic Sweet Forming Machine**

By

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Abstract

“Osh bulbul” is a type of sweets Originates from Syrian kitchen , and after that it prevail around the world specially between Arab countries.

Its main component is vermicelli , Which Taking the form of nest , and after that a different types of nuts are placed inside the roll then exposed to certain rate of temperature inside the oven to be mature .

This type of sweets have broad turnout these days because of its distinctive taste , despite it’s high cost..

Sweets factory in Palestine use the traditional method to produce this product and it have many disadvantages in terms of shape ,and it requires effort and a long time in production,

Due to that, We designed and implemented this machine that aims to increasing the productivity, sweet quality, weight accuracy , reducing the sweet cost with h good finishing.

الملخص

عش البلبل هو نوع من الحلويات نشأ في المطبخ السوري وبعد ذلك انتشر الى مناطق واسعه حول العالم وخاصة المناطق العربية.

مكونها الأساسي هو شعر العجين ، والتي تأخذ شكل العش ، وبعد ذلك يتم وضع أنواع مختلفة من المكسرات بداخلها . ووضعها داخل الفرن حتى تنضج على درجة حراره معينه .

هذا النوع من الحلويات يحظى بإقبال واسع هذه الأيام لما له من مذاق مميز ، رغم كلفته العالية .

مصانع الحلويات في فلسطين تتخذ الطريقة التقليدية وسيله لإنتاج هذا المنتج ,لهذه الطريقة الكثير من السلبيات فيما يتعلق بالشكل ,وايضا تتطلب الكثير من الجهد والوقت في عملية الانتاج.

نتيجة لذلك قمنا بتصميم وتنفيذ آلة اتوماتيكية التي تهدف الى زياده الإنتاجية والجودة ودقه الوزن مع تقليل التكلفة والحفاظ على شكل جيد..

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Chapter One

Introduction to Automatic Sweet Forming Machine

1.1 Introduction.

1.2 Project Idea.

1.3 Project Importance.

1.4 Objectives.

1.5 Time Schedule for the Introduction Project.

1.6 Project's Estimated Cost.

1.1.Introduction

Hebron's history extends to a very ancient time approximately 5500 years ago, where the first civilization worked to produce their own culture that still affects the inhabitants of the near east until nowadays, one of these extensions is sweets.

sweets are not only a liquid food with sugar, milk and fruit, but rather each piece tells the story of a people who invented it and was attributed to its history.

Figure 1.1 illustrates "Osh Bulbul" which is traditional type of sweets, the origins of this recipe go back to the Syrian cuisine, where it was widely known in Syria, and then it spread to all countries of the Arab world, its recipe is distinguished by its lightness, delicious taste in addition to its distinctive appearance, which is mainly prepared from vermicelli, and also it is a type of baklava that Syria was famous for preparing a lot.

Sweets shops in Palestine use the traditional method of producing "Osh Bulbul", which includes the use of human hands.



Figure 1.1: Shapes of "osh bulbul".

1.2. Project Idea

Design and implement a machine that produce a Palestinian sweet called "Osh Bulbul" by an automatic method, which will use PLC to control the electromechanical process.

1.3. Project Importance

1. Save the time needed to produce such sweets, since that each bead has to be rolled by hand and takes a lot of time (around 20 seconds for each one) compared to other sweets species.
2. Save effort and number of workers needed.
3. Ensure a healthier method of production.
4. Increase productivity and production of different types and varieties that difficult to make it by traditional methods.

1.3.1. Recognition of the Need

The research team made a questionnaire that took (9) purposeful samples of sweet Shops who have “Osh Bulbul”, to decide if there is an importance of the project, and if there is really a need for an automated “Osh Bulbul” machine.

The analysis of the questionnaire is attached in Appendix A. with the following main results: 40% of the interviewed shops have Produced more than 100 kg of “Osh Bulbul “daily as average of year, and as shown in Figure 1.2 This is a large percentage, so we decide to work with them, and solve their problem. There is a need for such automated machine as shown on figure (1.2)

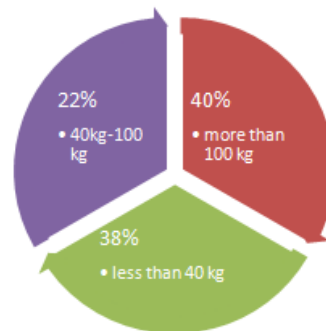


Figure 1.2: Annual production of “osh bulbul”.

Referring to figure (1.3), 90% Declares that they are ready to Purchase the “Osh Bulbul “machine, and the others declare yes but, if the cost is acceptable.

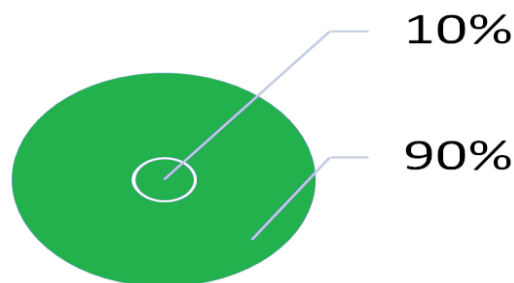


Figure1. 3: Desire to buy the machine.

1.3.2. Quality of Osh Bulbul

In Palestine and other Arab countries, there's need for machine that produces a high quality of “Osh Bulbul”, the proposed is expected to offer high quality of produces sweet rather than the conventional method. Furthermore, the produces sweet should be characterized with uniform shape, weight and cleanness.

1.4. Objectives

We need to convert the rolling part from the classical operation to mechanical operation working semi automatically on this part from manufacture process to make this process with lower costs, faster, easier, uniform and with higher productivity.

1.5. Time schedule for the Introduction Project

.Table1.1: First semester time plane.

TASKS	WEEKS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1		■	■	■	■												
T2					■	■											
T3						■	■	■									
T4								■	■	■	■	■					
T5												■	■	■	■		
T6															■	■	■

Where:

T1: Select the idea of the project.

T2: Research about the idea of the project.

T3: Introduction (Chapter1)

T4: Conceptual design (Chapter2)

T5: Mechanical design (Chapter3)

T6: Electrical design (Chapter4)

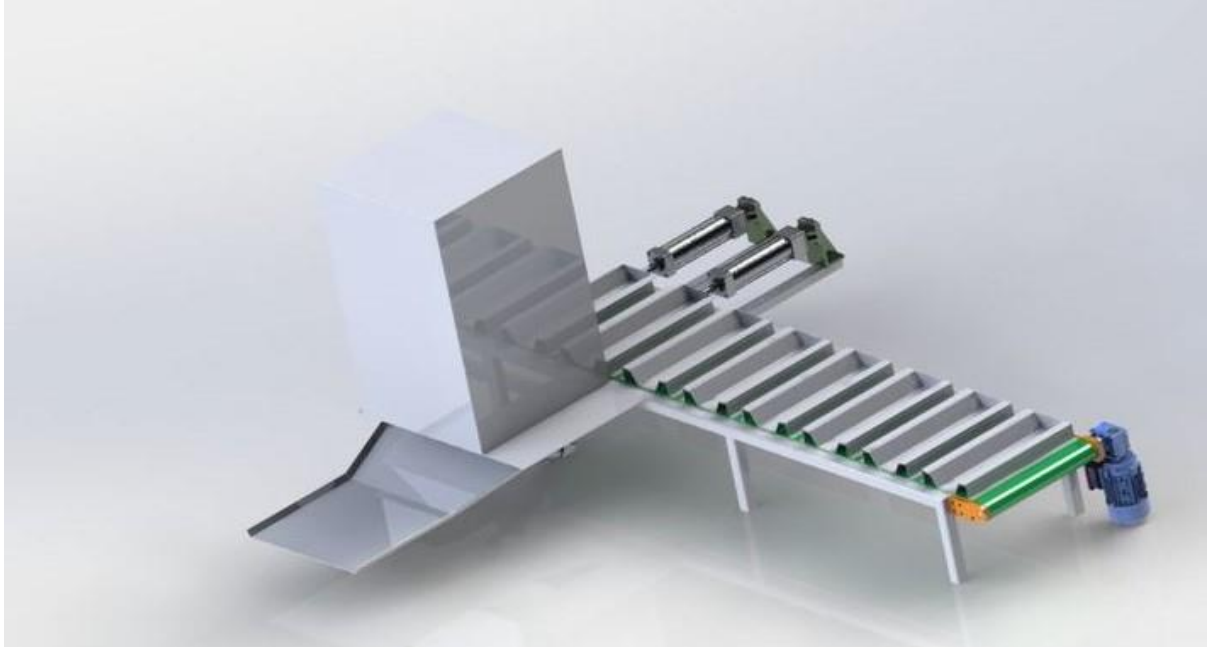
1.6.Project's Estimated Cost

Table1.2 1: Total cost of the project.

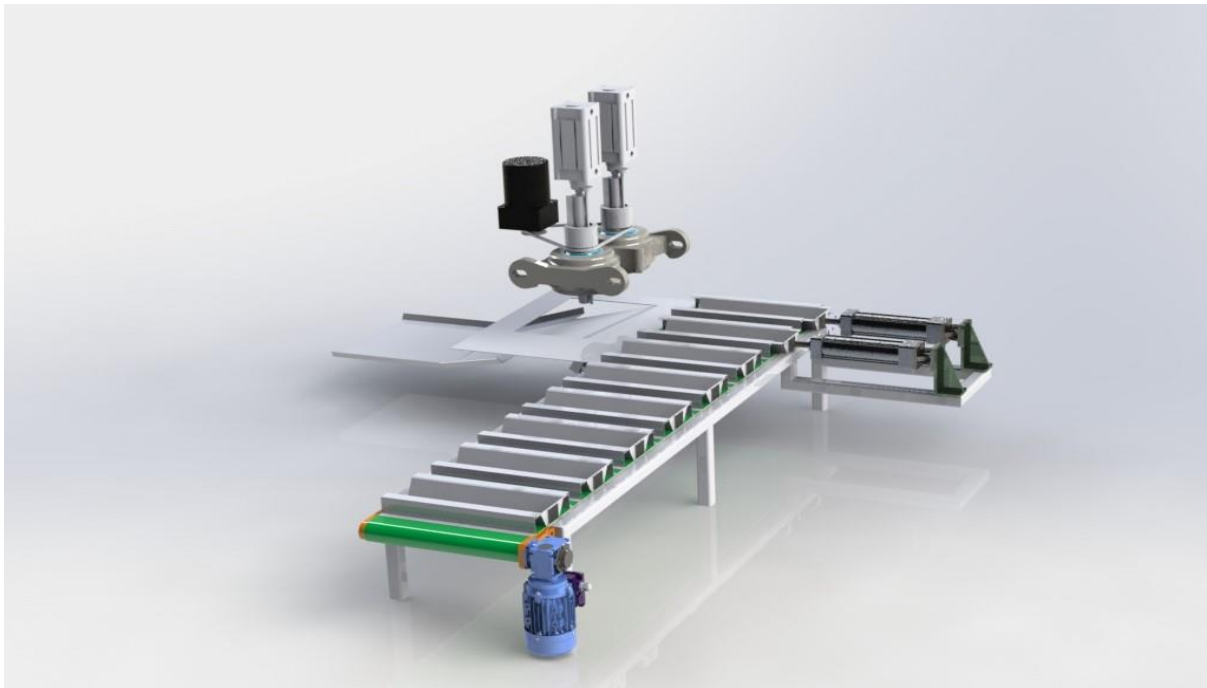
Tools & devices	No.	Piece Price (NIS)	Price (NIS)
Air piston	5	200	1000
Steel	20 meters	30	600
Three phase motor	1	600	600
Stepper motor	1	1000	400
PLC	1	700	700
Limit Switches	4	20	80
Gears	1	400	400
Proximity switch	1	110	110
sensor switch	4	90	360
Light Sensor	1	100	100
Conveyor belt	1	1500	1500
Switches	3	50	150
Other	3000
Total			7000

The Final View of the Design

Figure (1.4) illustrates the overall view of the proposed machine that has been designed by Solid works program:



a-Side view .



b- Front view .

Figure1. 4: Machine overall view.

Chapter Two

Conceptual Design

2.1 Production Process Flow Chart.

2.2 Description of the Product.

2.3 The Main Mechanical Parts of the Machine.

2.4 The Machine Description.

This chapter will present the conceptual design for the main parts of this machine and the relations between them.

2.1.Production Process Chart

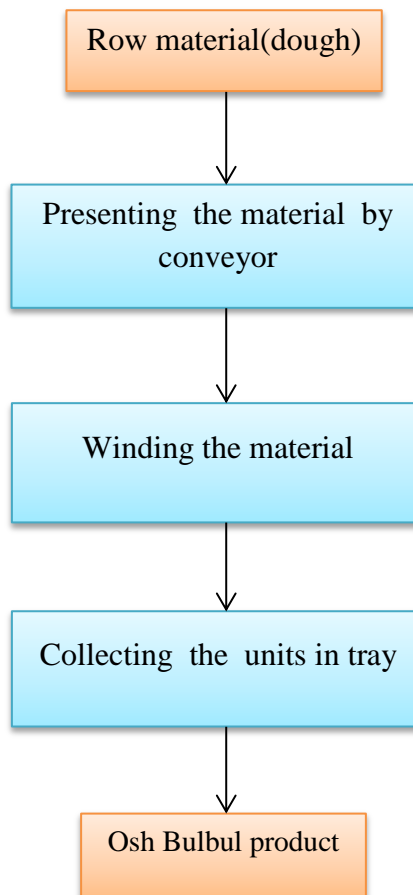


Figure 2.1: Production process chart.

2.2.Description of the Product .

Taking into a count on figure (2.2) the following data is presented for the conventional shape of " Osh Bulbul" :

- 1) Nest dimensions:
 - Internal diameter = 35 mm.
 - External diameter = 45 mm.
 - Height = 35 mm.
- 2) Each nest has a bottom, and each bottom must be knit with its nest. frame to be containable for padding.
- 3) The dough comes continuously with a width around 25 mm.

- 4) The process should be completed Within a 40 minutes Along the same lines.
Traditional method takes around 4 hours for each 220 nests.
- 5) Uniform dimensions for all nests



Figure 2.2: Nest dimensions.

2.3.The Main Mechanical Parts of the Machine

- 1) **The conveyer:** Transmitting the raw material from the starting point to the loading point.
- 2) **Tray:** This is where the raw material (vermicelli) is stored.
- 3) **Rotor:** Rotate the dough pieces to winding it like a nest.
- 4) **The second tray:** This is where the nests (final product) which is finished is collected.

2.3.1 Conveyor

Figure 2.3. illustrates the conveyor belt which has been purchased to achieve the desired goals of the project within the following specifications:

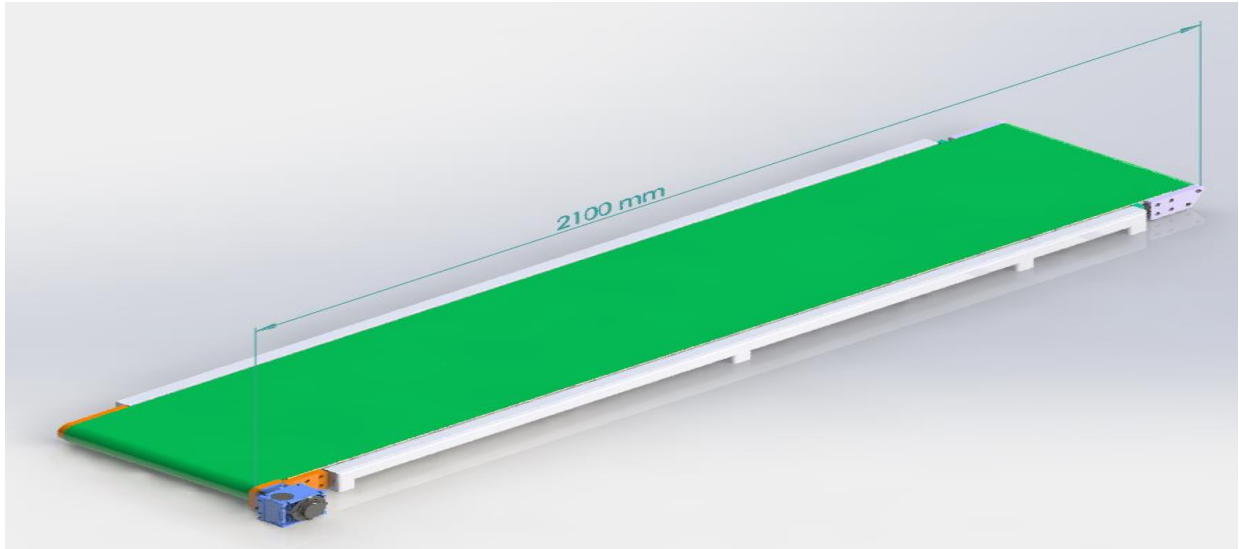


Figure 2.3: Front view of the conveyor.

2.3.2 Tray

The tray design consists of two main parts as presented in the figure 2.4 and 2.5 below:

- 1) Stain steel pot.
- 2) Trestle: Forms a path for the stain steel pot and carry it.

Figure 2.4 presents the final view of the tray in the conveyor .

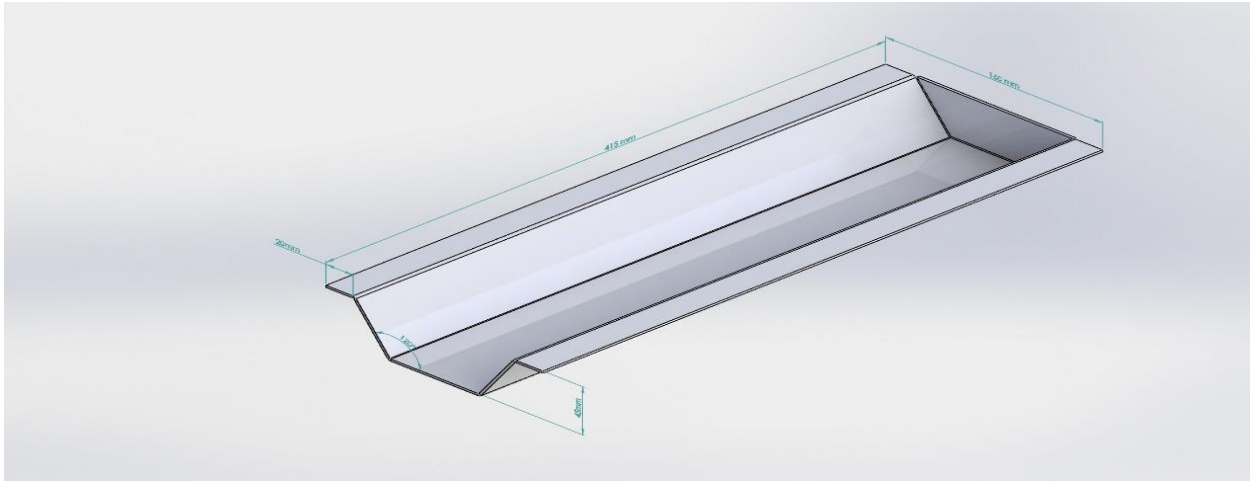


Figure 2.4: Stain Steel Pot With the Dimensions .



Figure 2.5: Final view of the tray at the conveyer .

2.3.4 The Second Tray

The second tray consist of two parts the first one is fixed and the second is connected to the piston which works as the table of the rotator as presented in the figure2.10.1and2.11

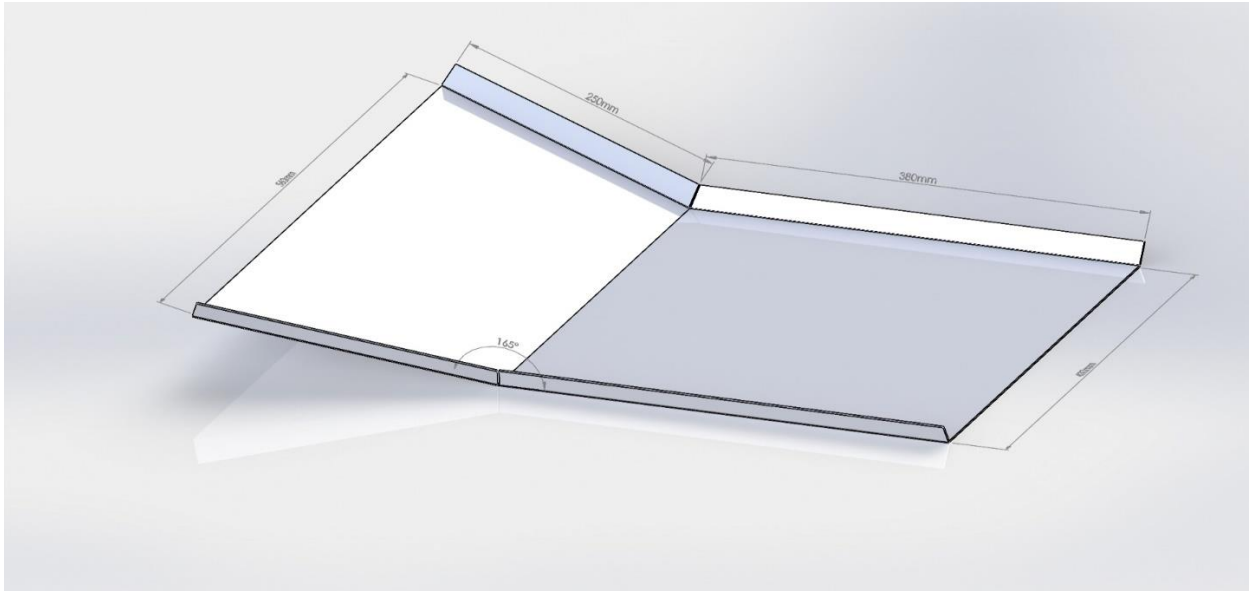


Figure 2.6: The fixed part of the second tray .

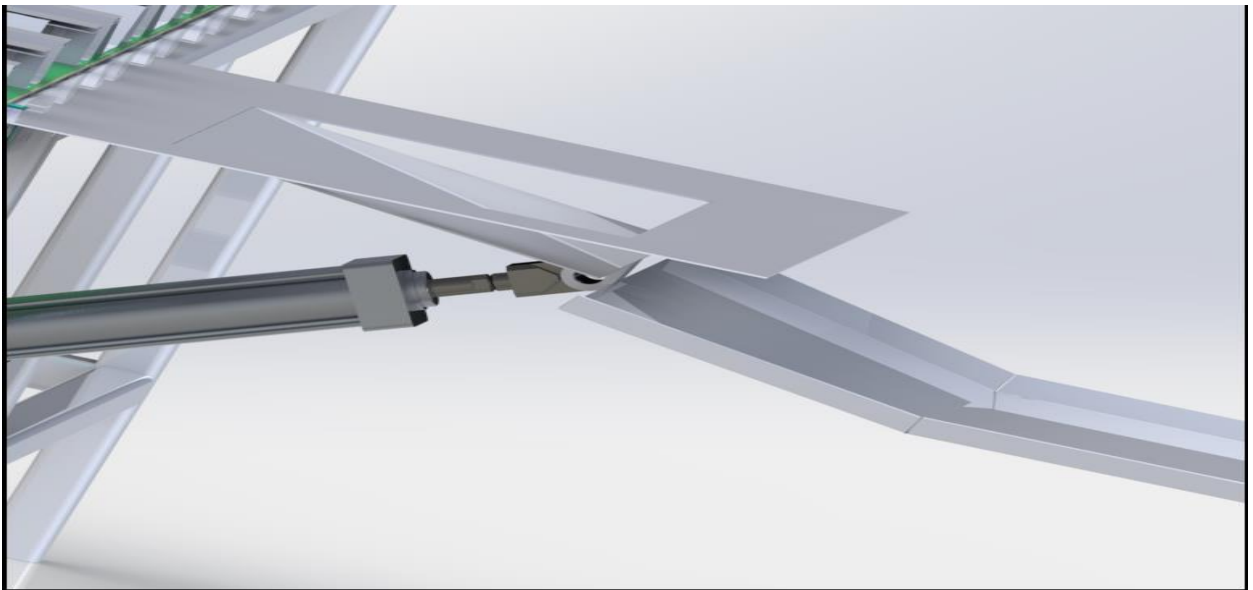


Figure 2.7: Movable part of the second tray.

2.4. Principle of Machine Operation

The machine is an automatically rotator for the bird nest dough .it contains mainly from two driving motors for the conveyer and the rotator, Air pistons for the magnet and rotator pin, and one for the second tray.

When the first motor started, the conveyer will move the dough towards the rotator, and pulls up more dough from the machine operator; when the dough margin reach to the required position ,the conveyer will stop and the magnet will be energized then the air piston will push the pot to the rotator position , then the holder will hold the dough till the pot get to the initial position, then the rotator will rotate the dough to make the nest , then the piston will retract to return the holder and the rotator to the initial location, then another piston will move the nest to the second pot and repeat the process.

2.4.1 Conceptual Operation Design

The operation of the machine is running through the control panel. The machine will run under auto or manual operation depending on the selection switch:

a) Automatic Operation

- 1) The machine operator must press on the zero-position switch on the control panel, the machine will set All the mechanical elements to the initial position.
- 2) Sensors will give information about the mechanical elements position.
- 3) If the zero-position process is done, green light will be on otherwise the controller (PLC) will send a warning message to the machine operator by alarm with flasher light.
- 4) The machine operator can run the machine by pressing on the start push button after filling the tray.
- 5) Dough will move from the first tray to the part responsible for the dough rotating process passing by the limit switch which is responsible of stopping the conveyer by sending signal to the plc.

- 6) After breaking the conveyor at the right position double acting cylinders will be activated (the magnet holder) as shown in the figure 2.8, after passing the tray to the rotating area and the dough being holed by the rotator.

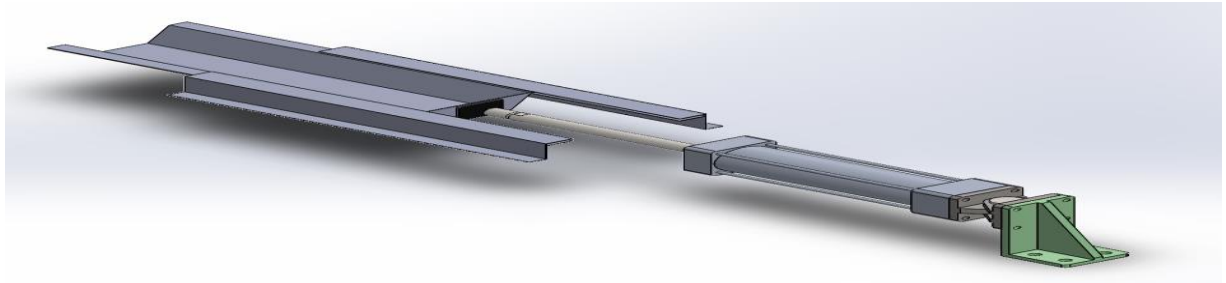


Figure 5: Magnet holder.

- 7) The magnet holder will retract to the initial position and the magnet will de energized.
- 8) Rotating will start, by activating the cylinder (rotating holder) and motor responsible for rotation as shown in the figure 2.9 while the conveyor brings more material.

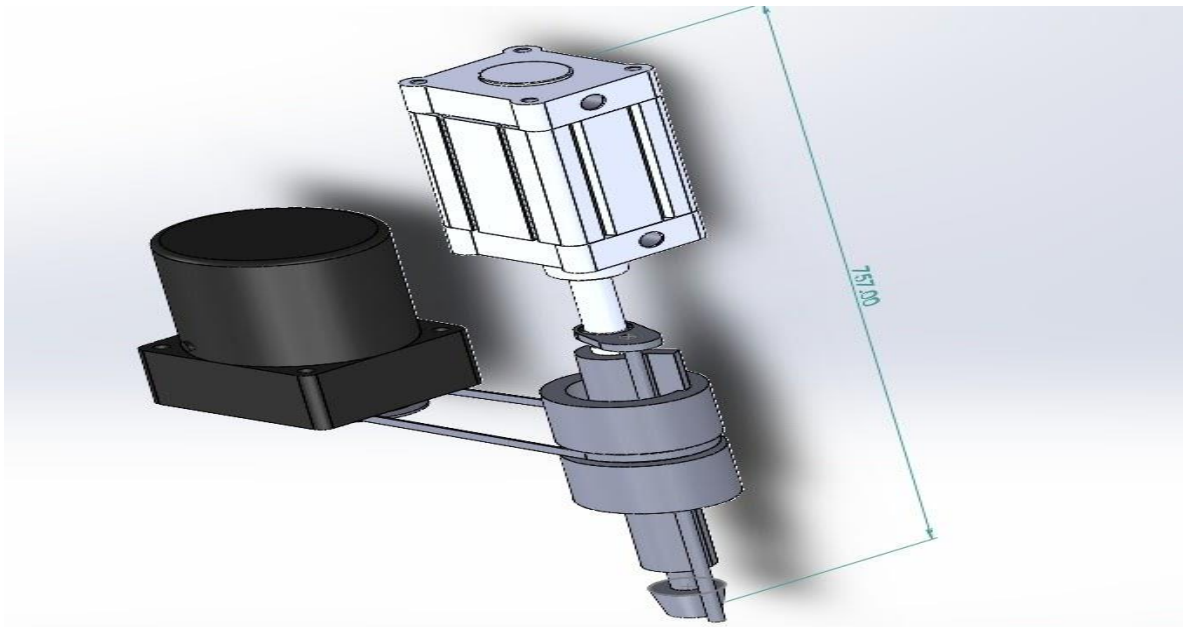


Figure 2.9:Rotating holder.

- After rotating complete, the nest (ready dough) will move by the collector to the second tray.
 - The machine is stopped if the stopped switch is pressed from control panel or if an unrequired position of a mechanical element has occurred.
- b) Manual operation: In this mode, each component is separately controlled via the touch screen.

Chapter Three

Mechanical Design

3.1 Calculation of Conveyor Belt.

3.2 Pneumatic System.

3.3 Rotator system.

3.4 Bearings .

3.1.Conveyor

Figure3.1. illustrates the conveyor belt which has been purchased to achieve the desired goals of the project within the following specifications:

- Total length of the conveyor:2100mm.
- Width of the conveyor:420mm.
- Length of the belt:3800mm.
- Thickness of the conveyor belt:3mm.
- Roller Diameter:100mm which is presented on figure3.2.
- Length between Pulleys centers:1900mm .

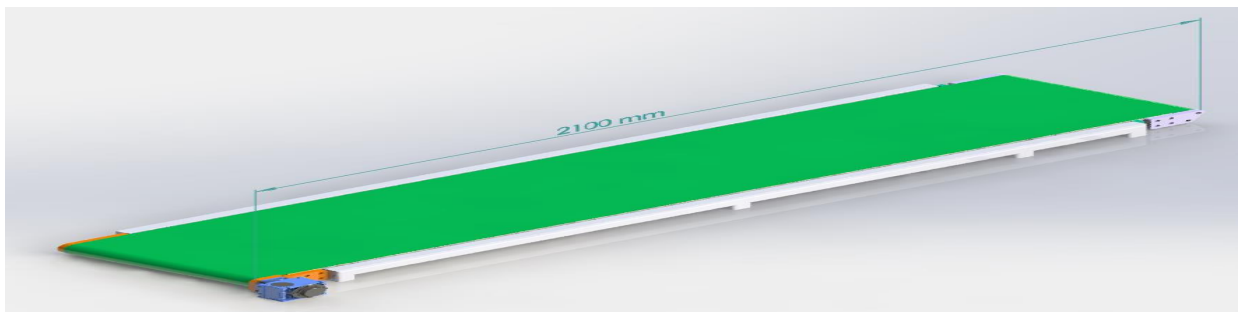


Figure 3.1: Final view of the conveyor.

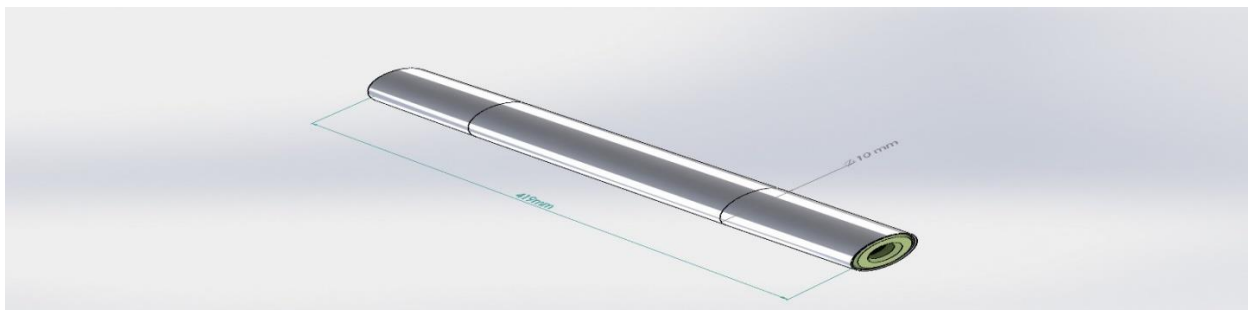


Figure 6: Final view of the roller.

3.1.2 Stain steel parts

$$\text{Density} = \frac{\text{mass}}{\text{volum}} \quad (3.1)$$

$$\text{Density of stain steel} = \frac{7.81g}{\text{cm}^3} = 0.00781 \text{ kg/cm}^3.$$

Standard dimension of stain steel sheet:

Length:125cm.

Width:100cm

depth:0.1 cm.

Standard dimension of stain steel tray :

Length:40cm.

Width:20cm

depth:0.1 cm.

$$\text{Volume of stain steel} = L * W * D. \quad (3.2)$$

Mass of stain steel = $125 * 100 * 0.1 * 0.00781 = 9.7 \text{ kg}$

Holders of raw materials: **16holder piece needed.**

Number of stain steel sheets needed = **1sheet .**

Stain steel tray as shown in fig 3.3.

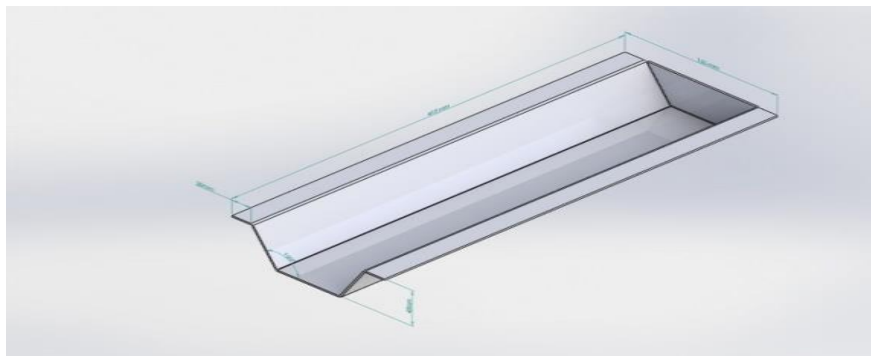


Figure 3.3: Stain steel tray.

3.1.3. Rubber:

The rubber is made from **Nylon.**

Nylon density:

$$\frac{1.15g}{cm^3} = \frac{1.15}{1000} * 10^6 = 1150kg/m^3.$$

Belt weight : (Length*width*thickness) *density =4.2*0.42*0.0015*1150=**3.04kg**.

Belt as shown in fig 3.4.

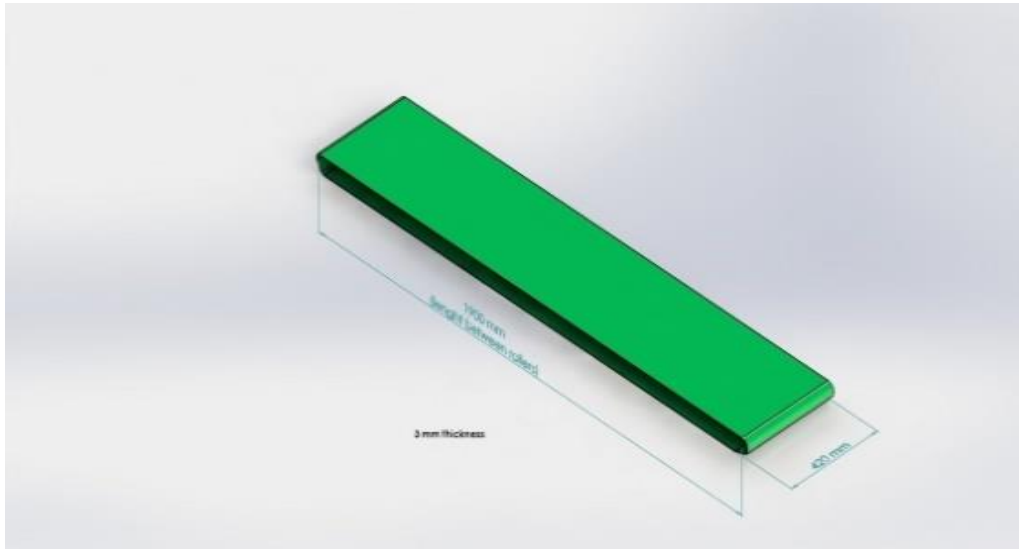


Figure 1: Belt.

3.1.4 pipes:

Mass of pipe = $2\pi rhtd=2*3.14*0.5*0.43*0.03*8=3.2kg *2=$ **6.4kg**

Total mass= $\Sigma(6.4, 9.7, 3.04)=$ **19.04kg**.

Pipe as shown in fig 3.5.

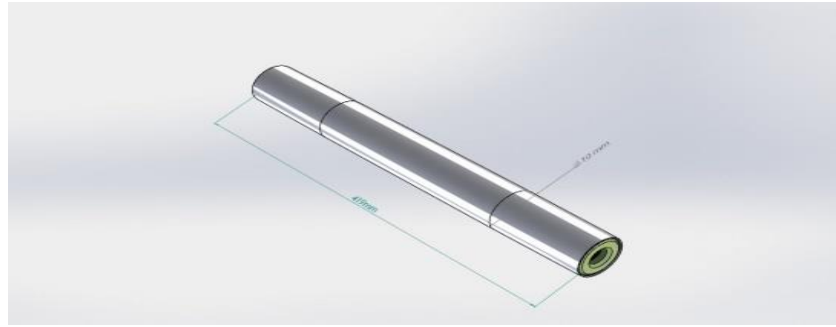


Figure 3.5: Pipe .

3.2. Pneumatic system

Pneumatic cylinders are mechanical devices which use the power of compressed air to produce a force in a reciprocating linear motion. The piston is a disc or cylinder, and its rod transfers the force it develops to the object to be moved[5].

The pneumatic system in the machine contains the following parts:

- 1) Magnet: cylinder 1&2 will carry the magnets to push the pot and bring it back to the initial position as shown in the figure 3.6.
- 2) The rotation system: cylinder 3&4 will be attached with the holder and rotator as presented in the figure 3.7.
- 3) The second tray: the cylinder will be attached with the door of the tray to slip the products to the second pot as shown in the(figure 3.8).

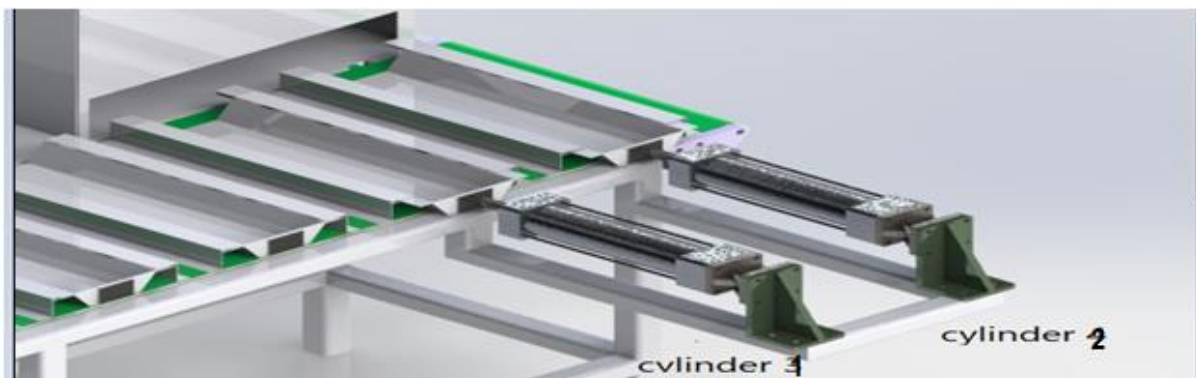


Figure 3.6: Cylinder 1&2.

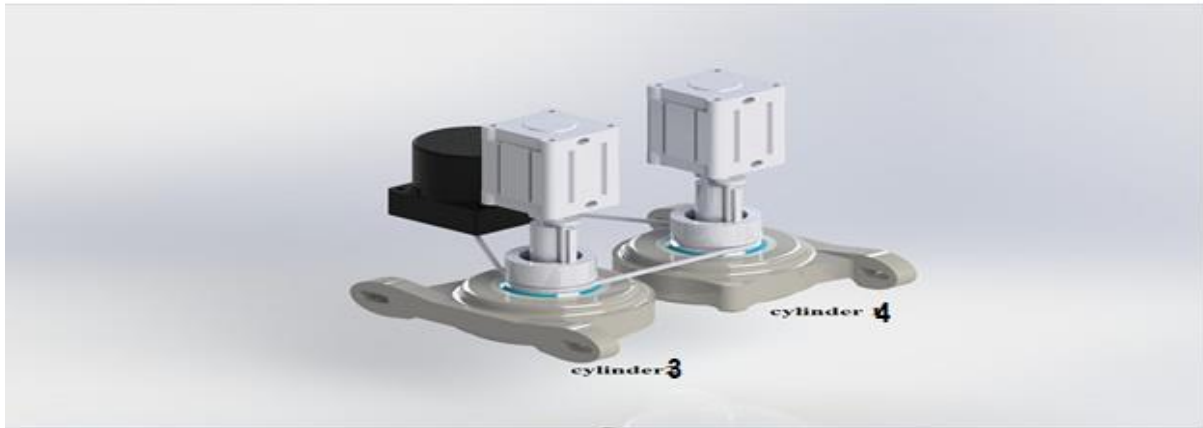


Figure 3.7: Cylinder 3&4.

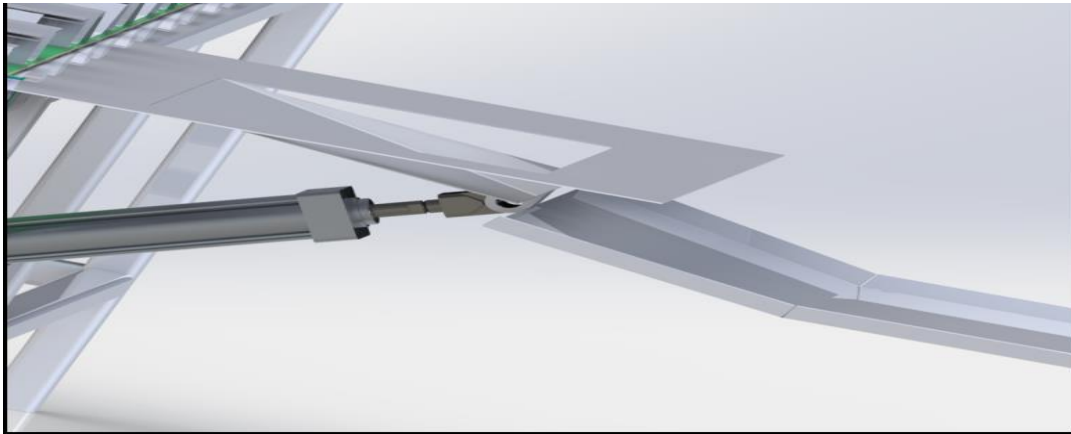


Figure 3.8:Cylinder 5.

➤ **Cylinder one &two parameter:**

- Double acting cylinder .
- Stroke is equal 200mm.
- Piston diameter 12 mm. **(For more details refer to appendix A- Festo data)**
- Pressure is equal 8bar .

According the parameter the Air Cylinder DSNU-12-200-P-A is selected .

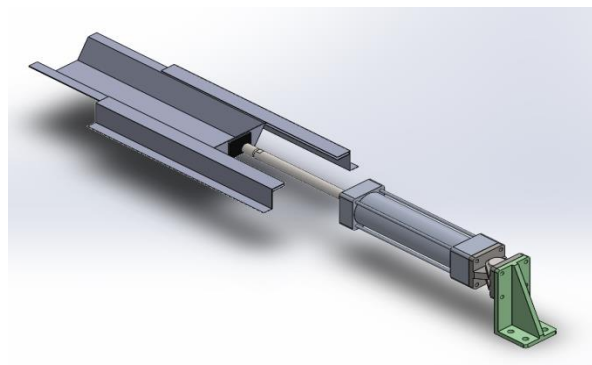


Figure3.9: Cylinder 1.

➤ **Piston three &four parameter:**

- Double acting cylinder .
- Stroke is equal 160mm.
- Piston diameter 12 mm. (**Appendix A**)
- Pressure is equal 8bar .

According the parameter the Air Cylinder DSNU-12-160-P-A is selected .

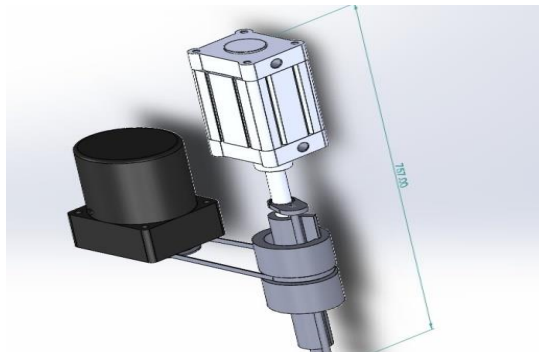


Figure 3.10: Cylinder 3.

➤ **Piston five parameter :**

- Double acting cylinder .
- Stroke is equal 125mm.
- Piston diameter 12 mm. (**Appendix A**)
- Pressure is equal 8bar .

According the parameter the Air Cylinder DSNU-12-125-P-A is selected .

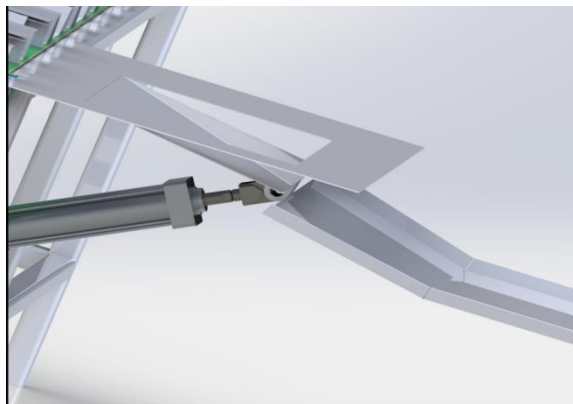


Figure 3.11: Cylinder 5.

3.3 Rotator

Mechanical parts responsible for this section:

- cylinder three and four .
- (A1)holder .
- (A2) guide.
- (A3) rotator.
- Bearing .

And this part as shown in (figure3.12).

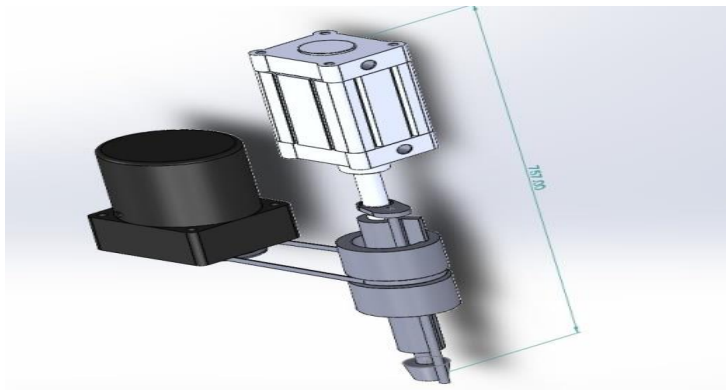
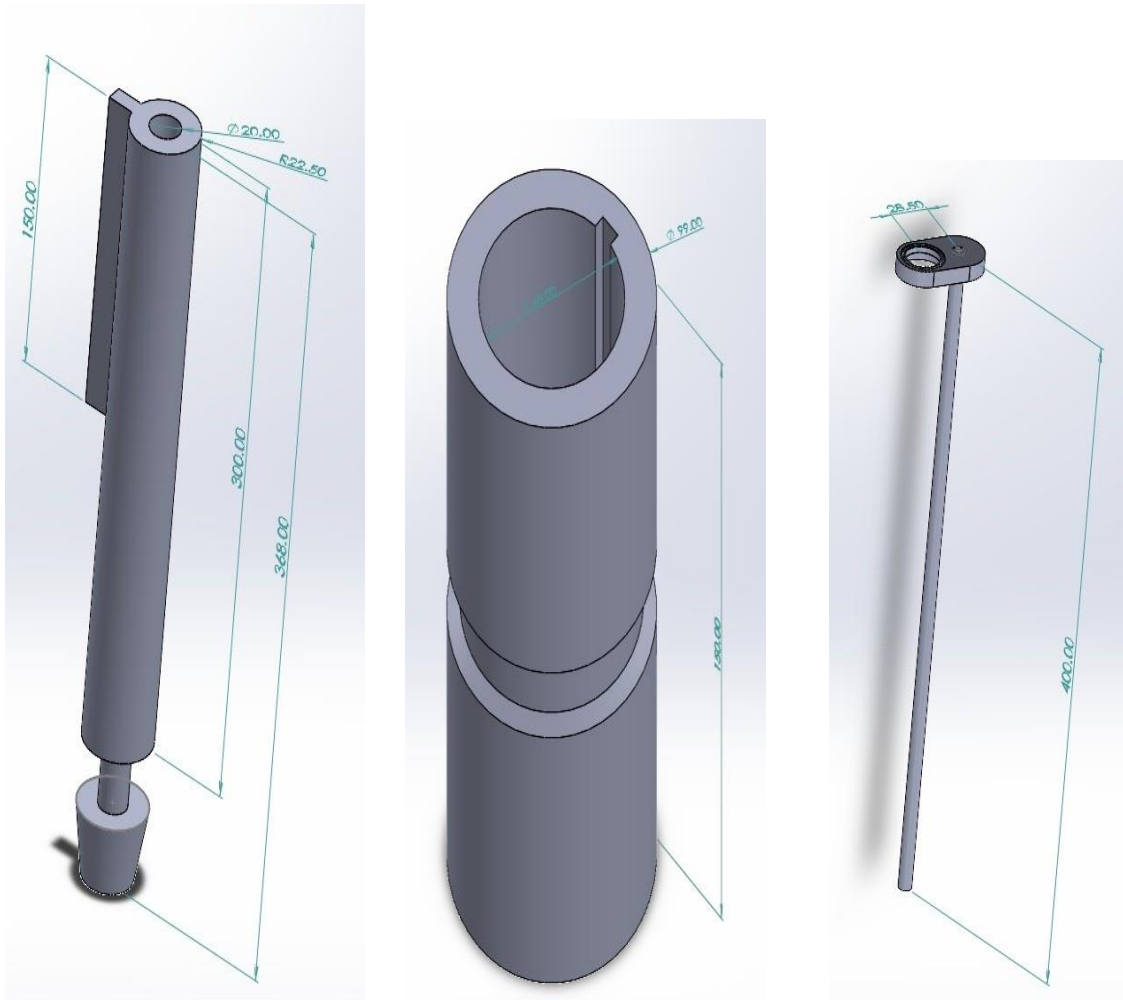


Figure 3.12: Rotator mechanical parts .

And There is (3) drafts for this part from the process.



(A1) Holder

(A2) guide

(A3)Rotator

Figure 3.12: Rotator mechanical parts .

This design mainly 3 different parts, A1 represents the holder which is responsible for keeping the dough in the position and will work side by side with the (A3) rotator to rotate the dough to form it, A2 will work as guide for A1,A3 and link with the motor[1] .

3.4 Bearings

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing provide free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction and the bearing in this part(as shown in fig 3.13)

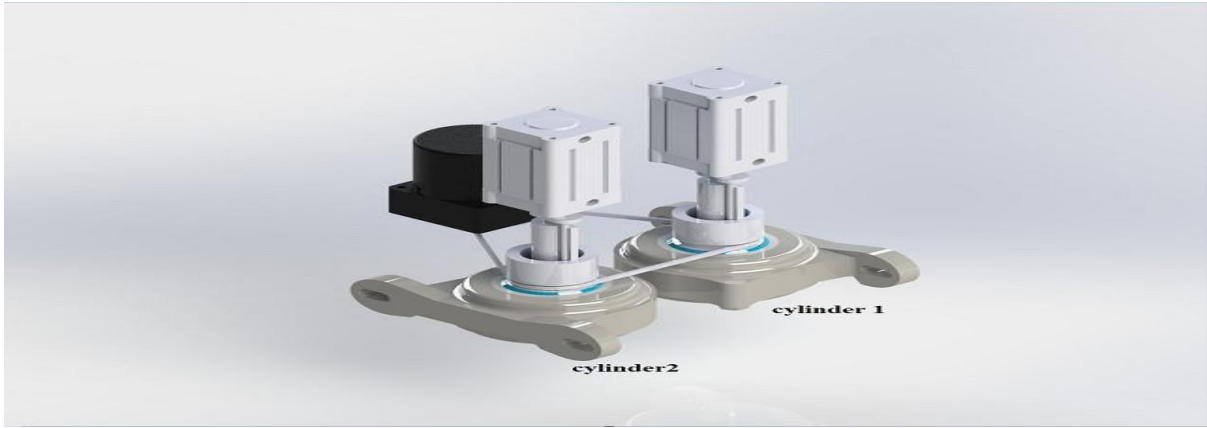


Fig 3.13:Bearing overview.

And the type of bearing as we need as shown in (fig3.14)



Figure3.14: Bearing view .

Bearings internal diameter = 79 mm.

Table (3.1) illustrates the mechanical elements quantity of whole of project .

Table3.1: Mechanical elements quantity.

Items	Items title	Quantity	Specification
1.	Stain steel	1 sheet	---
2.	Steel	20 meters	---
3.	Pipe	2	D=10cm ,L=42 cm
4.	Belt .	1	W=42cm ,L=210cm
5.	Cylinder	5	DSNU-12-200-P-A
6.	Tray	16	Stain steel
7.	Trestle	32	Stain steel
8.	Holder	1	---
9.	Guide	1	---
10.	Rotator	1	---
11.	Bearing	2	Internal diameter =79mm

Chapter Four

Electrical Design

4.1 Motors' selection.

4.2 Sensors .

4.3 Pneumatic system.

4.4 Control Circuit.

Electrical block diagram with function

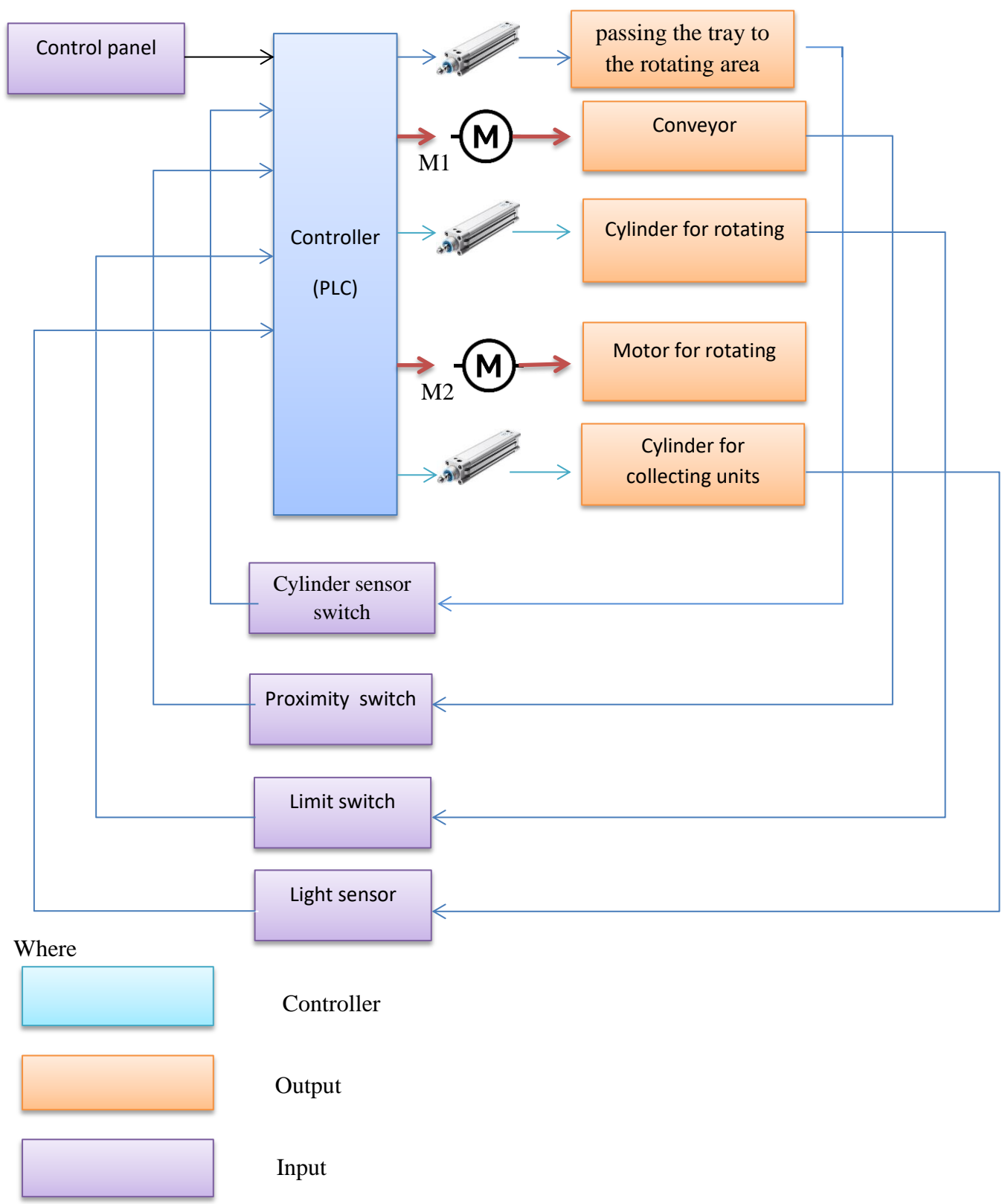


Figure 4.1: Electrical block diagram with function.

4.1 Motors' selection .

The machine requires two motors the first motor is for the conveyor belt, and the second one is for the rotator and the holder which they will be connected through the guide part in order to rotate with each other to shape the final product .

4.1.1 conveyor motor.

The conveyor motor must run and stop depending on the required position which will be connected to mechanical break in order to break the motor in the required position.

Types of motor (as shown in figure 4.2)

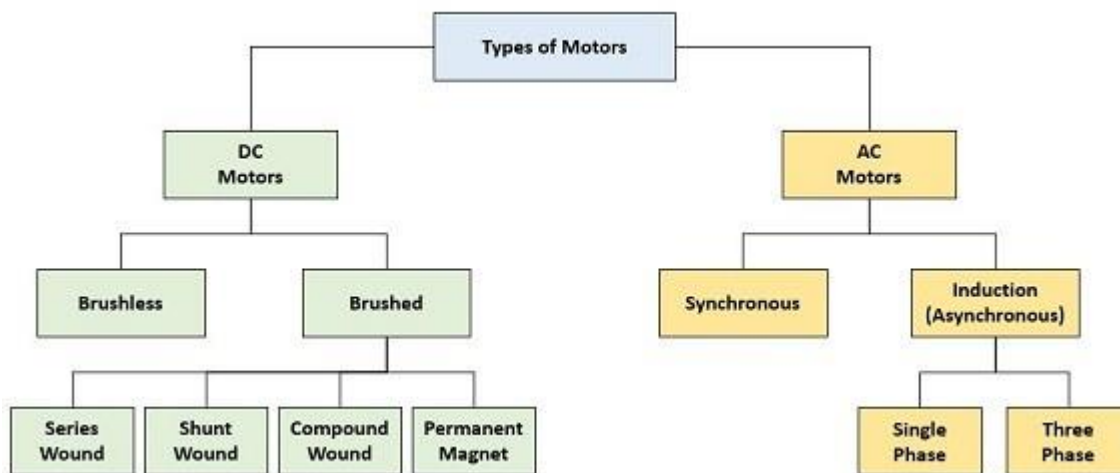




Figure 4.2:Types of motor .

- **But the motor selection :ac motor , asynchronous , three phase .**

1) Three phase motor type :

- Squirrel cage motor .
- Slip ring motor .

Table 2.1: Advantage Between squirrel cage motor& slip ring motor.

The motor	View	advantage	Dis advantage
Squirrel cage motor		Less maintenance required less expensive high power factor and efficiency.	Low starting torque High starting current
Slip ring motor		High starting torque. Low starting current	Frequent maintenance required Low power factor and efficiency. High expensive.

- **The selections motor :** Squirrel cage motor, because :
- Efficiency is high.
- The cost is cheap .
- Less maintenance required

Motor calculations :

The following calculation it explain how to calculate the conveyor speed and the load torque:

To calculate the conveyor speed :

Time needed for each parts :

To product 220 units we need 40 minutes so every units :

$$\text{One unit} = \frac{40 \text{ mint}}{220 \text{ units}} = \frac{0.18 \text{ mint}}{\text{unit}} = \frac{11 \text{ sec}}{\text{unit}} \quad (4.1)$$

But the distance traveling it almost 4 sec ,and the distance it can calculated by:

The length of conveyor 210cm but $\frac{210 \text{ cm}}{4 \text{ sec}}=52.5 \text{ cm/ sec}$.

Converting to mint :

$$\frac{52cm}{sec} * \frac{60 sec}{1 mint} = 3150 cm/ min.$$

$$= 31.5m/min$$

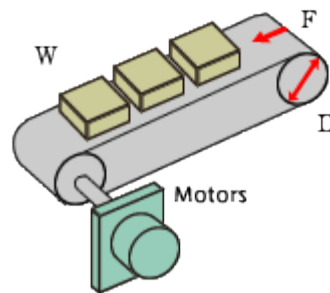
$$= \frac{3150 cm}{mint} * \frac{1 rev}{2\pi r}, \text{ but } r=5cm.$$

$$= 100rpm .$$

The speed of conveyer =100rpm.

To calculate the motor torque:

$$T = \frac{1}{2} 0.1(F + \mu Mg) \quad (4.2)$$



.Figure4.3: Conveyer analysis.

T:Torque (N.m).

D:Roller diameter .

W:Mass of load (kg).

g:Gravity acceleration (m/s²)

μ:Fraction coefficient .

F:External force.

But in this project :

$$D=100\text{mm}= 10\text{cm}=0.1\text{m}$$

$$W=30\text{kg} .$$

$$g=9.81 \text{ m/s}^2.$$

$$\mu=0.5.$$

$$F=0 \text{ N}.$$

So the torque is equal :

$$T = \frac{1}{2} \cdot 0.1(0+0.5 \cdot 30 \cdot 9.81)$$

$$T=7.5\text{N.m}.$$

Therefore, the conveyor speed = 100 rpm.

$$P = \tau \cdot \omega \quad (4.3)$$

$$\omega = \frac{2\pi n}{60}$$

$$\omega=10.46 \text{ rad/sec}.$$

$$p=5 \cdot 10.46$$

$$=80 \text{ watt} .$$

**But the moto sizing r that used in the project 200 watt.

4.1.2 Gear box

The gearbox performs the task of increasing or reducing the rotational speed by connecting the motion from the electric motor to the axle to the gears[2].

To selecting gear box ratio :

$$\frac{\text{speed in}}{\text{speed out}} = \frac{Gr}{1} \quad (4.4)$$

Speed in =1400 rpm .&speed out =100rpm.

$$\frac{1400\text{rpm}}{100\text{rpm}} = \frac{Gr}{1}$$

$$Gr =14.$$

Therefore , the gearbox ratio : (1:14).

Figure below illustrate the motor with gear box .



Figure 4.4: Motor with gear box .

The motor selection:

Ac motor ,induction , Three phase , Squirrel cage motor.

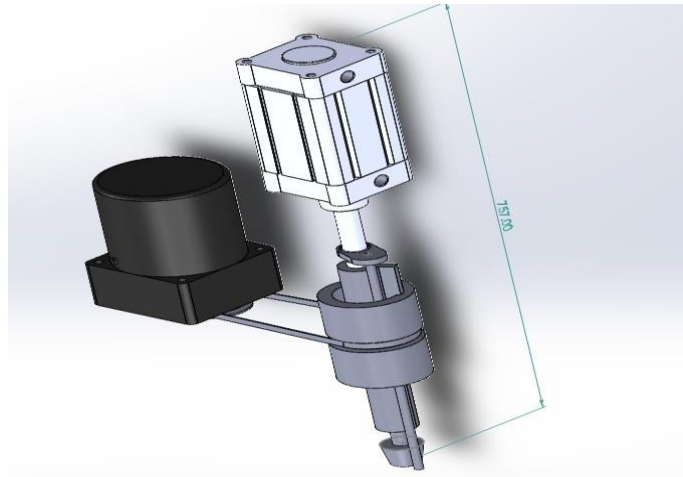
Table4.2: Motor parameter.

Phase	Three phase
Frequency	50HZ
Voltage	220\380v λ\ Δ
Current	$I_{\lambda} = 2.2 \text{ A} \setminus I_{\Delta} = 0.9 \text{ A}$
RPM	1400
Horse power	0.487 hp
Power factor	0.86
Efficiency	0.82
IP	54
Duty	S3

Rotating Head.

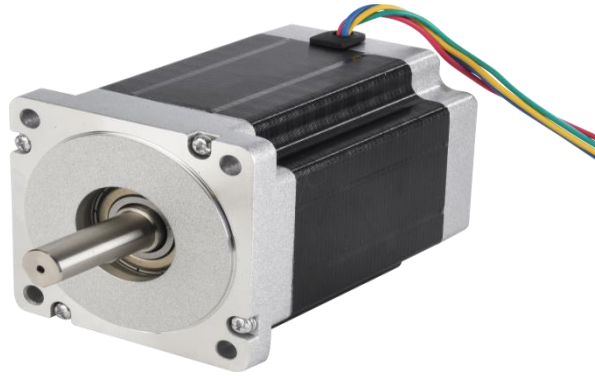
A **stepper motor** is a brushless, synchronous electric motor that converts digital pulses into mechanical shaft rotation .Its normal shaft motion consists of discrete angular movements of essentially uniform magnitude when driven from sequentially switched DC power supply and is a digital input-output device[3].

Some industrial and scientific applications of stepper motors include robotics, machine tools, pick and place machines, automated wire cutting and wire bonding machines, and even precise fluid control devices and the(figure4.5below as shown the rotator motor).



. **Figure4.5:** Stepper motor as part of machine.

Stepper motors are used every day in both industrial and commercial applications because of their low cost, high reliability, high torque at low speeds and a simple, rugged construction that operates in almost any environment .So that , the rotator motor in this machine is a stepper motor (stepper motor as shown in Figure 4.6).



7 . **Figure4.6:** Stepper motor

Advantages

- The rotation angle of the motor is proportional to the input pulses.
- The motor has full torque at standstill (if the windings are energized).
- Excellent response to starting, stopping and reversing.
- Extremely reliable since there are no contact brushes in the motor, therefore the life of the motor is mainly dependent on the life of the bearings.
- The motors response to digital input pulses provides open-loop control, making the system simpler and therefore more cost efficient.
- It is possible to achieve very low speed synchronous rotation with a load that is directly coupled to the shaft.

Disadvantages

- Resonances can occur if not properly controlled.
- The motor is not easy to operate at extremely high speeds, 3000+ rpm.

Stepper Motor Types:

There are three basic stepper motor types. They are:

1. Variable-reluctance stepper motor.
2. Permanent-magnet stepper motor.
3. Hybrid stepper motor.

Table4.3: Different Between three type stepper motor.

Type	Variable-reluctance stepper motor	Permanent-magnet stepper motor	Hybrid stepper motor
Cost	Low	Low	Expensive
Resolution	Low	Middle	High

➤ **The Hybrid stepper is selected motor because :**

- Provides better performance with respect to step resolution, torque and speed.
 - The hybrid stepper motor combines the best features of both the PM and VR type stepper motors.
 - Very high torque/size ratio
 - Long operational life due to absence of brushes
 - Open loop operation (no need for feedback device in positioning applications).
- **Generally speaking, the hybrid stepper motor may be the better choice along with reducing cost, as it offers better performance with respect to step resolution, torque and speed.**

Selection sizing motor

Technical Specifications

Table 4.4: Stepper motors specifications.

	Shaft	Rated Voltage	Current /Phase	Inductance /Phase	Holding Torque
		Volts	Amps	mH	Nm
M60STH88-3008DF	Double	5.46	2.1	12.8	3

M60STH100-4004S	Single	2.8	4.0	3	4
------------------------	---------------	------------	------------	----------	----------

According to table 4.4 ,a single acting stepper motor type **M60STH100-4004S**, NEMA 23 High Torque Stepper Motors(**Hybrid Stepper Motor**).

4.2 Sensors

4.2.1 limit switch.

Limit switch is a switch operated by the motion of a machine part or presence of an object. They are used for controlling pneumatic cylinder as part of a control system, as a safety interlocks, or to count objects passing a point. A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection. (as shown in fig4.7)



.Figure4.7: Limit switch.

4.2.2. Proximity sensor.

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors .It used for controlling the start stop conveyor and an proximity sensor(as shown in fig4.8).



Figure4.8: Proximity sensor.

4.2.3. Cylinder Sensor Switch.

Reed sensor also called magnetic switch, reed sensor is applicable for position determination of pneumatic and/or hydraulic cylinder and piston pump. They are used for controlling pneumatic cylinder stroke as part of a control system. Cylinder Sensor Switch (as shown in figure 4.9).



Figure4.9: Cylinder Sensor Switch (cs1-G).

4.3 Pneumatic Cylinder

Double acting cylinder.

In a double acting cylinder, air pressure is applied alternately to the relative surface of the piston,

producing a propelling force and retracing force. As the effective area of the piston is small, the

thrust produced during retraction is relatively weak. The impeccable tubes of double acting

cylinders are usually made of steel. The working surfaces are also polished and coated with chromium to reduce friction.

In this project we use one double acting cylinder as shown in figure 4.10.



Figure4.10: The double acting cylinder.

Operation and needed

The cylinders as working at 24 V DC and In this project we used four cylinders, first and second cylinder passing the pot to the rotating area. The third and fourth cylinder are rotator holder . And we are used four limit switch to limit the motion of the cylinders, and we are controlling of them by electrical control valve.

3.4.2 control valve

(5/2 directional control valve):

When a pressure pulse is input into the pressure control port ‘P’ , the spool will move to the left, connecting inlet ‘P’ and work passage ‘B’. work passage ‘A’ will then make a release of air through ‘R1’ and ‘R2’. The directional valves will remain in this operational unit signals of the contrary are received. Therefore, this type of directional control valves is said to have the function of ‘memory’. As shown in figure 4.11

- A. Cross section.
- B. 5/2 directional control valve.
- C. Pneumatic symbol.

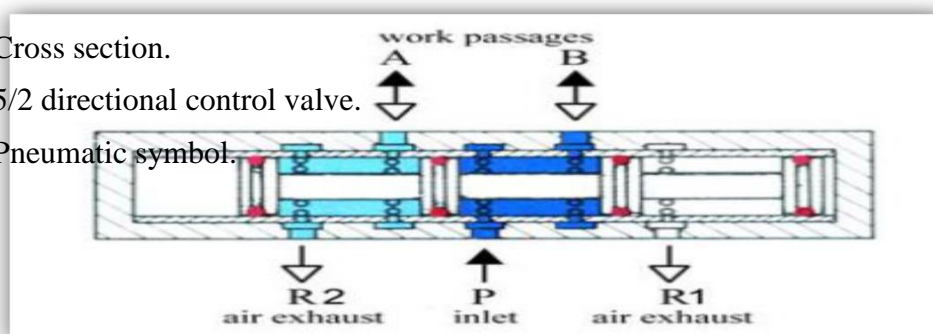




Figure4.12: Plc delta.

2)Relay

A Relay, as shown in figure 4.13, is an electromechanical device that can be used to make or break an electrical connection. It consists of a flexible moving mechanical part which can be controlled electronically through an electromagnet, basically, a relay is just like a mechanical switch but you can control it with an electronic signal instead of manually turning it on or off. Again, this working principle of relay fits only for the electromechanical relay.



Figure4.13 : Relay.

3) Switches

The Emergency switch are used to stop the machine immediately when something wrong happened with the machine as shown in the figure 4.14.a. The start pushbutton switch are used to turn on the project as shown in the figure 4.14.b .The stop pushbutton switch used to turn off the project as shown in the figure 4.14.c .



a-Emergency switch



b- Start pushbutton switch



c- Stop pushbutton switch

Figure 4.14: Switches.

- **When emergency switch is pressed, the system will directly stop running. Everything and needs to be reset to start the operation again.**

4)Contactors

A contactor is an electrically-controlled switch used for switching an electrical power circuit. A contactor is typically controlled by a circuit which has a much lower power level than the switched circuit, such as a 24-volt coil electromagnet controlling a 230-volt motor switch. The contactor view(as shown in fig4.15).



Figure 4.15: Contactor .

For contactor selection:

The full load current :

$$I_{Fl} = \frac{Px1000}{1.73.v.pf} \quad (4.5)$$

$$I_{Fl} = \frac{0.35x1000}{1.73.380.0.85} = 1.5A .$$

- **Type of Contactor= AC3.**
- **The contactor current rating =1.5A.**

5) Motor Overload

Overload relays are intended to protect motors against excessive heating due to prolonged motor over currents up to and including locked motor currents. Protection of the motor due to short circuits or grounds is a function of circuit breakers, or motor short-circuit protectors.

As shown in figure 4.16.



Figure4.16: Over load.

For over load selection:

The full load current :

$$I_{Fl} = \frac{Px1000}{1.73.v.pf} \quad (4.5)$$

$$I_{Fl} = \frac{0.35x1000}{1.73.380.0.85} = 1.5A.$$

- **The over load current rating = 1.5 * 1.25 A.**

$$= 1.9A.$$

6)Control Panel Circuit.

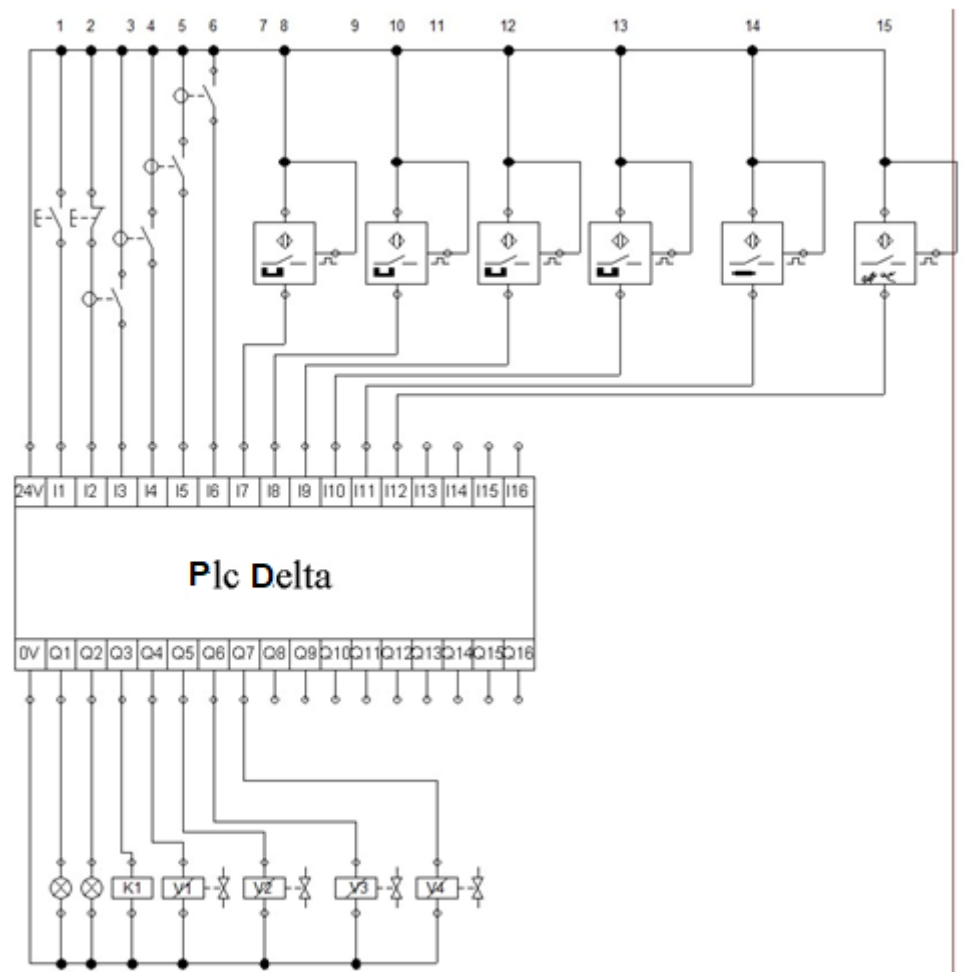


Figure 4.17: Electrical control panel .

Table (4.5) illustrates the electrical elements quantity of whole of project .

Table4.5: Electrical elements quantity.

Items	Items title	Quantity	Specification
1.	Three phase motor	1	Squirrel cage motor
2.	Stepper motor	1	M60STH100-4004S, NEMA 23
3.	Cylinder Sensor Switch	10	cs1-G
4.	Plc.	1	Plc Delta
6.	Limit switch	1	---
7.	Proximity sensor	1	---
8.	Switches	3	---
9.	Contactator	1	AC3
10.	Relay	3	---

Chapter Five

Experimental Result & Recommendations

5.1 Introduction.

5.2 Experimental Result.

5.3 Recommendations.

5.4 Future Work.

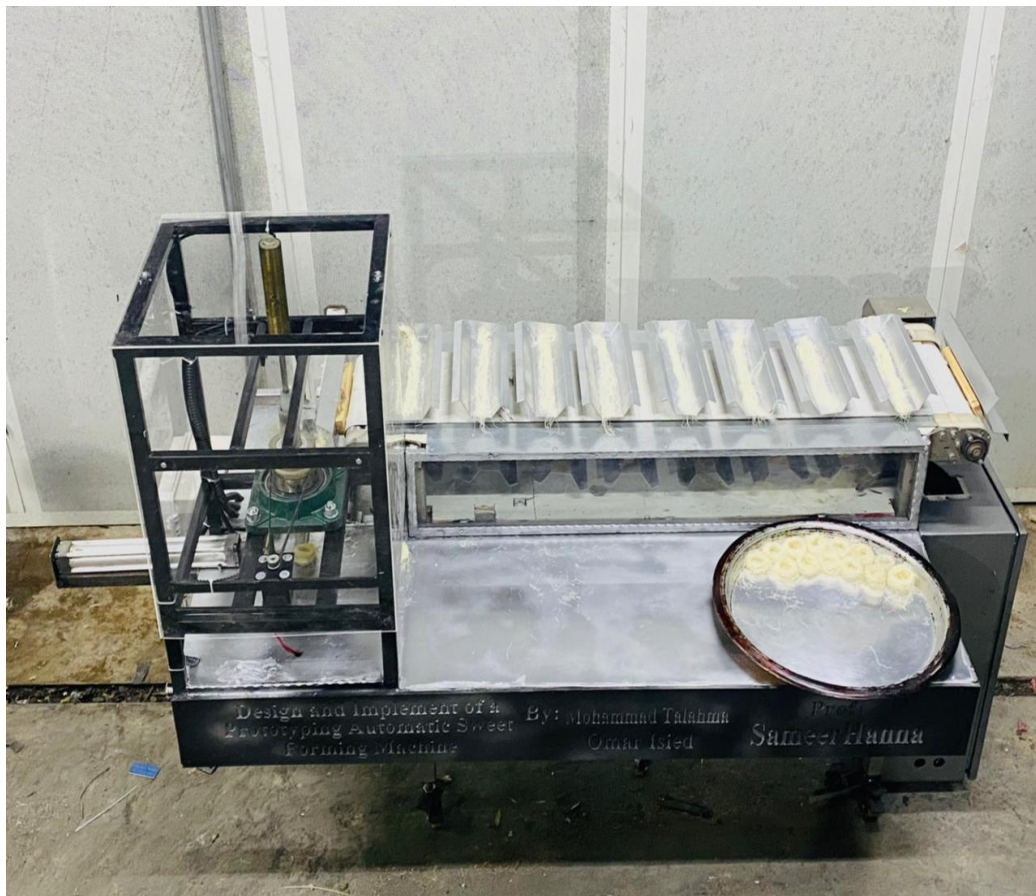
5.1 Introduction

This chapter provides experimental result and, some recommendations from the work team for this project. In this chapter we are listing some goals hope to be accomplished or_ at least_ under attention .

5.2 Experimental Result

The Final View of the implemented project .

Figure (5.1) illustrates the overall view of the machine that has been implemented.



a- Front view .



b- side view .



c-Side view .

Figure5. 1: Machine overall view.

We made some experiments on parts of our project and these are some of results:

First Stage: The user place the dough in trays , and the figure below (5.2) illustrates this operation .



Figure5. 2: Dough in trays .

Second Stage: The tray turns over the dough into the other trays . and the figure(5.2) below illustrates this operation.



Figure5. 3: Dough turns over.

Third Stage: The tray transfer the dough into the rotator head ,consequently the mould (القالب) form the dough to get the final shape.

Figure (5.4) illustrates this operation .



Figure5. 4: Rotates dough.



Figure5. 1: Rotates dough..

The output of this project .

1. A machine is able to produce the”osh bulbul” automatically and smoothly.
2. Gives a consistent shape and the same size.
3. Save time and effort .
4. Produce s quickly and excellent the shape quality.

Figure (5.4) illustrates the operation production .



Figure5. 1: Machine overall view.

5.3 Recommendations

1. Such projects should be handled among different departments according to the project nature (we had lots of electrical and mechanical problems that might solve without having enough previous knowledge).
2. Once the university administration financially supported graduation projects, this support must be provided at the beginning of the project work, to enable students to do their projects according to the time plan, and to test them at the proper time.
3. The university should make it easier for students to borrow pieces from previous projects, because we faced many difficulties in this matter, of course, with the student’s pledge to return the pieces intact.

5.4 Future Work

The following tasks are suggested as future works:

1. To double the productivity, a second mold can be placed to perform the winding process, but what prevented us from that is the high cost.
2. The shape of the mold can be changed, thus obtaining other and various shapes, thus adding a quality to the local market.

References

[1] J.E.Shigley ,Mechanical Engineering Design , McGraw-Hill Book, Michigan university ,1989.

[2] G.K.Duby, Electric Drives,Narosa Publishing House,1995.

[3] A. J. Bianculi, "Stepper motors: application and selection," , vol. 7, no. 12, pp. 25-29, Dec. 1970, doi: 10.1109/MSPEC.1970.5213082.

[4] J.P.Bentley,Principles Of Measurement Systems, University Of Teeside,2005.

[5] Data sheet of festo devise :https://www.festo.com/cat/en-il_il/products_DSNU_1.

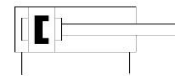
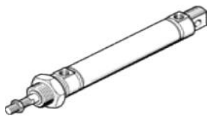
Appendix A

Data sheet of some devices :

The cylinders selection datasheet.

ISO cylinder
DSNU-12-200-P-A
 Part number: 19197
 ★ Core product range

FESTO



Data sheet

Feature	Value
Stroke	200 mm
Piston diameter	12 mm
Piston rod thread	M6
Cushioning	P: Flexible cushioning rings/plates at both ends
Assembly position	Any
Conforms to standard	CETOP RP 52 P ISO 6432
Piston-rod end	Male thread
Design structure	Piston Piston rod Cylinder barrel
Position detection	For proximity sensor
Variants	Single-ended piston rod
Operating pressure	1.5 ... 10 bar
Mode of operation	double-acting
Operating medium	Compressed air in accordance with ISO8573-1:2010 [7:4:4]
Note on operating and pilot medium	Lubricated operation possible (subsequently required for further operation)
Corrosion resistance classification CRC	2 - Moderate corrosion stress
Ambient temperature	-20 ... 80 °C
Maritime classification	see certificate
Impact energy in end positions	0.07 J
Theoretical force at 6 bar, return stroke	50.9 N
Theoretical force at 6 bar, advance stroke	67.9 N
Moving mass with 0 mm stroke	18.5 g
Additional weight per 10 mm stroke	4 g
Basic weight for 0 mm stroke	75 g
Additional mass factor per 10 mm of stroke	2 g
Mounting type	with accessories
Pneumatic connection	M5
Materials note	Conforms to RoHS
Material cover	Wrought Aluminium alloy neutral anodisation
Material seals	NBR TPE-U(PU)
Material piston rod	High alloy steel, non-corrosive
Material cylinder barrel	High alloy steel, non-corrosive

Stepper motor data sheet :

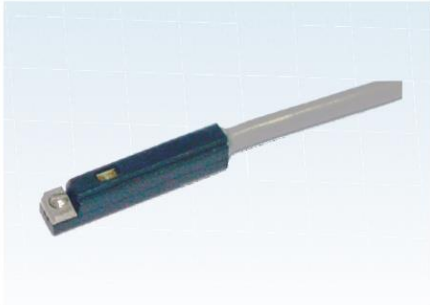
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<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:15%;">PHASE</td> <td style="width:15%;">2</td> <td style="width:15%;">PHASE</td> <td style="width:15%;">COMMENT</td> </tr> <tr> <td>STEP ANGLE</td> <td>1.8±5%/STEP</td> <td></td> <td></td> </tr> <tr> <td>VOLTAGE</td> <td>V 2.8</td> <td></td> <td></td> </tr> <tr> <td>CURRENT</td> <td>4.0 A/PHASE</td> <td></td> <td></td> </tr> <tr> <td>RESISTANCE</td> <td>0.7 ±10% Ω/PHASE</td> <td></td> <td></td> </tr> <tr> <td>INDUCTANCE</td> <td>3.0 ±20% mH/PHASE</td> <td></td> <td></td> </tr> <tr> <td>HOLDING TORQUE</td> <td>400 Ncm</td> <td></td> <td></td> </tr> <tr> <td>DETENT TORQUE</td> <td>Ncm</td> <td></td> <td></td> </tr> <tr> <td>INSULATION CLASS</td> <td>B</td> <td></td> <td></td> </tr> <tr> <td>LEAD STYLE</td> <td>FF46-1/0.5</td> <td></td> <td></td> </tr> </table>				PHASE	2	PHASE	COMMENT	STEP ANGLE	1.8±5%/STEP			VOLTAGE	V 2.8			CURRENT	4.0 A/PHASE			RESISTANCE	0.7 ±10% Ω/PHASE			INDUCTANCE	3.0 ±20% mH/PHASE			HOLDING TORQUE	400 Ncm			DETENT TORQUE	Ncm			INSULATION CLASS	B			LEAD STYLE	FF46-1/0.5						
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Sensor switch data sheet :

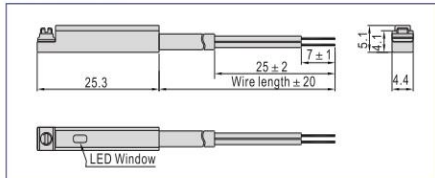
Sensor switch



CS1-G Series



Dimensions



Specification

Item/Type	CS1-G	CS1-GX
Switch logic	STSP Normally opened type	
Switch type	Reed switch with contact	
Operating voltage(V)	5-240V AC/DC	
Max. Switching current(mA)	100	
Switching rating(W)	Max. 10	
Current consumption	No	
Voltage drop	2.5V Max. @100mA DC	
Cable	Φ 2.8,2C Gray oil resistant PVC (Flame retarded)	
Indicator	Red LED	No
Leakage current	No	
Sensitivity(Gauss)	60-75	
Max. Frequency(Hz)	200	
Shock(m/s ²)	300	
Vibration(m/s ²)	90	
Temperature range(°C) ①	-10-70	
Enclosure classification	IP67(NEMA6)	
Protection circuit	No	

① Note: Please contact us for high temperature resistant(125°C),low temperature resistant(-40--25°C) and explosion-proof sensor switch.

Ordering code

CS1 G X 020

- Number of sensor switch**
CS1: Sensor switch
- Specification of sensor switch**

Specification	Product Series
G: G type	MD, MK, TR, TC, ACQ, STW TWH, TWM, TWQ, SDA20-100 QCK, HFZ10-40, HFY10-32 HFP10-32
- Connecting way** ①
 - C08: M8 quick joint, length of wire is 150mm
 - C12: M12 quick joint, length of wire is 150mm
 - 020: length of wire is 2m
 - 030: length of wire is 3m
 - 050: length of wire is 5m
 - 100: length of wire is 10m
- Model of sensor switch**
 - Blank: two-line magnetic spring pipe with contact/normally opened
 - X: two-line magnetic spring pipe with contact, without indicator light/normally opened

① Note: The quick joint that is attached at the end of wire is three-needle-male joint-linear-rotary screw thread type. The female joint plug has to be ordered additionally. Please refer to P420 for the specific data.

Mounting

Installation example	Installation method
	<p>No additional accessories are necessary for the sensor switch of CS1-G, CS1-GX series. It can be directly fixed onto the groove of the cylinder, which is convenient and fast.</p> <p>1. Loosen the clamping screw on sensor switch, lead the sensor switch to the additional slot and adjust it to the proper position. Tighten the clamping screw to fix.</p>



Sensor switch

